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Fostering Innovation in Collaboration between Higher Education and Industry

A Systemic Model Based on Case Study

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Abstract

This research focuses on collaboration between higher education and industry in connection to innovation and entrepreneurship creation. Competitiveness of firms, regions and nations depends on their innovativeness. Higher education fosters innovation and entrepreneurship by producing knowledge that sums to the existing knowledge of industry. There is a gap in research in combining entrepreneurial university research to the other mainstream theories. This research fills the gap by linking it to innovation management theory. It focuses on practical collaboration models between higher education and industry and creates a systemic model based on innovation management theories.

In this research the regional context is Satakunta region in Finland. It has a rich, diverse industrial base and has experienced a structural change and has been able to sustain its competitiveness. Satakunta University of Applied Sciences is used as a higher education case study and case firms are from automation, ICT and knowledge intensive business service sectors. The research is a constructive qualitative research where models are created and tested. Experimentation gives insights to the developed models and their application.

According to the research the systemic innovation management approach should be used in fostering innovation between higher education and industry. In this approach strategy, partnerships, dynamic networks, knowledge creation and combination, and created knowledge intensive firms, are important. The co-creation of innovations requires new completing combinations of knowledge. Knowledge intensive business firms started by students have an important role in interaction as innovators and in the transfer of knowledge. Actions based on a strategy create a sustainable basis for fostering innovation. Collaboration can develop into partnerships between actors. Teachers and students are a central resource. Considering students as equal actors means that students can grow into partnership with higher education. The research has implications both for theory and practice. The created models can be utilised in management of interaction and creation of innovations and entrepreneurship in collaboration between higher education and firms.

KEYWORDS: Higher education, industry, interaction, innovation, entrepreneurship.

Preface

This thesis was carried out at the Tampere University of Technology, Pori during years 2002-2010. For me doing research and writing papers for this thesis was an inspiring journey which sums my twenty years of work on the interesting fields of research, development, entrepreneurship, and innovation.

I want to thank Tampere University of Technology for providing support and infrastructure for my studies. I am grateful to my supervisor Professor Hannu Jaakkola for scientific and practical advice and Adjacent Professor Jari Palomäki for his expertise in research and motivating discussions. I also thank Satakunta University of Applied Sciences (Satakunnan ammattikorkeakoulu, SAMK) for providing support and infrastructure for my research. I am grateful to my second supervisor Adjacent Professor Matti Lähdeniemi for his contribution and comments to my research and all the stimulating interaction and collaboration during the study. I also thank President Seppo Pynnä for the arrangements during my research that made it possible to have a two year track as a research director, which was the acceleration for my research.

I am grateful to my colleagues Martti Honkasalo and Hannu Piiroinen for collaboration which gave me insights into the collaborative R&D projects, innovation and entrepreneurship. I thank the co-authors of papers and editors of publications for their positive impact to my research process. I also thank all my colleagues in higher education and interaction with industry field in Finland and other countries for discussions during my research. I thank engineers and entrepreneurs Kalle Vuorio from KMJ-Engineering Oy and Jaakko Suutarla from BF Engineering Oy. Their enterprises and entrepreneurial thinking have been an inspiration for my research. I thank Mrs. Johanna Palmgren for helping me to say in English what I mean to say. I greatly acknowledge the European Union for funding the projects where this thesis has partly being carried out. I also want to warmly thank Satakunta High Technology Foundation and Ulla Tuominen Foundation for funding my research.

I am grateful to my parents Aino and Veikko who a long time ago said that studying is always worth of efforts. My biggest gratitude goes to my wife Elisa and our children Anton, Venla, and Vilma who are my dearest supporters.

“Every organization – not just business – needs one core competence: innovation.”
-Peter Drucker

Siikainen November 23rd 2010
Kari Laine

Contents

Papers of the Thesis

The thesis consists of the introduction and seven published papers.

[I] Laine, K. 2004. “Regional Development and Proactive Interaction – A Finnish Application”, *Industry and Higher Education*, 18, 5, 321-327.

[II] Laine K and Lähdeniemi, M. 2007. ”Effective Model for Higher Education and Industry Interaction”. In: Gibson, D., Heitor, M. and Ibarra-Yunez, A. (eds.) *Connecting people, ideas and resources across communities*. Purdue University Press. Chapter 12, 229-238.

[III] Laine, K. 2009 “The Role of Knowledge Intensive Business Service Firms in University Knowledge Commercialisation”. In: Oakey, R., Cook, G., Groen, A., and Van Der Sijde (eds.) *New Technology- Based Firms in the New Millennium*. Bingley, UK. Emerald Group Publishing. Volume 7, Chapter 5, 63-74.

[IV] Laine, K., Kainu, A.-P., and Lähdeniemi, M. 2007. “Mentoring Knowledge Intensive Entrepreneurs in Higher Education”. *Proceedings of International Council of Small Business World Conference 2007*, 13th- 15th June, Turku, Finland.

[V] Laine, K. 2008. “Managing Innovation for Growth in High Technology Small Firms”. *Proceedings of the High Technology Small Firms Conference*, 22nd - 23rd May, University of Twente, The Netherlands.

[VI] Laine, K. 2008. “A Finnish Concept for Academic Entrepreneurship: The Case of Satakunta University of Applied Sciences”. *Industry and Higher Education*, 22, 1, 19-28.

[VII] Laine K. 2008. “Satakunta University of Applied Sciences: A Learning Laboratory of Networked Innovation”. In: Laine, K., van der Sijde, , Lähdeniemi, M. and Tarkkanen, J. (eds.) *Higher Education Institutions and Innovation in the Knowledge Society*. Helsinki. ARENE ry. Chapter 1, 25-35.

List of Abbreviations and Definitions of the Terms

Abbreviation or Term	**Explanation**
Absorptive Capacity	Ability to recognise, acquire and use useful knowledge
BSC	Balanced Scorecard, strategic planning and management system
Collaboration	The act of working together with other persons or oganisations to innovate together
Closed Innovation	Research, development and innovation related activities are done in house without using external ideas or ways to commercialise them
Controlled Acceleration	Concept of utilising study time to gain knowledge on which the knowledge intensive entrepreneurship is based on
Competence	Organisation's ability to do something well
Core Competences	Competences that define an organisation's fundamental purpose
Disruptive Innovation	Innovation that improves a product or service in ways that the market does not expect
Dynamic Capabilities	Organization's ability to integrate, build, and reconfigure internal and external competences
Engagement	Commitment to interaction between higher education and industry
Entrepreneurship	Process of opportunity recognition and exploitation
Enterprise Accelerator	Incubator for student entrepreneurs in Satakunta UAS
Experimenting	Trials and tests with knowledge and technologies to see their value for application or problem solving
Expertise	Progressive problem solving capability where a person constantly strives to exceed her previous level of knowledge and skills
Firm	A business or company
FINHEEC	The Finnish Higher Education Evaluation Counsel
Fostering Innovation	To create favourable conditions for innovation to emerge, to be created, and to be utilised
ICT	Information and Communication Technology
Innovation	New beneficial combination of knowledge
Innovation Ecosystem	Network of whose parts are activated for innovation when there is a need for it
Innovation Management	Management of strategy, process and networks for new ideas and their utilisation
Innovation System	All actors involved with innovation creation and realisation, typically on regional and national levels
Innovation Technology	Set of technologies that help in integration of knowledge in order to effectively create innovations
Interaction	Mutual communication for better utilisation of knowledge for innovation
Intermediaries	Actors that create new connections and transfer

	knowledge between actors in innovation system.
KIBS	Knowledge Intensive Business Service
Knowledge Circulation	Free transfer of knowledge between actors of network to increase knowledge and create innovations
Knowledge Management	Strategies and practices used in an organisation to identify, create, represent, distribute, and enable adoption of insights and experiences
Mentoring	Developmental relationship in which a more experienced or more knowledgeable person helps a less experienced or less knowledgeable person to develop in a specified capacity
Mode 1	Knowledge production based on science
Mode 2	Knowledge production based on application
Model	A simple description of a system to describe how it works and to show its essential elements
Open Innovation	External ideas and exploiting opportunities are considered equal to organisation's own ideas and ways to commercialise them
Outreach	An effort to build connections between higher education and industry and create new services based on them
Partnership	Long lasting collaboration between organisations to solve strategic challenges
Process	Series of actions that are done in order to achieve a particular result
QAS	Quality Assurance System
R&D	Research and Development
RDI	Research, Development and Innovation
SME	Small and Medium size Enterprise
SNIFF	Searching New Innovations For Firms, a process created in Satakunta University of Applied Sciences
Spinoff	A firm that has its origin or important part of its knowledge base in higher education
Sustainable	Being able to continue or continuing over a long time
Sustainable innovation	Utilising full potential of innovation
Strategy	An elaborate and systematic plan of action
System	Set of components that must be optionally organised in order to realise the purpose
Systemic Model	Description of a system with complex interconnections and covering an entity
Triple Helix	Collaboration between industry, higher education and public authorities in innovation
UAS	University of Applied Sciences, also Polytechnic, in Finnish higher education context

1 Introduction

This chapter introduces collaboration between higher education and industry in context of innovation, changes in society and innovation and entrepreneurship as a research area. It explores the motivation for the research and its goals and introduces the argumentation structure of the study.

Knowledge based economy is based on production, distribution and use of knowledge (OECD 1996). Innovativeness is the most important single driver of competitiveness (Tidd et al. 2005) and the engine of the global economy (Hirsfeld and Schmid 2005, 5-8). It can give strategic advantage on markets (Tidd et al. 2005, 5-10). "Most modern companies now recognise that the best way to increase corporate earnings is through top-line growth, and the best route to top-line growth is through innovation" (William E. Coyne, in Miles et al. 2000, 300). In knowledge based society the role of higher education as a producer of knowledge is emphasised (OECD 2003, Potter 2008). There are expectations for higher education to contribute to innovation at least regionally and nationally (Clark 1998, Lundvall 1992, Etzkowitch 1998). Higher education institutions are brought into the centre of innovation systems (Lundval 1992, Ezkowitch 1998, Tulkki 2008). Innovation systems are also called innovation environments or ecosystems to emphasise the systemic nature, evolutionary change, ad hoc structures and interaction based on needs between actors of the system. This is parallel with today's understanding of non-linear, iterative, networked, social, and interactive nature of innovation processes (Tidd et al. 2005, Lundvall 1992, Etzkowitch 1998, Tulkki 2008).

In global economy value chains are splitting. Research, development and production are done where circumstances are most favourable. At the same time Information and Communication Technology (ICT) technology make regions more equal in their knowledge and business creation. There is also happening a transformation of business. In developed nations the emphasis in gross national product is in services. The value of products and services is based on unique and personalised experience of consumers. Customisation is mostly based on ICT technology. (Prahalad and Krishnan 2008). Knowledge and technology are so complex that innovators have to search for collaboration in their new product and service development if they want to stay competitive (Van de Ven 2005, Van de Ven et al. 2008). Competition between firms is harder than ever because of deregulation. Disintegration of large companies creates new service providers. There are many ultra low cost competitors globally. Internet makes it possible to be born global without building a traditional global infrastructure. Web-empowered customers have barging power. Internet lowers transaction costs and it also makes distribution monopolies break down. All this equals collapsing entry barriers,

hyper effective competitors and customer power will lower margins. (Hamel 2007, 49-50). Most firms react to globalisation in the same way by focusing, specialising and outsourcing. Firms and organisations collaborate because collaboration exceeds the benefits of doing everything by oneself (Halme et al. 1999). This also happens in innovation. Increased complexity and competition make industries focus to their core competencies and processes. They outsource all but their core processes, including research and development and even the whole innovation chain or parts of it. The outsourcing of R&D is expanding to *open innovation* where new ideas are searched outside the organisations, and ways to commercialise ideas are looked for outside of the organisation as well. Every firm must learn to access resources from multiple sources and emerging markets can be perceived as sources of innovation. One of the main challenges will be: how to access external knowledge. (Chesbrough 2003, 43) The global economy requires local and global presence simultaneously. Knowledge intensity is increasing and new technologies enable novel processes. Change is happening with an accelerated speed in the operating environment of firms and therefore renewal through innovativeness is also seen as a central source for competitiveness in firms. (Hirshfeld and Schmid 2005). In global economy locality still matters and can create unique sources of competitiveness for firms (Porter and Stern 2001).

Innovation is mostly based on knowledge and therefore innovation is also closely connected to learning, knowledge, and knowledge creation (Nonaka and Takeuchi 1995, Senge 1990, Tidd et al. 2005, Lundvall and Johnson 1994, Kaplan and Norton 1992). That is why higher education is also deeply involved with innovation. Universities started by commercialising their knowledge (Etzkowitz 1998). This new role began with incubation, creation of science parks and increased collaboration between higher education and industry in 1980's. This collaboration broadened to licensing and spinoff creation in 1990's. In spinoff creation also students became involved (Rasmussen et al. 2006). Development has created a situation where a complex web of relations exists between higher education, spin offs created by them and large firms. New terms describing the actions are interaction, knowledge circulation and engagement. The circulation of knowledge connects the higher education to the users of the knowledge and therefore it is also important for higher education. (Etzkowitz 1998, Laine 2007, Laine 2008b).

Europe could be more effective in utilising research results as it now is on a global scale. European R&D and innovation landscape faces many challenges. It has: good, but fragmented scientific performance, declining industrial R&D, insufficient innovative performance, increasing competition from outside, low interest in science and engineering and inability to mobilise sufficient resources to respond to the global challenge. To become more competitive it should increase the usage of created scientific knowledge and, all in all, increase interaction and collaboration between higher education and industry for better utilisation of knowledge. (Aho et al. 2006,

Atkinson and Andes 2009) In addition to science based innovation there is also a need for user and application based models of innovation (von Hippel 1988, 2001, 2005, Jensen et al. 2004).

Higher education faces many challenges and requirements from society. There is a "demand overload" (Clark 1998). The impact of globalisation for higher education is summarised in Figure 1-1 based on Good et al. (2007). *Entrepreneurial university* is a concept according to which higher education responses to challenges set by society, sees opportunities and exploits them. The challenge is not to change once but to sustain momentum of entrepreneurial actions (Clark 1998, 2004). The rise of knowledge based society also brings the creation of *Knowledge Intensive Business Service* (KIBS) firms into the focus. They produce services for other firms that are based on knowledge and therefore they are important in innovation creation and diffusion. Small technology based KIBS can have an important role in innovation processes especially in peripheral regions (Mayer and Kuusisto 2003, Miles 2003). *Small and Medium sized Enterprises* (SMEs) are important because they are the backbone of European economy: 99 % of enterprises in EU are SMEs. They produce 60% of European gross domestic product. They have about 100 million employees and are expected to be the net employers and source of growth in the future. SMEs also have a major role in innovation and are important actors in a knowledge based society (EU 2009, 3).

According to existing research patenting alone does not solve the commercialisation challenge for universities (Fabrizio, 2006, 2007). Only ten percent of patents administrated by technology transfer offices at universities are licensed and one licence creates half of the licence incomes. (OECD 2003). There are also critical research results concerning patenting and licensing in research organisations saying that patenting can even slow down the commercialisation process (West 2006, Fabrizio 2006). Most innovations in society rise from practice, not from research results. There is a clear need to find new models that are more effective and especially practise-based (Jensen et al. 2004). These new mutual knowledge circulating models can be called *interaction* (Groen and van der Sijde 2002).

Because of the knowledge and learning intenseness of the economy, the interconnection of learning and innovation is important (Lundvall and Johnsson 1994, Senge 1990, Nonaka and Takeuchi 1995, Kaplan and Norton 1996, Porter 2001). Therefore higher education can have a significant contribution to innovation. Above also it seems that innovation management, knowledge management and learning theories are related to innovation and can be used when there is a need to study and model new ways for interacting to innovate. Higher education can have a contribution to society if it makes good decisions. It produces significant amounts of highly skilled workers, science and technology and diffuses new technology (Tornatsky et al. 2002). Higher education fosters innovation by producing knowledge that sums to the existing body of

knowledge. It does it in interaction with industry. It creates new knowledge, combines knowledge from diverse sources and develops connections and new networks. It is important to create models of interaction to understand it better and to develop it further. Experimentation gives insights to the developed models and their application.

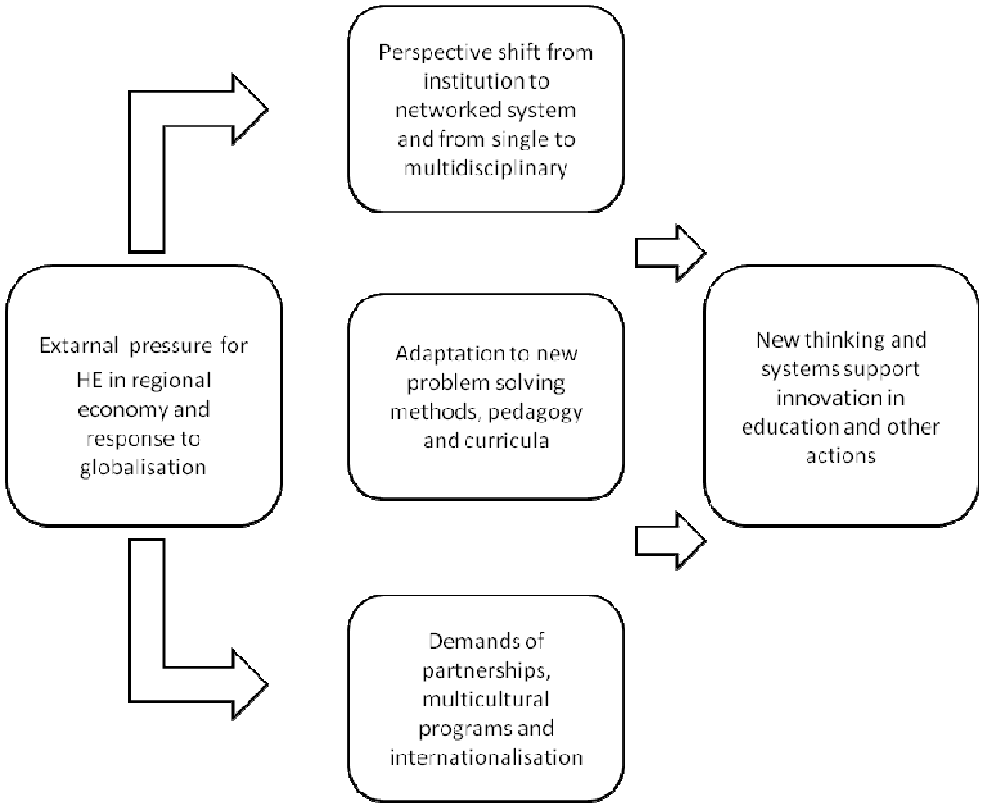

Figure 1-1 Impact of globalisation to HE according to Good et al. (2007, 18)

This research uses the Finnish context as a framework for interaction. On a national level in Finland science and technology policy has fostered competition based funding, large cluster programs, effective networking and triple helix collaboration. Higher education policy emphasises interaction with industry, knowledge commercialisation and educating and supporting entrepreneurship. The amount of firms collaborating with higher education institutions is high in Finland. In Finland services make up over 70% of the gross national product. Outsourcing in industry adds to the need of services. Nationally 3,5 % of GNP is used to *Research and Development* (R&D) which exceeds the European average and is one of the highest in the world (OECD 2008). Regions differ in their R&D expenditure in Finland. The areas with highest expenditure are those where multinational companies and universities are located. In low expenditure areas there may also be plenty of industry and export and several units of higher education, but all large firms do not have their R&D functions on the region.

Higher education is a central actor in innovation that creates and co-creates knowledge that enables innovation when summed to other knowledge. Changes in society and economy create pressure both for industries and higher education to be innovative and to benefit from each others' knowledge. Higher education can take an active approach and start making strategy based actions. Entrepreneurial university concept emphasises seeing changes as opportunities. There is a gap in experimental innovation research and a gap in combining entrepreneurial university concept with other main stream research (Rothaermel et al. 2007). Open innovation requires new models while innovation paradigm is changing from closed innovation to open innovation, and entering other industries outside large firms based on high technology (Chesbrought 2003). Experiment based innovation research is not used enough, especially when it comes to new practical tools and processes. Experiments can help create new models and new ways to execute innovation processes. Open innovation paradigm requires new models that help in the application of open innovation in practice (Sørensen et al. 2010). Management of innovation requires systemic approach where all relevant parts of the system are affected with simultaneous actions. Organisations, processes and resources need similar attention.

1.1 The Goals and Method for the Research

In this research the main goal is to model the interaction between higher education and industry in creating innovations, knowledge intensive entrepreneurship and the graduates that are employed. In this research the entrepreneurial university concept is combined with the innovation management research and the concept of open innovation. One of the main challenges for innovation management is to find out how to create favourable conditions to support innovation, to foster innovation. In this research several ways will be detected and modelled to make the complex process of innovation visible and more understandable in the context of higher education and industry interaction. The model aims to effectiveness. That means mainly doing the right things instead of making things right.

Modelling of interaction focuses on processes which aim for the creation of innovations and entrepreneurship by creating new valuable combinations of internal and external knowledge. This thesis concentrates on interaction between university and industry in the creation of innovations and entrepreneurship in a regional context. Satakunta *University of Applied Sciences* (UAS) in Finland is used as a source for the case study to model interaction and entrepreneurial actions of higher education. The research aims for a systemic model of innovation and entrepreneurship support in local context. A systemic model refers to the modelling of a complex system that consists of parts that

interact but do not have clear causal relations. The model should be pragmatic and have practical implications. There will be many potential benefits of using the model both for industry and higher education.

In this research *innovation* is understood as a new valuable combination of the organisations' internal knowledge and knowledge from external sources. The thesis examines ways to support these internal and external knowledge combinations. It aims for a systemic model consisting of several elements and their interactions, like internal and external interaction, knowledge management for innovation, knowledge intensive entrepreneurship, and learning. Entrepreneurship is seen as a manifestation of innovation. The research has a practical interest and goal: how to improve interaction between higher education and industry to make it more effective in the creation of entrepreneurship and innovations, and entrepreneurship as opportunity recognition and exploitation.

This research is based on the assumption that higher education can have a significant impact on the knowledge based society in the creation of innovation and entrepreneurship.The second assumption is that KIBS firms can have an important role in this interaction. Interaction for innovation can be seen more broadly than just as commercialisation of knowledge. It can be seen as a means to a two-way transfer of knowledge to ensure better synergies and collaboration for effectiveness and innovation results. In this thesis the focus is on the interaction that happens in the search of innovation opportunities and exploitation or opportunities. In this research the main research question is: *How can higher education have a significant role in the creation of innovation and entrepreneurship?* The research looks for a systemic interaction model to create innovations for SMEs, KIBS enterprises and graduates that have competences required in working life.

Parts of the systemic model are studied and created in papers 1 to 5 and the systemic model is described in papers 6 and 7. Theories and parts of the systemic model are collected from the papers and the final systemic model is built in the long introduction. The structure of the thesis is described in Table 1-2. The main view of interest is the higher education's point of view. The emphasis is in the beginning of the innovation process where search and combination of different knowledge sources is central. The core question is: how to support new combinations of user and application based knowledge, technological knowledge and scientific knowledge. The aim is to model these combination creating processes to one innovation generating entity.

Table 1-1 Research questions and their examination in this research

Research Question	**Examined in Paper**
How can interaction with industry be entrepreneurial? How to recognise opportunities and exploit them, and turn reactive action into proactive in regional context?	Paper 1
How to add effectiveness and impact of interaction on region?	Paper 2
What kind of role do KIBS firms have in interaction with industry?	Paper 3
How can creation of firms be supported among the students in higher education?	Paper 4
What kind of innovation management tools and process can be used to support interaction for the creation of innovation?	Paper 5
What is a systemic model of interaction like?	Papers 6 and 7
Theoretical framework, wrap-up and conclusions	Thesis

Table 1-2 Structure of the thesis

Content	**Chapter**
Research goal setting: How to foster innovation between higher education and industry?	Chapter 1
Creating understanding of interaction between higher education and industry, and innovation management theories	Chapters 2 and 3
Constructing the model based on a case study	Chapters 4 and 5
Evaluating the model	Chapter 6
Conclusions and discussion	Chapter 7

This research is based on a realistic world view. According to it, the reality exists without knowledge about it. The research results are true if they have correspondence to reality. That is, correspondence theory of truth is adopted. The research is constructive in its nature**.** Constructive research is an applied research method and means problem solving in forms of construction of models, diagrams, plans and organizations, for example. It is widely used in technical research, but also on other fields like mathematics and clinical medicine (Kasanen et al. 243). The process of constructive research is the following although not always in the same order

1. find a practically relevant problem
2. obtain a general and comprehensive understanding of the topic
3. innovate i.e. construct a solution
4. demonstrate that the solution works
5. show the theoretical connections and the research contribution of the solution and
6. examine the scope of applicability of the solution. (Kasanen et al. 1993, 246)

The realisation of a new construction is an accomplishment in itself. Effectiveness and impact are the central measurements of the realisation on the construction (March and Smith 1995). The results of constructive research can also be judged by relevance, simplicity and easiness of operation (Niiniluoto, 1985). The results are often empirical and normative, leading to suggestions (Kasanen et al. 1993). Truthfulness can be used as a criterion for the validation of constructive research but primary the criterion is its practical usefulness, the market based validation. Market based validation can be divided into three categories. A weak market test applies when some actors are willing to apply to the construction. A semi strong market test to the construction applies if the model is widely adopted. Finally, a strong market test applies if the construction systematically produces better results than not using it would. Even the weak market test is a strict test. (Ibid. 253)

Constructive research must have both practical relevance and theory connection. A construction is a solution to a selected problem. The construction usually has both practical implications and theoretical contribution. The innovation phase is heuristic by nature; stricter theoretical justification and testing of the solution often come afterwards (Kasanen et al. 246). Most constructive research use case studies (Eisenhardt 1989).
Qualitative approach can be used to create a deeper understanding of the phenomenon under examination. The main goal is to understand the phenomenon more deeply to be able to develop it further. The aim is not to make large generalisations of other environments. Qualitative research requires theoretical sensitivity from the researcher. (Yin 2003, Eisenhardt 1989). The research will use mixed methods by combining qualitative and supporting quantitative methods, process modelling and network analysis. Innovation management research typically models idea development paths, the people and organisations involved, interactions and transactions between actors, the outcomes of the innovation process, and the context of innovation. Although innovation paths are individual, general elements fitting to most similar processes are supposed to be found (Vand de Ven et al. 2008).

The researcher of qualitative research should not rely only on documents and interviews in case studies but also on observation (Silverman 2007, 145-147). The source of evidence in the case study is documentation, archival records, interviews, direct observations, participant observations and physical artefacts (Yin 2003, 86). There are

three principles in collecting evidence: use multiple sources of evidence, create a case study database and maintain a chain of evidence from research questions to conclusions and back (Ibid., 97-106). There will be several sources of research data. Observations, interviews and process modelling will be used as primary sources. Documents will be used as a secondary source. Case study process tools like comparisons will be used inside the cases, between the cases and to other actors and models (Yin 2003, Eisenhardt 1989). The researcher will also be involved with projects and interaction in practice. The projects will serve as platforms both for model creation and verification. Experimentation and testing of created models will be done in a real environment.

Several potential theories and concepts will be examined for the study. This research will use the organisational level, and not the personal level, as its outlook. Although legal and immaterial property rights and other legal issues are important in innovation, they will not be covered in this thesis. The thesis will model interaction with SMEs. It will not cover traditional technology or knowledge transfer and licensing. It will be interested in interaction models where teachers and students are in central roles and the goal is to create innovations and entrepreneurship. This research does not cover pedagogy theories except when taking into consideration that when students participate in the interaction it will support the building of their expertise and core competencies.

The research will use the framework of innovation management and it will be based on a broad conception of innovation. In this conception innovations are embedded in social activities. There are many useful types of innovations besides radical technological innovations, like incremental, disruptive and systemic innovations. Innovation is closely linked to learning, and tacit knowledge has an important role in innovation. Innovation is a complex process and innovation diffusion is important in addition to innovation creation. Innovation is a collective undertaking and networks are essential for it. (Toivonen 2004, 103) In the research a system approach will be used. In a system approach general conceptual and abstract structures and parts are described. A system is described as models that are simplified and subjective descriptions of the phenomenon. Therefore the models are not exact, objective copies of the reality. Models are described as a system with interrelating parts.

Satakunta University of Applied Sciences in Finland will be used as the case. Several areas will be studied concerning R&D processes, entrepreneur incubation, knowledge intensive firms created within the incubator, R&D and innovation networks. The study will concern the years 1994 to 2008 but the emphasis will be on years 1997 to 2008 at the Faculty of Technology and Maritime Management in Satakunta UAS.

2 Higher Education and Industry Interaction

This chapter describes how higher education has changed from science based knowledge production towards application based knowledge production. It explains the entrepreneurial university concept and introduces success factors of interaction between higher education and industry. It also explores the state of the art in interaction research in Finnish UAS context.

2.1 Change from Science based Research to Entrepreneurial Actions

Knowledge has become a commodity. The ways of producing knowledge are also changing. Most knowledge is produced in connection to its application. Higher education has also transferred from traditional science based *Mode 1* knowledge production to application based *Mode 2* knowledge production. In Mode 2 knowledge is produced in context of application and it is created interdisciplinarily by heterogeneous actors, social accountability and impact demand are built in the knowledge creation process, and finally quality is evaluated by a wider set of criteria and actors than in the traditional Mode 1 peer review judgement (Gibbons et al. 1994). Terms technology transfer and knowledge transfer are changing into knowledge circulation, interaction and outreach of higher education. Triple helix is an emerging social structure between higher education, industry, and the state to make Mode 2 knowledge creation work. Higher education has to rethink its role in knowledge production because it is no more only a large producer of knowledge. Knowledge creation does not have to be merely science based or application based but it can also be a combination opf the two. This so called Pasteur's quadrant in knowledge creation is a combination of Edison's quadrant application based mode and Bohr's quadrant science based mode of knowledge creation (Stokes 1997).

The knowledge transfer to society is seen as central role of higher education. Often this role has a regional emphasis. There is a trend towards commercialisation of publicly funded research of higher education. Several higher education institutions and public research organisations now have research commercialisation as their task (van Eecke et al. 2009, 20-21). Commercialisation has led to a situation where a complex web of relations exists between higher education, spin-offs created by them, and large firms. The development has been important because it connects higher education to the users of the knowledge (Etzkowitz 1998). There are three situations when higher education is a particularly potential partner for industries in innovation: the idea has a relatively high

amount of research knowledge; the idea is novel and its strategic importance is high; and the idea is novel and difficult to industrialise. (Cassiman et al. 2009).

Higher education faces challenges caused by globalisation and new modes of knowledge creation. It can see change as an opportunity and change from reactive role to proactive role. *Entrepreneurial university* concept (Clark 1998) means that university takes an active role and recognises opportunities, adds interaction and transfer of its knowledge to environment and makes strategic actions to develop itself and its surroundings. The attributes of entrepreneurial university are: a strengthened steering core that cam make strategic choices and lead the institution, an expanded development periphery in forms of active research and transfer centres that have deep connections with industries, a diversified funding base to ensure a stable financial balance, a stimulated academic heartland by the activation of faculties and their personnel, and an integrated entrepreneurial culture where all members of the organisation look for new opportunities and where failures are tolerated. The individuality of development must also be taken into consideration (Ibid. 1998, 3-8). There are three requirements for the transformation into an entrepreneurial university: transformation driving elements, sustaining dynamics, and a resulting steady state of change (Clark 2004, 173-184).

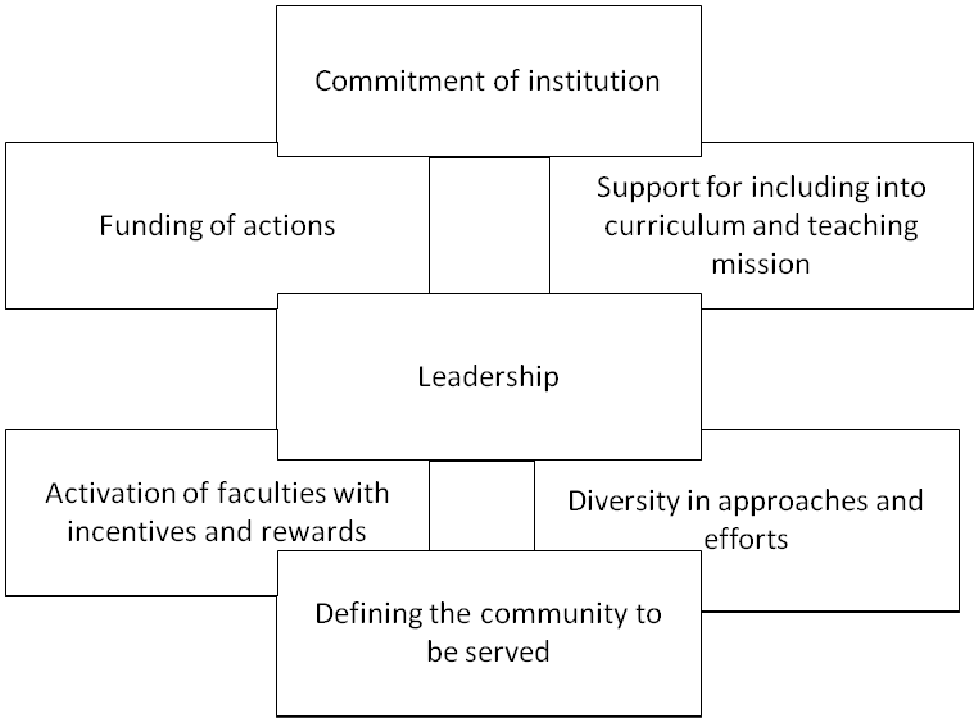

Figure 2-1 Overlapping elements of engagement with industry for higher education (Kellogg 1999)

The second important concept in this context is *engaged institution* (Kellog 1999). Engagement refers to a situation where higher education has a commitment to regional impact. Elements of engagement are presented in Figure 2-1. Engagement starts by

defining the community to be served. Diversity of approaches is needed because there are no single right ways to do the outreach. Faculties can be activated with incentives and rewards. External connections and actions require funding and support to integrate actions to curriculum and teaching. Commitment shows as the sum of these actions. An engaged institution creates responsiveness for its surroundings. It respects its partners and encourages joint definitions of problems, solutions and success. It remains a neutral source of knowledge despite of diverse pressures. It makes itself accessible and available. It integrates outreach with its basic functions and knowledge creation processes and commits to multidisciplinary work. It coordinates actions to share knowledge and to be more productive. An engaged institution creates resource partnerships to ensure adequate resources for all activities. (Ibid. 45).

The third well recognised model is *Innovation University* (Tornatsky et al 2002). In regional level the actors in interaction are higher education institutions, industries, local authorities and development organisations. The processes may be industry research partnerships, industry education and training, industry extension and development, entrepreneurship development, technology transfer, career services and replacement, supporting boundary spanning elements like partnerships with local development organisations and industry advisory boards. Institutional enablers like vision, mission, goals, policy, culture and rewards. Outcomes of collaboration can be new knowledge, smart people, state of the art knowledge, technology and entrepreneurial firms. The impact is the sum of actions and it leads to the economic development of the region. (Ibid. 16-22)

2.2 Interaction between Higher Education and Industry

The critical success factors in university industry interaction have been studied. There is a need for a method of partner evaluation to ensure that partners are interested, able to support and can actively contribute to the work. High quality project management is needed. Trust, commitment and continuity must be created. Management should be flexible so that it reacts to external changes. Benefits must be achieved as fast tangible outcomes. There should be mutual benefits and a balance between academic objectives and industrial priorities. (Barnes et al. 2002)

According to European Union's Lisbon agenda, the universities' contribution to the creation and dissemination of knowledge throughout the Union must be reinforced. The European responsible partnering between public research organisations and industries is defined as a ten-step collaboration process that starts with fostering strong institutions. This is followed by aligning interests. Collaboration should be treated strategically, and it should be organized for lasting relationships. All actors should be provided with the

right professional skills. Clear intent must be established. Standard practices should be used and communication should happen on a regular basis. Effective intellectual property should be achieved. Relevant training should be provided and innovation should be viewed as a trans-disciplinary activity. This scheme was created mainly for large firms and their collaboration with public research organisations. (*RP 2007*)

Nations have created national *innovation systems* to support and enhance innovations to ensure competitiveness. Regional innovation systems are projections of national innovation systems on the regional level. Regionally, two sides can be seen, the producers of knowledge and the users of knowledge. The evaluation of innovation systems may be difficult for external evaluators because of the richness of tacit knowledge related to the system (Autio 1998). In spite of global economy, locality still matters and on local levels competitiveness and innovations can still be created (Porter 1990, Porter 2001, Porter and Stern 2001). *The triple helix* model refers to collaboration between university, industries and public authorities to enhance innovation capacity. Triple helix can be used as a model on national and regional levels. Recently, models have developed towards interactive and networked models, as have done innovation models. The end users are also emphasised because most innovations are found to have their origin in application and not in research. (Jensen et al. 2004) The triple helix and entrepreneurial university are common success factors found in several regional development case studies focusing on the development of regional innovativeness. There is a certain amount of fluctuation in the role and need of higher education. The important role may be forgotten for a while. When old technological paradigm needs to be renewed, the higher education is called up again as a source of innovation. (Etzkowitz and Klofsten 2005).

European Union has developed the interaction framework by introducing open science (EU 2004a) and responsible partnering models (RP 2005, 2009). The responsible partnering model was issued by the main European organisations supporting research, development and knowledge transfer in companies, universities, and public research organisations.

Intensive higher education and industry interaction can occur under the following conditions: when the industrial demand is high, there are well developed incentive schemes, there are special programs which facilitate SMEs, legislation does not constitute a barrier for interaction, there are public initiatives to foster interaction, science and technology policies follow a long term approach of strengthening interaction. There are many good practices for interaction, but they are specific for market and institutional environments, and fields of technology. There can be various incentives, like individual or institutional mission and objectives, administrative and managerial support, balancing with other major objectives of science, i.e. education and fundamental research. There are also barriers for interaction between higher education

and SMEs. Main barriers for SMEs include difficulties in time investment, lack of financial and coaching assistance, lack of understanding from universities, and increased competition in EU funding especially after the enlargement. (Polt et al. 2001, 27-32) Barriers for universities include that they have their own non-commercial agenda, they may be too large to think small, and they may lack of enthusiasm for what has "not been invented here". (RP 2007) There should also be open-ended and "meaning searching" collaboration in addition to clear goal oriented collaboration projects. This also requires spaces for interaction and interpretation (Lester and Piore 2004, 96-120). Similar views are seen in industry as well, claiming that universities should be involved with strategy processes and open ended discussions where new directions are searched (RP 2005, 2009).

There are views in industry that see that industry and higher education relations should be seen as a process and not as a transaction. The relations should be strategy based where also senior management brings broader views to collaboration. Industries see that short-term relationships should be turned into partnerships to build new capabilities. Senior management must be involved to give the collaboration a strategic direction, and the collaboration should not only consider isolated problems but also let higher education get involved in the industrial partners' strategy. (Wright 2008) Close and effective forms of collaboration serve to enhance research and knowledge exchange and support productive innovation, and there is a strong desire to avoid approaches that polarise the interests of universities against companies. The business community recognises the major contributions that universities make to modern societies and economies and wishes to see these contributions grow: sustaining research excellence at the top level, training of scientists and engineers, supporting the development of the local community, including its SMEs, supporting the people's capacity to create and be creative, and acting as long-term guardians of knowledge on the behalf of society. (RP 2007) Higher education has changed its role from science based research to entrepreneurial actions. There is a strong will on both higher education and industry fronts to increase collaboration and to avoid interest polarisations. There are best practices, guidelines, and general processes for interaction but a lack of concrete collaboration models in diverse environments.

2.3 State of the Art in Innovation and Interaction Research

This subchapter introduces the main references in the context of this research. Collaboration models are presented in literature. They are mostly based on case studies and the theory of higher education and industry interaction is not much developed. It may be because studies are not strongly connected to other main research streams to finf supporting theories. Innovation management research litterature is rich. It offers a

possibility to find explanations how collaboration for innovation can be successful. The related research in international contexts is briefly presented in Table 2-1. Only the main references are mentioned.

Table 2-1 Related research in international contexts

Research area	**Researcher and year**
Concepts for higher education and industry collaboration	Clark 1998, 2004, Tornatsky et al. 2002, Kellogg 1999, Etzkowitz 1998, Etzkowitz and Leydesdorff 2000, Groen and Sijde 2002, Polt 2001, OECD 2003, Barnes et al. 2002, Schutte and Sijde 2000
Knowledge production	Gibbons et al. 1994, Stokes 1997
University Entrepreneurship literature typologies	Rorhaermel et al. 2007
Innovation management, strategy, process and networks	Tidd et al. 2005, Van de Ven 2005, Van de Ven et al. 2008, Teece et al. 1997, Apilo et al. 2007, Hardagon 2003, Burt 2004, Hamel 2000, 2007, Rothwell 1994, Markham 2002, OECD 2008, Rogers 1995, Davenport 2009, Thomke 2001, von Hippel 1998, 2005, Hamel and Prahalad 1994, Doz and Kosonen 2008, 2010, Blomqvist 2002, 2005, 2007, Blomqvist and Levy 2006, Miles et al. 2000, 2005, 2006
Open Innovation and Open Business models	Chesbrough 2003, Chesbrough 2006, Chesbrough et al. 2006, West and Gallagher 2006a, 2006b, Weber 2004, Quinn 1999, 2000
Knowledge management, learning and absorption capacity	Nonaka and Takeuchi 1995, Nonaka et al. 2000, Cohen and Levinthal 1990, Zahra and George 2002, Teece et al. 1997
Entrepreneurship	Groen 2005, van der Sijde et al. 2002, Kirwan et al. 2008, Klofsten 2008a, b, Potter 2008, Davidsson and Klofsten 2003

Relating research in Finnish UAS and innovation context linked to this research covers diverse areas. The main contributions from the point of this research are presented in the following table 2-2.

Table 2-2 Related Innovation Research in Finnish UAS Context

Research area	**Researcher and year**
Strategic thinking and strategic management in UAS	Jaatinen 1999, Toikka 2002
UAS as a part of the regional innovation system	Tulkki and Lyytinen 2001
Role of UAS in the innovation system	Lyytinen et al. 2003
Collaboration between UAS and firms	Marttila et al. 2004
R&D centres in the intersection of education, research and development	Marttila et al. 2005
UAS and emerging industries	Suvinen et al. 2006
Innovation activities and spaces of learning	Heiskanen et al. 2007
Student entrepreneurship and incubation in UAS context	Saurio 2003, Kuvaja and Saurio 2004, Ylikerälä 2005, Mertanen et al. 2008
Interaction between education and R&D processes	Saurio and Heikkinen 2004
Business incubation in Finnish contexts	Gadd and Saurio 2002, Saurio 2003, Kuvaja and Saurio 2004
Profile of UAS as an innovative learning community	Hokkanen 2001
Innovation-generating model in the Finnish work life development context	Ramstad 2008
Excellence in education in UAS context	Huttula 2001, Salminen and Kajaste 2005, Malinen et al. 2009

Their main results, from the point of view of this research in Finnish context, are the following. A strategy in UAS context is a complex phenomenon with all its connections, actors and stakeholders on different levels (Toikka 2002). Higher education is brought to the centre of innovation systems in new national innovation models (Tulkki et al. 2001). Student incubators are adequate in realising the entrepreneurial intentions but the intentions are mostly created already before entering incubator (Ylikerälä 2005). Integration of educational and R&D processes brings instant benefits for firms and HE. The future challenges are how to develop the innovation capability and the business development capability of UAS. (Saurio and Heikkinen 2004). The roles of expert organisations are becoming blurred, meaning that diverse actors do similar things (Ramstad 2008).

UAS can have an important role in the emerging fields of industry. It can add the critical mass of knowledge and technology searching, collective learning, image building, converging management routines, and in adding trust and control. UAS should add boundary crossing and networking to adapt new knowledge and methods and to

start renewal processes also inside UAS. (Marttila et al. 2007, 73-75). UAS can help small technology based firms by transferring technology and providing environments and platforms for innovation (Heiskanen et al. 2007). UAS acts like a large KIBS firm within its region when it transfers knowledge and technology to other actors (Katajamäki and Huttula 2002). Forms of collaboration with industries are diverse and best practices are not transferred effectively (Zacheus 2008, 57-65). There is a gap between entrepreneurial intentions and true entrepreneurship among students of higher education. Models that produce true entrepreneurship are rare. There are also no models for open innovation in particular from the point of view of SMEs or KIBS firms.

UAS can act as an innovative learning community. The profile of innovative learning community consists of four elements: clear vision, realistic and well communicated strategy and goal oriented operations. In addition to this, the culture of the organisation allows three types of actions: the community works in an open, flexible, brave and unprejudiced way, and its members are respected. The ideas and insights can be developed into products, marketed and utilised rapidly and at the right time. (Hokkanen 2001, 189-198)

As a new research area, entrepreneurial university concept was earlier a niche research object. It has grown during the years and it is ready to be seen from other disciplines and to become a part of mainstream research fields. Seeing the entrepreneurial university from key discipline views serves to bring the issue to mainstream research (Rothaermel et al. 2007). Entrepreneurial university literature has diverse views and elements. The main elements are: entrepreneurial university, efficiency of (technology) transfer office, new firm creation, environmental context including innovation networks and facilitating the process (Ibid). Diverse views, actors and stakeholders often lead to multidisciplinary approaches. Until today, only few research papers have been published that combine all the elements and their interaction. The usage of diverse theories in researching the entrepreneurial university is justified because of diverse goals and stakeholders (Rothaermel and Siegel 2008). Interaction between higher education and industry has been studied in the Finnish UAS context but practical models have not been much presented so far. There is also a gap in combining interaction research with other main research streams. In addition to this there is a need to create holistic and systemic models for innovation collaboration.

3 Innovation Management

This chapter explains innovation as a phenomenon and introduces a general process model of innovation. It explains the importance of strategy and networks for innovation. It explores science and practice as sources of innovation and introduces innovation technology as a means to support innovation. It also explains the ongoing chance from closed to open innovation and the role of entrepreneurship and expertise in innovation.

Innovation is about novelty and benefits (Kettunen et al. 2008). Innovation can be defined as a new commercial product or service. The utilisation of ideas and concepts is emphasised. In this thesis innovation is seen more broadly as a renewal that is to be implemented in organisations. It may be a new product, process, service, type of organisation, way of networking, management renewal etc. The innovation process is a process which creates new knowledge combinations. Systemic R&D is important in the creation of innovations (Schumpeter 1942). Earlier, the innovation process was understood mainly as a new product development process. Today it is extended to an idea gathering and enrichment phase, a so-called fuzzy front end. At the other end it reaches all the way to the commercialisation of the developed product. Innovation management aims to the management of the innovation process. Earlier, the management of innovation was the management of a new product or service process. At present it also includes the management of people, resources, funding, networks, strategy and learning. (Tidd et al. 2005, Apilo et al. 2007, 33-55). There is a growing emphasis on user based innovations. Innovation is needed in both manufacturing and services. Innovations have a multidisciplinary nature. Both public and private innovation is needed and they should be combined. Innovations are often produced in globalised networks and competition is global. Both SME firm innovations and large firm interventions are needed. (Kotilainen 2005, 78)

Innovation management refers to management of strategy, process and networks of new ideas and their utilisation. There are several types of innovations and they require diverse processes and networks. To manage innovations it is also important to notice the separate phases of the innovation process. Systemic approach requires that the innovation process should be managed as an entity. It is not enough to optimise one part of the innovation process. Most of the innovations are created in intra-organisational networks. Therefore the third important part of innovation management is to understand how networks can be utilised in the creation of innovations. (Tidd et al. 2005) Effective innovation management is not doing single phases definitely well, but the capability to manage all dimensions of the innovation system (Rothwell 1992). Good innovators emphasise a systemic approach to the innovation process which is not only maintained but also continuously developed (Bessant et al. 2005).

3.1 Types of Innovation and Innovation Process

Incremental innovation refers to making existing things better, meaning for example the improvement of products, services and processes. The rules for continuous innovation are usually clear because they are based on existing customer needs. Therefore also the risk is usually lower and easier to manage than in other types of innovations. In the case of incremental innovation the firms work in close connection to customers and suppliers, and use effective resource allocation to select strategic meaningful project portfolio. They also use well developed risk and project management methods in the development of new products and processes. (Bessant et al. 2005)

Radical innovation refers to something totally new. It may be new for the organisation, new for the market, or new for the whole world, depending on the definition. Radical innovation is not based on existing customer needs, but more on sophisticated guess or forecasting and new findings in science and technology. Therefore the risks are also bigger and the development and commercialisation is more difficult to handle. (Ibid, Tidd et al. 2005) Disruptive innovation is based on a change that is not expected on the markets. *Disruptive innovations* are often based on emerging technologies that make new products possible with lower prices and business models that grow their market share by offering interesting possibilities for overshot customers and new market segments (Christensen 1997). Systemic innovation requires other related innovations or changes to happen to make the usage of the innovation possible. Systemic innovations are challenging for small firms and organisations because they usually do not have enough power to make the related changes to happen (Maula et al. 2003).

Change, and change in rules of environment, creates new opportunities (Hamel 2000). Sources of discontinuity are for example new markets, new emerging technologies, new political rules, end of technology life cycle, changes in the market behaviour, deregulation or new regulations, unexpected events, new business models and change in the techno-economical paradigm (Bessant et al. 2005, Drucker 1998). In the case of radical innovation at least not all of the rules are clear. In this case the actors need to function proactively with innovation possibilities and threats which rise from the nonlinearities. (Hamel 2003, Drucker 1998). The fast changes act as drivers that dominate the slow changes (Hamel 2004). There are two typical mistakes when forecasting the forthcoming changes. Usually the speed of change is overestimated and the impact is underestimated (Naisbitt 2006). Sometimes change is also seen as too simple or the causalities are not clear. This makes the observation of the change difficult (Senge 1995).

An organisation should develop new routines for radical and disruptive innovations which work parallel with continuous innovation. Managing radical innovations requires agility, new learning and avoiding pre-understanding of how things will improve. In the case of radical innovation customers are more distant. Perhaps the new idea has no customers at all. This makes the risk management in the case of radical innovation difficult. This makes a clear difference to incremental innovation where existing customers have new needs and therefore the risk is more manageable. In the case of radical innovation the key issue is acting on network and system levels. Collaborative development and trials on a high level of risk are emphasised. It is recommended to have deep interaction between research and developing organisations to recognise the emerging and disruptive changes and models. (Bessant et al. 2005)

Gary Hamel divided innovations into four groups or levels: management, strategic, product and service, and operational innovations. Management innovations often combine other levels of innovations and are a new interpretation of meaning of the organisation (Hamel 2007, 32). Management innovation combines renewals on many levels at the same time. There are three main sources where innovations come from: institutional, which create favourable conditions; technology, like new products and services; and finally management related, which means new innovative ways to execute innovations. (Ibid.) There are best practices in management innovation implementation. To find solutions to systemic problems, a deep understanding of the matter is needed. It is often easier to add something new to the management process than to renew it totally. Goals may be revolutionary but evolutionary trial and error steps are needed in the implementation. Metrics are important in validating the impact, and sustainable actions are needed instead of fast results thinking. (Ibid. 2007, 227-229).

In general, *a process* is a set of activities that produces value. The nature of innovation is fuzzy and nonlinear. All activities do not have clear beginnings and ends. Therefore it is difficult to describe *an innovation process* as linear processes supporting it. (Kettunen et al. 2008, 10). An innovation process is difficult to model in an accurate and repeatable manner but it can be modelled as a general process (Tidd et al. 2005, 67-69, Tidd and Bessant 2009, 54-55), which consists of searching, selection and implementation as presented in Figure 3-1. These phases are linked to strategy and organisation. The innovation process cannot be separated from other functions of the organisation or from its environment. (Tidd and Bessant 2009, Tidd et al. 2005, Tidd 2008).

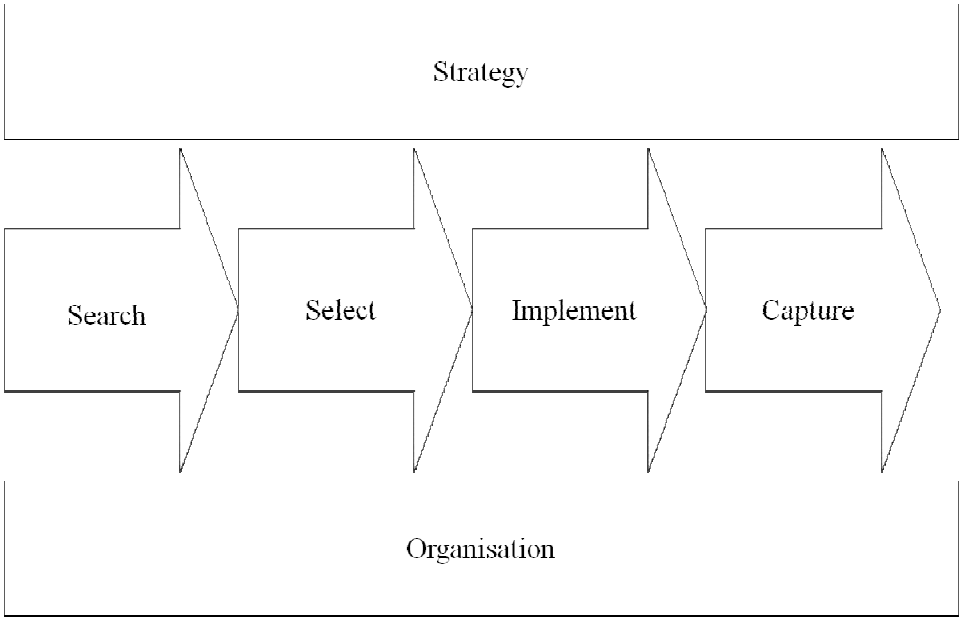

Figure 3-1 General and simplified model for innovation process based on Tidd and Bessant 2009, 44

An innovative organisation means supportive attitudes towards new ideas and a toleration of failures. Strategy context suggest that organisation must have a conscious desire to innovate. External connections to other actors are in most cases important because innovations are increasingly created in networks. The phases of the process can partly take place simultaneously and parts of it can even fade away. The linear model is a simplified description of real innovation process.

In the beginning of the process there is a fuzzy front end where decisions are made with highly uncertain conditions. Mistakes made during this phase will be costly at the end of the process. This suggests that if there are any means of bringing more knowledge to the beginning of the innovation process it will lower the risk of the process. The linear model does not apply in most cases. 95% of innovations have their origin in practice and only 5% in science. Still the research knowledge is needed in the process although it is not the origin of most of innovations. This suggests that innovation process should be more integrated in order to gain benefit from practical ideas and scientific knowledge when creating new solutions. In practice most innovation processes are trial and error processes. At least this is the case in innovation processes where experts are involved. In trial and error process, specifications for innovation and expert knowledge give direction for the first innovation efforts. Prototypes are created and tested in real or almost real environments. Iterations are made in the process if results are not as specified or external knowledge changes during the process. It is estimated that transfer of knowledge makes approximately 20 % of the development costs (von Hippel 2005). This indicates that effective knowledge transfer can lower innovation costs.

In general, incremental innovation is underrated, although many radical improvements start as small improvements. Employer-driven innovations are also often underestimated although they have several positive impacts on organisations. (Lemola 2009, 162-165, The Danish federation of Trade Unions 2008)

Problems, solutions, innovations and innovation systems are increasingly systemic. System thinking emphasises the understanding of entities, interactions between subsystems, and paying attention to slow changes. It also means breaking free from linear learning processes to see interactive loops where actors affect the development (Stacey 2003). Social systems are reactive from their nature and the challenge is to create proactiveness. Social systems have blurring boundaries and interactions take place on diverse levels. People have their intentions and motivations. The most important goal is to make systems simple enough to understand (Laamanen and Tinnilä 2009, 36-38). *A system* is a set of components which are optimally organised to realise the purpose of the system. System thinking promotes the understanding of the whole and the impacts. This in turn prevents one from taking actions that will affect the whole negatively. Concepts and models help thinking in a similar way. (Ibid. 77-79)

Besides knowledge intensity, the word is more complex. In complexity theory, systems build from subsystems that interact in many ways. Changes in one subsystem may cause unexpected changes in other subsystems. Systems receive energy flows: resources, materials and knowledge, they constantly reorganise themselves. Without the flow their functionality will regress. The basic principles of complex systems are connectivity, co-evolution, enforcing cycles, nonlinearity and sensitivity to initial conditions and self-organisation. (Juuti and Luoma 2009, 106-175). Complexity emphasises integrative thinking, finding new solutions, seeing positive alternatives and their connection, rethinking and reframing (Martin 2007). The innovation process is not linear. It is often a fuzzy, iterative, interactive trial and error process (von Hippel 2005) that mostly happens in networks. This creates challenges for the management of the innovation process (Kettunen et al. 2008, 5-10). In fast-changing and complex environments experimentation is important (Doz and Kosonen 2008, 2010). Smart experiments can lower both the risk and costs of innovation (Thomke 2001, Davenport 2009).

3.2 Innovation Strategy, Clusters and Networks

In order to have controlled benefits, innovation management should be based on strategy. A strong vision forces one to think in new ways. It also provides goals for long range development. The main capabilities of innovation are competences in the innovation focus field, appropriate process and information technology that supports and adds effectiviness (Malinen and Barsk 2003, 52, Hamel 2000). Coordination,

communication, conflict management, creativity and problem solving, and capacity management are also considered important (Beer et al. 2005).

Executing strategy requires an appropriate process. Parts of a justified process are participating, explaining, and clarified expectations. Participating means that all members of the organisation are involved in the strategy process and strategy renewal. Explaining refers to explaining the members of the organisation why strategic decisions are what they are. The personnel must also know what is expected from them. Taking in account all three parts makes the process justified (Thibault and Walker 1975). Kaplan and Norton related a Balanced Scorecard system for strategy execution. It was based on balanced metrics and interconnections between parts of the strategy. In the model innovation and learning are also important parts. Innovativeness and learning, combined with resources, lead to success in processes. Process success leads to customer results that also suggest success in financial results. (Kaplan and Norton 1992)

Competence based competition is based on effective utilisation and development of competencies. Customer-seller relations, partnerships and strategic alliances are seen as effective ways to add competencies. Organisations concentrate on their core competencies and search for completing competencies from other actors. Core competence is a combination of knowledge, technologies and skills, knowledge areas. A *core competence* adds value to the customers, differentiates organisation from its competitors and is expandable meaning that it can create a wide variety of products and services. (Hamel and Prahalad 1994, 5-15). Competence based competition theory has four main attributes: it is dynamic, systemic, cognitive, and holistic. (Sanchez and Heene 1997) According to dynamic competence theory a firm can be competitive if it has unique processes, specific assets and evolution experience. Processes help in management and coordination. Assets and the development path define the kind of opportunities the organisation sees in its environment. Development paths and assets differ in core areas. (Teece et al. 1997)

Networks are increasingly important in the creation of innovations. The type of network needed for innovation depends on which types of innovation we are aiming at and how similar the actors are. Radical innovations are usually created in strategic partnerships with similar actors or in heterogenic networks with different actors. Incremental innovations can be created in forums or regional clusters. (Laine 2007, Tidd & al. 2005, 413). Innovation networks also need boundary spanners who understand the language of all partners and can work effectively as network builders and coordinators.
In networks innovating and development can be more effective than within a single organisation. The more organisations and people are involved, the more critical mass there is and the following benefits may result: effectiveness of the search process, collective learning processes, improved image and communication, convergence of management and harmonisation of decision making routines, trust and control. (Marttila

et al. 2007, 10-11, Cooke 1998, Camagni 1991) In networks there is a need to evaluate the partners. Ring and van den Ven created a cyclic model for interaction of organisations where evaluation is an important and embedded part of the process. Relationship begins with negotiations. The negotiations can result in commitment on a contract level and a psychological level. After commitment there is action which usually happens in interaction. Evaluation takes place during the whole process and it is especially based on effectiveness and value creation. (Laine 2007, Ring and Van de Ven 1994, 97)

Organisations differ in their ability to innovate. The first group consists of organisations which do not recognise the need to change. The second group consists of organisations which know how to change but do not have the resources. Into the third group belong the organisations who know how to change and they have the ability to create and absorb new knowledge. The fourth group consists of organisations which have a strong vision about the change and their capability to create and absorb knowledge. (Tidd et al. 2005)

Regional clusters create both horizontal and vertical connections between actors (Porter 1990). Hard regional competition can be a driver of competitiveness (Porter 2001). Regional circumstances and partners can also be a source of unique innovation (Porter and Stern 2001). Regional circumstances, like development history, culture and the ways to innovate, must be taken into consideration in regional cluster development (Martinez-Vela and Viljamaa 2003, Laine 2004). The knowledge intensive services have been noticed to be important for cluster development (Kuusisto and Mayer 2003). KIBS have an important role as innovators and transfer agents. They are fast in adapting new knowledge and technology and transferring it to their customers and partners. This is important in peripheral regions (Miles 2003)

A partnership means a formal agreement between two or more parties that have agreed to working together in the pursuit of shared goals. There are three types of partnerships: operational for efficiency, tactical for learning, and strategic partnership for innovation. Strategic partnership can also lead to radical growth. (Ståhle and Laento 2000) In knowledge economy, knowledge is created in long term partnerships. Trust plays a major role in those partnerships which are used for improving the innovativeness. (Fisher et al. 2002) Networks can be seen as more dynamic and less formal forms of connections between different actors than clusters and partnerships. Networking is also a social phenomenon. There are strong and weak ties between actors (Granovetter 1973). For innovation there are three types of network development. Firstly, there are connections that do not exist although actors would benefit from them. The first task is to see these non-existing connections or holes (Burt 2003). Secondly, there should be intermediaries that can transfer or deal knowledge through these holes from actor to actor (DiMaggio 1992). Thirdly, there is a need to develop new networks that connect

existing networks. Thus there are three roles for *intermediaries* in networked innovation (Hardagon 2003, 55-64). Intermediaries are actors that create new connections and transfer knowledge between actors in innovation system.

National innovation system refers to all actors affecting innovation capability (Tidd et al. 2005). Regional innovation systems are reflections of the national innovation system on the region. Regionally the innovation system is built of creators and users of knowledge (Autio 1998). It is difficult to evaluate innovation systems externally because of rich tacit knowledge involved (Ibid.). New forms of innovation models are living labs, where users can innovate products and services in their real context (Lemola 2009). An innovation ecosystem refers to dynamic and ad hoc based new connections for innovation between actors. An innovation ecosystem has potential that is activated in focused actions or emerging situations. An innovation ecosystem is more flexible than an innovation system and is more based on emerging case-by-case connections. Actors of the ecosystem create the potential for the system that can be utilised by orchestrating the ecosystem. The orchestration requires active members that see opportunities and are willing to utilise the potential with other actors. In a dynamic environment sustainability requires learning capability from the system. It also requires control and interaction with its environment (Ala-Mutka 2008, 268).

Trust creation is necessary before the networked partners are willing to share knowledge openly and spontaneously. Trust is constructed from three dimensions: competence, goodwill, and identity. Competence is the most important element of trust (Blomqvist 2007, 178-190). Trust can be created with immediate problem solving, frequent contact, honest communication and by developing wide relationships (Wilson and Wilson 1994). In dynamic situations entrepreneurs use fast personal trust based on fact analysis and intuition (Blomqvist, K. 2007, 178-190). Collaboration competence is seen as a core competence for innovation (Blomqvist and Levy 2006, Miles et al. 2005, 2006). In the future, the success of innovative SMEs is based on technology and trust (Miles and Snow 2005, Miles et al. 2005).

Diffusion of innovations has similar elements irrespective of environment and subject. Diffusion is a communication process where ideas are transferred between members of social system. There are individual differences in take-up and adoption, and those who are interested in innovation are the key actors. Adopters can be divided into five groups: innovators, early adaptors, early majority, late majority and laggards. Innovators are more often highly educated than laggards. (Rogers 1995) The implementation of an innovation sometimes requires *re-innovation*. This often happens with complex innovations. In those cases a reflective way of working helps to implement the innovation. The role of early adaptors is important in knowledge diffusion and in the support of other adaptors. An innovation has properties which explain its success or at least support the diffusion of innovation: the added value of the innovation,

compatibility with the user and her values, simplicity, trialability without complete commitment and observability of results and other benefits for the user and the observers. (Ibid.)

3.3 Open innovation

Innovation is changing from *a closed innovation* paradigm to *an open innovation* paradigm (Chesbrough et al. 2006). Closed innovation referred to doing Research and Development (R&D) and innovation related activities in-house. The open innovation paradigm considers external ideas and exploiting opportunities as equal to an organisation's own ideas and ways to commercialise them (Chesbrought 2003, 43). In the open innovation paradigm higher education is an important collaboration partner for firms (Ibid, xxviii). In knowledge society the knowledge is more widely distributed. Open innovation is about finding new creative combinations of internal and external knowledge (Ibid, 43). Open innovation seems to be applicable in a growing range of industries (Vanhaverbeke 2006, Gassmann et al. 2010). Customer based innovation and networked innovations in communities are new ways of applying open innovation and they are on the increase (von Hippel 2005). Open source software is an important part of the open innovation paradigm because it enables other innovations as well. The open innovation models introduced are mostly for large high technology firms. There are also signs that the traditional industries are in transition to the open innovation paradigm (Chesbrough et al. 2006, Chiaroni et al. 2009, Gassmann et al. 2010).

There are four major drivers that drive the outsourcing and opening of innovation. Firstly, the demand for innovation is growing while new market demands, in the form of new products and services, are rising. Secondly, the supply of scientists, technologists and knowledge is growing fast. Thirdly, interaction capabilities are better due to the internet and information technology. Also, interactions between technologies grow all the time. Fourthly, new incentives also exist, like lower taxes, lower trade barriers and a lower level of investments required. (Quinn 2000). Also the rise of complexity directs towards open innovation. Therefore organisations cannot easily innovate alone anymore (Van de Ven 2005, Van de Ven et al. 2008). The outsourcing of innovation requires several things from the actors involved. All actors must be committed to the goals and all actors must also benefit from the actions. The processes must have managers or "masters" and these managers must also be trained further as the process gets more complicated. Actors should have interactive software tools. There should also be challenging development goals which force one to think in unusual ways. The focus should be on the results and not on the ways they are achieved. Especially applying rules that are too tight can hinder creativity. Software tools should be used to coordinate the actors. The benefits should be divided between the actors. Interaction

between actors works on three levels: senior managers, masters and developers. There should be incentive systems and the knowledge circulation should be open. However, there are risks in the outsourcing of innovation. The outsourcing organisation must coordinate the process and create adequate added value. In other cases there is a danger to be left outside the value chain by other actors. (Quinn 1999, 2000).

There are requirements for open development that are prerequisites for its deployment. Distributed knowledge can be collected if there is an open access to it, in other words it is not closed or owned. A large enough amount of users consider the product (knowledge) valuable. The product benefits from large peer observation and evaluation. It can be improved with creative initiatives and by correcting errors. An individual or a group can step up to take the leadership of the project and create a core of contents that is promising enough to develop into something really beneficial. A constantly interacting community of volunteers can build around production of the knowledge (Weber 2004, 271). The open source process suggests that there are general organisational principles for the distributed innovation: to empower people to experiment, to enable parts of information to find each other, to structure information so that it can combined with other pieces of information, and to create a governance system that supports this process (Ibid. 234). The user innovation communities can be successful when at least some users have sufficient incentives to innovate. Also at least some users have incentives to voluntarily reveal their inventions and the means to do so. The user-led diffusion of innovations must also be able to compete with commercial production and distribution. (von Hippel 2001)

One of the main challenges in open innovation is what will make people reveal their ideas and knowledge for free (West and Gallagher 2006a, 2006b). The expectancy theory says that individuals are motivated when the attractiveness of reward and the road to reward are present. Firms are found to reveal their innovations when they benefit and there is no loss in return. Customers are willing to innovate when they get better products (von Hippel 1988). Firms can reveal their innovations even to their direct competitors when there is a growth in market share. They may grow an ecosystem of innovation around a product or a service although even their competitors may partially benefit from the results. (West and Gallagher 2006a, 2006b) The most important issue from the point of view of open innovation is to understand how to motivate spillovers (West and Gallagher 2006a). The second challenge is how firms can recognise external knowledge and how they can effectively benefit from internal and external ideas and their exploitation (West and Gallagher 2006b). Opening up the innovation process also requires a new type of management that the traditional industries are not used to (West and Gallagher 2006a). Some higher education institutions create open source software. This software can also enhance innovation, like when being used for open innovation processes to enhance triple-helix and user participation to the innovation process (Santonen 2009, Santonen et al. 2007).

Open innovation creates technology and business interdependencies and therefore it also makes the innovation process more complex (Dogson et al. 2006). One of the few practical open innovation models introduced in literature is the Connect and develop model. The model emphasises the important roles of strategy, entrepreneur networks and open innovation platforms in the innovation process (Huston and Sakkab 2006). Innovation has a changing character. It is moving from a closed to an open innovation paradigm. In the open innovation paradigm, internal R&D is still needed in organisations. Its role is to identify valuable external knowledge and fill missing parts not found outside the organisation in question. It should combine and integrate external knowledge to create more complex combinations of knowledge and even create revenues by selling research outputs to other firms. (Chesbrough 2003, 53) The outsourcing of innovation may be an important strategy for a firm from the very beginning. A network growth strategy best fits productive firms and those who have fluctuation in their volume of business. It also fits any new firms that do not have plenty of resources. Internal growth emphasises the more traditional management competencies while networked growth places more emphasis on new competencies, like networking, trust creation, social skills, communication, collaboration, network building and management, partner evaluation, network working models. (Varamäki and Tornikoski 2007)

From the recent and past research concerning open innovation some trends can be identified. Open innovation is turning from pioneers to mainstream. It is spreading from high to low tech and from large firms to SMEs. The innovation process is changing from a controlled process to an iterative probe-and-learn process. Innovation structures are changing from independent action to various types of alliances. Higher education institutions are changing their role from ivory tower to knowledge brokers and corroborative research partners for industries. Internal processes within industries are becoming more professionally managed from the point of view of open innovation. The context of innovation is changing from products to services. Intellectual property management turns into buying and selling rights instead of only protecting them. (Gassmann et al. 2010).

Open innovation requires new competences and management from firms. In open innovation higher education can be an important partner for firms. At the time open innovation makes innovation more complex. The existing practical open innovation models emphasise strategy, entrepreneur networks and innovation platforms.

3.4 Innovation Based on Science, Practise, and Technology

This subchapter examines science and practice as sources for innovation. It also studies the role of information and communication technologies (ICT) in innovation and

technologies that can enhance knowledge creation, combination and innovation. These technologies are defined as *innovation technologies*.

Innovations can be science or practice based. In innovation based on science (STI model) the basic research results are turned to products and services via applied research. In innovation based on practise (DUI model) the sources of innovation are diverse. In DUI model of innovation the innovations raise from doing, using and interacting. Doing means learning by doing, using means using of complex systems and interacting means knowledge intensive service processes. STI model is mainly based on explicit knowledge and DUI model is more based on tacit knowledge. STI model needs to be complemented with DUI model. In practice, the models are overlapping and there are no pure STI or DUI models. (Jensen et al. 2007) DUI-model organisations use interdisciplinary working groups, quality circles, systems for collecting proposals, autonomous groups, integration of functions, and low hierarchy. STI-mode learning organizations use positive expenditure to R&D, co-operation with researchers and employers with higher education degrees. (Jensen et al. 2007) New product concepts start from three main sources, from strategy, forecasting or free ideas (Kettunen et al. 2008, 184). The value of innovation is largely based on technology, application and context (Ibid. 31-33). In science based innovation there is a valley of death in the knowledge path between basic research and application. Research resources diminish when commercialisation becomes more likely. Commercialisation resources grow significantly only when the risk of failure is small enough. (Markham 2002).

Today, software dominates all innovation steps. It is strongly involved in research and the publication of research results, applied research, product and service development, manufacturing, interaction with customers, monitoring usage of products, diffusion and organisational learning, interactive opportunity recognition, user innovation. The internet and open source have enabled masses of innovations themselves. ICT seems to have an important role also in the future. (Quinn et al. 1996). Technology and ICT competencies are positively related to radical innovation (Di Benedetto et al. 2008). In particular ICT helps to move from the closed innovation to the open innovation paradigm because ICT enables the exchange of distributed sources of knowledge. Tools that can be used are for example data mining, simulation, prototyping and visual representation that are here called innovation technology. ICT also helps to change implicit knowledge to explicit and effectively transfer explicit knowledge. It also helps in open innovation by effectively transferring all codified knowledge between actors. (Dodgson et al. 2002, 2006)

ICT is intensively used on several areas that support innovation creation: basic research, applied research, development, manufacturing, interaction with customers / interactive customer design, monitoring the usage of products, diffusion and organisational learning and new value added systems. It looks like IT will stay in the core of

innovation. (Quinn et al. 1996). Customisation of products and services is mostly based on ICT technology (Prahalad and Khrisnan 2008). In general business spending on ICT R&D is high (the share of all business R&D that is in information and communications technologies). As an example in Finland it is about 60 % and in Netherlands over 45% (Hirsfeld and Schmid 2007, 11). *Innovation technology* is broader by definition than ICT. ICT refers to computers, internet, and communication devices and so on whereas Innovation Technology is a broader set of new technologies like simulation, modelling, virtual reality, data mining and rapid prototyping to name some of them. They can be used in several ways in open innovation to accelerate the creation of new knowledge combinations. (Dogson et al. 2006).

Innovation technology speeds up the innovation process and makes the fast creation and integration of knowledge possible. Effective innovation requires a combination of science based and practice based innovation and the utilisation of innovation technology. The role of ICT and innovation technologies is essential in innovation based on technology. ICT competences are also related to radical innovation capability.

3.5 Entrepreneurship

Entrepreneurship is one implication of innovation and entrepreneurs are seen as creators of innovations. Entrepreneurship is a process of opportunity recognition and exploitation (van der Sijde 2006). The process takes place in a social system where economic, strategic, cultural and network capital are present (Groen 2005). Entrepreneurs have a unique contribution by creating creative destruction with innovations based on new combinations of knowledge (Schumpeter 1942). Innovation begins with opportunity recognition as described earlier in the innovation management part. The path dependency or corridor principle explains why an entrepreneur sees certain opportunities and not others. The opportunity emerges because the entrepreneur has started a firm or project that creates knowledge about customers, suppliers, technologies, new trends and about entrepreneur herself. These opportunities would not have been met if the earlier firm or career would not have been started. (Teece et al. 1997, Ronstadt 1988)

Knowledge intensive business services (KIBS) are services and business operations heavily reliant on professional knowledge. They are mainly concerned with providing knowledge-intensive support for the business processes of other organizations. When considering studies about knowledge based entrepreneurship and innovation management in knowledge based economy, an integrated approach is recommended so as not to lose important aspects (Miles 2000).

Student entrepreneurship is defined as a model where a student becomes an entrepreneur during her studies. Van der Sijde (2006) created a research agenda for student entrepreneurship consisting of specific topics, support structures, teaching entrepreneurship and curriculum development. Most research is done on teaching entrepreneurship. Student entrepreneurship can be supported by training, coaching and mentoring (Kirwan et al. 2008). *Training* is the teaching of knowledge, skills, and competencies. *Coaching* is a method of directing, instructing and training a person or a group of people, with the aim to achieve a goal or to develop specific skills. *Mentoring* refers to a developmental relationship in which a more experienced or more knowledgeable person helps a less experienced or less knowledgeable person to develop in a specified capacity. In universities there is a dramatic rise in entrepreneurial activities (Siegel et al. 2007).

There is a need for holistic models that support the creation of entrepreneurship. Important areas supporting new businesses cover business idea formulation, product development, market definition, organisation development, competence, commitment, customer and other relations (Davidsson and Klofsten 2003). According to case studies three supporting systems are used in university environment: training, coaching and mentoring. All three ways of support are recommended (Kirwan et al. 2008). Coaching and mentoring are parallel and both are needed in supporting young entrepreneurs. Success factors include a holistic approach, competence fit, defining needs, contacts to networks, confidence increasing, commitment, measurable results and using a set of proven tools (Klofsten 2008a,b). Strategic focus and commitment of management is required when introducing new entrepreneurial concepts in higher education (Mertanen et al. 2008). Entrepreneurship is based on innovations and entrepreneurs create innovations. Therefore innovation and entrepreneurship are closely connected and the creation and support of entrepreneurship also create innovations. Holistic models are needed in supporting entrepreneurship in higher education.

3.6 Knowledge Management, Learning and Expertise

Innovation is mainly based on knowledge. Therefore learning and knowledge management are involved in the innovation process. *Knowledge management* can be seen as strategies and practices used in an organisation to identify, create, represent, distribute, and enable the adoption of insights and experiences. Knowledge management should support the accumulating and creating of new combinations of knowledge in interaction that aims to the creation of innovations. *The absorption capacity* is defined as an ability to recognise, acquire and use useful knowledge (Cohen and Levinthal 1990). Absorptive capacity can be divided into potential and realised absorptive

capacity. Realised absorptive capacity leads to strategic flexibility and innovation performance (Zahra and George 2002).

In knowledge economy learning is accelerated (Lundvall and Johnson 1994). Knowledge management methods can help to accelerate learning together in practice. What actually matters is learning to learn (Lundvall et al. 2002). Knowledge intensity emphasises the importance of learning for individuals, organisations and innovation systems (Nonaka and Takeuchi 1995, Senge 1990, Kaplan and Norton 1992, Lundvall and Johnson 1994).

According to Nonaka and Takeuchi (1995), knowledge creation is a process where experience based tacit and writing based explicit knowledge interacts. Knowledge is created with expanding spirals in different epistemological and ontological dimensions. The knowledge creation process has the following steps: sharing tacit knowledge, creating concepts, justifying concepts, building an archetype, and cross levelling of knowledge to new levels of knowledge and organisation. Knowledge interaction requires appropriate spaces. Knowledge can be effectively created in a hypertext organisation which consists of line organisation, dynamic project teams and supporting ICT structure. Nonaka and Takeuchi claim that new product development process is the most important knowledge creation process in the organisation. They emphasise the role of project managers as important actors (Ibid. 240). Tacit explicit transformation is performed by an individual but supported by organisation. The core of the knowledge creation happens on a group level (Ibid.).

An organisation's knowledge assets can be created in spiral like process where tacit and explicit knowledge are accumulated (Nonaka et al. 2000). Innovation and knowledge creation circumstances are created in a space called "Ba". Bas can be divided into types like originating, discussing, organising and executing Ba. In these spaces diverse types of knowledge are created. Executing Ba creates routine knowledge, originating Ba creates individual and collaboration knowledge, discussing Ba creates definitions and concepts, organising Ba creates systemic knowledge (Nonaka, Nonaka and Takeuchi 1995, Apilo et al. 2007, 123-124) The workers who understand strategic goals and have a clear understanding of customer needs are in critical role. They are in the crossing of vertical and lateral knowledge flows. Usually those people are, despite of their titles, also in power to make important decisions and have rich internal and external contacts. The importance of informal tacit knowledge in addition to formal explicit knowledge should be noticed. (Nonaka and Takeuchi 1995, 240)

Expertise can be defined as a progressive problem solving capability where a person constantly strives to exceed her previous level of knowledge and skills (Eteläpelto and Tynjälä 1999, 17, 161). The development of expertise requires contacts to an expert culture (Beraiter and Scardemalia 1993) and surpassing limits (Vygotsky 1978).

Expertise can be divided into routine expertise and adaptive expertise (Hatano and Inagaki 1992). Routine expertise refers to solving problems on the same or a close level of expertise, whereas adaptive expertise means constant development and solving more and more demanding problems. In expertise, practical skills are combined to theoretical knowledge. Reflection skills are important in addition to professional skills. It is important for experts not only how problems are solved but also how they are set. This requires the integration of theory lessons, professional practise, research and training. Metacognitive skills are important in the development of expertise. These skills are used to control learning and motivation by the learner. Motivation is a centric element in the development of expertise.

Today employers require from experts in working life not only expertise but also capabilities to find new knowledge and apply it, collaboration and team working skills, written and oral communication skills, foreign language skills, flexible decision management skills and the ability to manage pressure and uncertainty. Traditional teaching does not much support this kind of expertise growth. One of the greatest challenges is to develop learning methods that combine professional skills and general competences. There are several emerging methods. One of the main theories that are common in these is constructive learning. (Tynjälä 1999, 162) In constructive pedagogy central elements are the following. It notices the existing knowledge the learner has. It accepts that there are different, individual interpretations of knowledge. The development of metacognitive skills (self regulative knowledge and skills) is also activated and so are the learning and thinking processes. Constructive pedagogy emphasises the importance of social interaction in learning. Learning should be combined with a simultaneous usage of knowledge. Learning is also a cultural transfer process. The evaluation of learning is an entity where the process matters the most. (Tynjälä 1999, 162-165)

Project execution is in the core of combining theory and practice. In a project, learning and teaching processes should be seen as a learning process where the participants have problems they can investigate together. All the essential elements of expertise can be developed in working life projects, like theoretical knowledge, practical knowledge and self regulative knowledge. Analytic tasks, discussions, tutoring, coaching and mentoring are the central mediating tools in this. (Tynjälä et al. 2006) Innovation processes and projects can be seen as collaborative learning. Collaborative learning is societal and collaborative work of which the result is more than the sum of its parts (Eteläpelto and Tynjälä 1999, 19). In collaborative learning interaction is an essential element. The process of collaborative problem solving builds from the following phases: collecting, sorting of knowledge and making conclusions, presenting views and defending them, challenges created by opposite views, conceptual conflicts, and uncertainty and new conceptualisation, synthesis and integration. The main signs of collaborative learning are direct interaction, positive interdependency, individual responsibility and equal

participation. To make the collaborative problem solving constructive, the central elements are collaborative environment, heterogenic groups, sharing of useful knowledge, social skills and rational argumentation. Reflection is a central element of collaborative learning. Collaborative learning is found to fit into the investigating and guiding of innovation processes as well if not taken too literally (Siltala et al. 2008).

There is an ongoing change from a knowledge society to a learning society where constant professional learning is a must for every worker and it requires new views. Also the working life organisations' development and organisational learning must be taken into consideration. (Kotila 2003, 21). The innovation process emphasises diverse types and levels of learning in its phases. In the search phase the ability of individuals to acquire knowledge and organise it are essential. In the selection and planning phase, team level expertise and learning is required. In the implementation learning by doing on both team and organisation levels is required. In the capture (value creation) phase effectiveness is needed on process levels (Apilo et al. 2007, 130). New trends and requirements are seen also in the pedagogy research and in teaching as innovative solutions (Good et al. 2007, Heinilä et al 2009, Kainu et al. 2010, Kairisto-Mertanen et al. 2009, Kallioinen 2007, OECD 2008, Ristimäki 2008).

3.7 Summary

Innovation management is based on strategic goals, appropriate processes and networking. Innovation is closely connected to learning and therefore innovation can be enhanced by using knowledge management to support knowledge creation and combination. Learning and expertise are also connected to innovation because knowledge intensity increases in society and in products as well. Experts go over limits and cross borders in their work and therefore they have opportunities to create innovations. And vice versa, the creation of innovations requires actions that are typical for experts. Entrepreneurship is a result of innovativeness and entrepreneurs are key actors in the creation of innovations. There are different forms of innovations. They are important for all firms. Innovation takes increasingly place in collaboration and clusters leading up to open innovation. In open innovation, higher education is an important partner in innovation for firms. New practical models are needed to enhance collaboration in innovation to harvest the benefits of open innovation and the combination of science and practice based innovation.

4 Introducing the Case and Context

In this chapter the Finnish innovation system and higher education's role in it is introduced. The Satakunta county and its characteristics are described. The main characteristics of Satakunta UAS are introduced, and the rationale for case selection is explained.

4.1 Innovation and Higher Education in Finland

Finland created its first national innovation strategy in 2008. According to it the major drivers of change are globalisation, sustainable development, new technologies, and the ageing of people. One of the key issues for a small country like Finland is how to find new crucial knowledge for innovation and absorb it. The main national innovation goals are selected to be productivity through innovation and being a global forerunner of innovation. The four selections made in the strategy are connecting to global innovation networks, emphasising customer-based and user-centred innovations, supporting of innovative individuals and societies and having a systemic approach to innovation (NIS 2008). In general Finland sees that its success is based on knowledge (FSTPC 2006) and therefore higher education has an important role in the national and regional innovation systems. The Finnish innovation policy fosters knowledge intensive services (Research in Finland 2008). The *Finnish Science and Technology Council* has listed the following important development efforts: to foster the total functionality of the innovation system, to strengthen the knowledge base, to improve the quality of research and the allocation of research, to to increase the utilisation of research and commercialisation, and to ensure financial resources. At the core of the innovation system are education, research and product development, and knowledge-intensive business and industry. Varied international cooperation is a feature running through the system. (FSTPC 2006)

The producers of new knowledge include universities and Universities of Applied Sciences, research institutes and business enterprises. The users are mostly enterprises, private citizens, and decision-makers and authorities responsible for societal and economic development. The role of scientific information in societal and economic development has been constantly growing, which increases the significance of cooperation and networking both between the public and private sectors and within the sectors. A key task for science, technology and innovation policies is to ensure a balanced development of the innovation system and the strengthening cooperation within it.

The main renewal for the national innovation system is Strategic Centres for Science, Technology and Innovation. Strategic Centres for Science, Technology and Innovation

will provide a new way of coordinating dispersed research resources to meet targets that are important for the Finnish business and society. In the strategic centres Companies, universities and research institutes will agree on a joint research plan. The plan will aim to meet the application needs for practical application by companies within a 5-10-year period. In addition to shareholders, public funding organisations will commit themselves to providing funding for the centres in the long term. (FMEE 2009, Pursula 2008)

Finland has a dual model for higher education. The higher education consists of Universities and Polytechnics, which are at present called Universities of Applied Sciences (UAS) in English. The law for UAS defines that UASs have an educational, a research and development, and a regional development mission. According to the law, UAS education is based on the needs of the working life and its development. The graduates are experts that are able to develop themselves and the society they work in (Law for Finnish UAS 2003). UASs produce education that supports the professional growth of students. Research and development is applied research that serves the development of teaching and it is based on the needs of regional economy. Education is emphasised in the law text and also funding emphasises teaching (Kotila, 2003). The main portion of the funding is addressed to teaching activities. The UASs have a special role in the research and development of small and medium sized enterprises and in the development of welfare services.

UASs are new actors in the higher education field in Finland. They started as Polytechnics in 1992. They educate experts that can combine theory with practical skills for the industries. The research function of UAS is application and user oriented. It enables quality in education and a better regional impact for UAS (Arene 2006). Funding for UAS is primarily addressed to education which shows in actions. In practice the limited funding of research and development activities has caused that most UAS connect teaching, applied research and regional development tightly together (Kotila 2006). UAS can have different roles in R&D, like coordinator or administrator, expert, educator or builder of R&D infrastructure (Marttila et al. 2007).

In UAS teaching, it is central to combine research, teaching and working life together. As a central teaching method there are research and development projects together with working life where the students can learn developing and investigating approach. In the learning process the learner, teacher and working life participant are in deep collaboration. The Finnish Ministry of Education has an entrepreneurial policy that emphasises supporting the creation of entrepreneurial spirit nationally and regionally, supporting internal and external entrepreneurship and starting new enterprises and supporting innovation in general, and developing existing enterprises and supporting succession. Many UASs have also added knowledge intensive entrepreneurship into

their strategic focus. Regional impact is seen as a sum of impacts of all the actions. (FME 2004)

The Finnish Higher Education and innovation policy has gone through some main changes and renewals. For Universities the main renewals are the university reform and the new innovation university concept. According to the university reform all Finnish universities are governmental agencies, but they will be separated from the state as autonomous private foundations. The state will be the main financer also in the future, but universities have the responsibility of their economy. The number of outside persons in university boards will be increased. Aalto University is based on a new Finnish Innovation University concept where three existing universities in Helsinki region are merged into a single new one. The merger is part of the structural renovation of the Finnish University sector. Aalto University has a vision to be a world class university by 2020 on the fields of technology, design and business. Aalto University will have a new structure and management system based on private foundation. Aalto University will have better resources and more autonomy and it will be highly international. The first academic year started in August 2009. Universities of applied sciences have also mergers in process and many UAS have either changed or going to change towards a limited liability corporation model where the regional industry, chambers of commerce and municipalities can be shareholders. All these changes aim for a more dynamic and competitive higher education system and better interaction with industry and society for knowledge utilisation. (Pursula 2008)

4.2 Satakunta Region and Satakunta University of Applied Sciences

Satakunta region is the most industrial region in Finland. Particularly the base metal, machine construction, wood processing, leather and food production industries are strong. The Pori and Rauma ports are important on a national scale. The Satakunta region has a diverse industry and clusters. Over 50% of production comes from the technology industry. Satakunta was among the first regions in Finland that created its technology strategy. Regional strategies are a reference for strategies of higher education on the region. Satakunta also has a diverse higher education with local University Consortium and two Universities of Applied Sciences with diverse innovation environments and networks. Satakunta is also a part of a national networked Centre of Expertise program. The region has a good technical infrastructure, rich culture and clean nature. There is plenty of space for living and business. It has active people, communities and countryside.

According to the industrial vision of Satakunta the development of industries continues in a steady and controlled fashion. The strong technology and wood industries create the

base for business and welfare and are significant developers of competitiveness. New growth industries like software and communication and automation integrate to existing industries. They have a central role in the development of competitiveness. The central challenges of the region will be

1. raising competitiveness by improving efficiency and innovative applications
2. solving the retirement of workforce by improved efficiency and foreign employees
3. ensuring the preconditions for business and forecasting the business environment
4. ensuring the local multi-field talent and expertise of new technology
5. forecasting future demands because of faster and wider change processes

The challenges are the same for both private and public sector.

On the Satakunta region industrial vision action list the first action is the fostering of regional innovation activities: firstly, by recognising the main trends and growing fields of industry. Secondly, fostering R&D by combining industry resources, research, and external resources of knowledge. Thirdly, adding collaboration between anchor firms and other actors on the region, like bringing together young innovative entrepreneurs and senior industrial managers to dialog, transfer good practices and change interdisciplinary knowledge. Fourthly, adding research funding on the region on focus areas via strategic centres of excellence and other appropriate channels. (Satakunta 2009)

Satakunta University of Applied Sciences (in Finnish Satakunnan ammattikorkeakoulu, Samk, previously called Satakunta Polytechnic) is located in the Satakunta region in Finland. Education, research and development and regional development are its core functions. It has three faculties: Business and Culture, Social Services and Health Care, and Technology and Maritime Management. Satakunta UAS is the biggest institution of higher education in the region. Satakunta UAS operates in the biggest towns of the Satakunta region. It provides the students with skills and expertise they need in working life. It conducts applied research and development and participates in the development of the region and the working life. It focuses on international activities and international cooperation in many ways and promotes cooperation between higher education institutions. It has three faculties and campuses in four towns and the city of Pori as a maintainer. There are over 500 teachers and staff members, 6500 students and an annual intake of 1,100 students. It has 25 degree programmes in Finnish and 4 in English and 900-1000 degrees awarded yearly. It has 34 million Euros of annual operating expenses. Satakunta University of Applied Sciences has been awarded by the Finnish Ministry of Education several times. It has the following achievements: Centre of Excellence in Regional Development 2001-2002, Centre of Excellence in Education 2002-2003 and Centre of Excellence in Education 2005-2006. (Linna 2009, 16)

According to SUAS vision it is a significant institution of European higher education and that produces knowledge that is valued by industries. It has the following strategic goals that help to achieve the vision: Satakunta UAS has an operational culture that supports strategic goals. It has products and services that are valued by its customers, competent and wellbeing personnel and excellence in processes. It actively manages its reputation and it has financial tolerance. Satakunta UAS has adjusted its strategies to national and regional strategies and its education programs and curricula to regional and national needs. It has also build metrics to turn the strategies into actions and results (Laine 2004). Strategic goals have their critical success factors and metrics that are built in the *Balanced ScoreCard* (BSC) system (Kaplan and Norton 1992) to help strategy execution. All strategies are updated according to goal and result contract periods with the Finnish Ministry of Education. This period is now three years. To also support vision achievement SUAS selected the values according to which: it values people, operates openly and honestly, produces knowledge and competence that is valued by its environment and creates outcomes in collaboration. (Satakunta UAS strategy, Laine 2007, 2008a)

Satakunta UAS has selected its core areas of applications research. According to its technology strategy the strategy helps to recognise the technological operating environment. It also helps joint understanding among R&D personnel and helps to define core technologies and core technology areas. It helps to direct applications research to develop its own profile and competence. It helps to increase the probability of successful projects and cumulates knowledge on selected areas. It supports the allocation of resources and investments to relevant projects. It helps to reduce detailed guidance and steering of actions. And finally, it helps to combine applications research to teaching and improves collaboration and atmosphere. (Ibid.) The collaborating opportunities in R&D with Satakunta UAS for SMEs and large enterprises are on four levels. Firstly, firms can participate into nationally funded large programs by partially funding them. Secondly, they can participate in EU funded European research programs in collaboration with Satakunta UAS. Thirdly, they can make a contract research agreement with Satakunta UAS. Implementation can be done in several ways varying from small to large projects in volume. Fourthly, firms can make student engagements such as a thesis, a student project or practical work as a part of study module or single course. In those cases guidance is provided by teachers. (Satakunta 2009)

Satakunta UAS has a quality system that covers all its main processes and functions. The management system in Satakunta UAS is described in its quality manual. It consists of the following elements: customer needs detection, strategic planning, goal agreement between the Finnish Ministry of Education, the city of Pori as the maintainer of the UAS and Satakunta UAS, annual planning, the development plan and management reviews, quality management and crisis management.

The pedagogical framework in Satakunta UAS is working life oriented. It is based on principles where the learner and working life competencies are brought to the focus. Learning, personal growth and competences needed in working life are supported with the appropriate pedagogical environment. Pedagogy is based on a humanistic view of man, a developing view of knowledge and a constructivist understanding of learning. According to *a humanistic view of man* a person is: free, decision making and responsible of the made decisions; developing, social and aiming at interaction; and valuable as a human being and having opinions that must be respected. *A developing view of knowledge* emphasises the application of knowledge and the developing nature of knowledge and the corresponding real world, active knowledge acquisition and transformation, a critical approach to existing practices and sources of knowledge, an understanding and capability to handle a large body of knowledge, the integration of knowledge and skills to expertise and the value of knowledge per se. *Constructivist learning* emphasises learning instead of teaching, the learner instead of the teacher and an individual construction of knowledge instead of the transfer of already constructed knowledge.

In Satakunta UAS the learner is responsible for her own learning. Satakunta UAS has the responsibility to offer teaching, guidance and a learning environment that facilitate learning as described, and challenges the learner to develop into an expert in her own field. It is crucial to support the students' motivation to learn. The learner is seen as a self-guiding, a development-intensive individual that aims to educate herself, grow as a person and grow into society. It is crucial in the constructivist view of learning that the understanding of learning subjects does not transfer in the teaching. The learner constructs her own understanding during learning. SUAS is responsible for producing pedagogical actions and environments that support the above principles. (Satakunta UAS strategy). Satakunta UAS has a competence based curricula for the programs. According to a large student survey for graduates and their employers, the five most important general competences for graduates are: a specific expertise of one's own field of study, negotiation skills, collaboration skills, problem solving skills and time management skills. (Jaatinen and Kuurila 2008). Generic competences are learning competence, ethical competence, communication and social competence, development competence, organisational and societal competence, and international competence. In addition there are the specific competencies of the degree programs. In ICT technology they are mathematics and natural science competencies, hardware competence, software technology competence, ICT-business competence, ICT development skills and networking competence. (Satakunta 2009)

4.3 Rationale for the Case Selection

There are two main reasons to select Satakunta UAS as the case for this research. Firstly, Satakunta UAS has been awarded several times for its regional impact and quality of education and noticed positively in several evaluations and research. Novel solutions for interaction with industry are expected to be found. Secondly, the researcher is able to receive a deep understanding of its functions and activities because of his affiliation in it. It also makes it possible that the modelling process lasts for several years. In evaluations and research about Satakunta UAS its interaction with industry complete models are not presented or evaluated. Only parts of the interaction are modelled or evaluated.

During years 2002 to 2009 Satakunta UAS has been evaluated several times by the Finnish Higher Education Evaluation Counsel (FINHEEC) in national evaluations. In 2001 Satakunta UAS was evaluated concerning its regional impact (Huttula 2001). In year 2005 Enterprise Accelerator incubator was evaluated by FINHEEC (Salminen and Kajaste 2005) and the Finnish Ministry of Education awarded the Enterprise Accelerator of SUAS as a Centre of Excellence in Education for years 2005-2006. The Quality Assurance system was evaluated in 2009 (Malinen et al. 2009).

According to the regional impact evaluation report Satakunta UAS is able to combine regional resources to a common goal. The main success factor was found to be the strategy that was based on the specific needs of the parts of the region. Leadership and management were the supporting factors. It was found that the model needs sensitivity from the management to find balance between the diverse requirements. UAS was found to have a unifying affect on the region. The administrative model is evaluated constantly. The management was found to be clear and in close interaction with the education process. (Huttula 2001, 90-91). Satakunta UAS has a remarkable role in producing professional experts for the region. Transfer offices do an impressive job. There is evidence from multi-field actions on all fields of education. The Institute for Automation and Information Technologies also builds UAS capabilities. In general the emerging industries are in focus but traditional industries are also noticed. The traditional industries should be noticed more strongly. Although welfare entrepreneurship and technology are developed by UAS, the weak signals need to be more carefully detected in these fields. Satakunta UAS is trusted and respected in the region. Interaction with stakeholders creates true benefits for all participants. The stakeholders also recognise these benefits. The students have good opportunities to execute the main idea of UAS: theory is connected to practical experimenting and all studies aim to employment. The evaluation group sees that opportunities for success are good in the future as well if the innovative culture is maintained. Satakunta UAS was also able to see its future challenges clearly. (Ibid)

In 2005 Enterprise Accelerator evaluation the evaluators pointed out that the development of education for the needs of the incubator needed a new innovative approach. In the evaluation report the interaction with industries, the contracts' important role in the creation of commitment, dialogue in mentoring, and the new understanding of customers and partnerships are noticed positively. (Salminen and Kajaste 2005) The incubator fulfills the innovative criteria of the evaluation, it is effective and the evaluators recommend it to be used in a larger scale as well. The future challenge will be taking an even more encouraged and proactive role. This means the creation of new research and the development of networks together with other regional actors, like business service organisations and the regional university centre. The aim is to create innovative types of entrepreneurial actions. There is a need for new funding models because funding in EU will change. The evaluators see that it is likely that the Enterprise Accelerator can be a remarkable and respected driver in the enhancement of entrepreneurship in higher education. They see the management of the accelerator as a challenge and they would like to see a larger management team sharing the management responsibilities. (Salminen &Kajaste 2005, Laine et al. 2007).

In the last external quality system audit done by FINHEEC Satakunta UAS passed the evaluation audit and was evaluated to be on the second highest quality management level according to the scale used in the audit. "In the audit report FINHEEC gives Satakunta UAS acknowledgement for the fact that a majority of the staff is committed to the quality assurance system (QAS) and understands its importance. The system also guarantees the students good possibilities to participate and influence, which has been well benefited among the students". (Malinen et al. 2009) In its audit feedback FINHEEC also states that Satakunta UAS is well integrated into the surrounding society through its close interaction with the working life. Through advisory boards it is possible for the representatives of the working life to actively take part in directing Satakunta UAS's future activities. FINHEEC gave Satakunta UAS positive feedback on the regular follow-up studies addressed to graduated students and employers, feedback gathered from the students and our partnership contracts with companies". (Satakunta UAS 2009). The evaluation group sees partnership contracts as a good practice that should be diffused (Malinen et al. 2009,36). FINHEEC also makes some development recommendations in its report. Satakunta UAS should clarify its Balanced Score Card metrics and increase the number of internal quality audits. It would also be vital for Satakunta UAS to better find out what kind of data produced by the QAS would be required by external stakeholders. In order to make the whole personnel committed to the QAS FINHEEC recommends Satakunta UAS to further develop its QAS and enhance the dialogue between management and personnel. FINHEEC will evaluate the QASs of all Finnish Universities of Applied Sciences by the year 2011. Satakunta UAS audit was part of this program. (Satakunta UAS 2009)

4.4 Summary

Satakunta UAS has several features that make it an interesting case for this research. Working life orientation is emphasised in all learning activities and in the faculty of technology all teachers have industrial experience. Learning in Satakunta UAS is working life oriented. The management system, the strategy, metrics and the quality system support interaction with industries. Satakunta UAS is also awarded for its regional impact and the incubator for students. In addition to this the affiliation of the researcher makes it possible to create deep knowledge about innovation creation and select Satakunta UAS as the case study in this research.

5 Systemic Interaction Model for Innovation

In this chapter a systemic model of interaction is described based on seven published papers. The model is based on case studies about Satakunta University of Applied Sciences and its partners. The model consists of six components that are all described in individual subchapters.

5.1 Strategy for Innovation and Entrepreneurship

Satakunta UAS has made a strategic decision to have an intensive interaction with industries. There are several modes of interaction like supporting the knowledge upgrading of higher education graduates by means of education, increasing knowledge and the level of technology with contract research and joint collaborative development projects, the activation of cluster collaboration and the detection of collaboration opportunities, specialised services for SMEs and the creation of KIBS firms. SUAS has chosen several focus areas to bring knowledge to the region. Firstly, it educates high level experts for working life. Secondly, it increases regional knowledge creation and technology development by contract and collaborative research. Thirdly, it develops specialised R&D for SMEs. Fourthly, it creates knowledge intensive spin-offs. And fifthly, it produces adult and continuing education. Actions are based on UASs strategies that are linked with policies and strategies on European, national and regional levels. Satakunta UAS has developed ways of interaction with its partners (Laine 2004a). There is a strong regional focus in strategy and actions. Research and development is aimed at helping regional companies and other organisations to add to their competitiveness. Satakunta UAS is not patenting actively. It wants to use faster and straightforward knowledge transfer and knowledge sharing in interaction.

All faculties have their own focal areas in the strategy and entrepreneurship is a common focus area for all faculties. It fosters both inward and outward entrepreneurship. There is no centralised transfer office for knowledge and technology transfer to industries. This emphasises the importance of the faculties' own work in the commercialisation of knowledge. There are support personnel in the faculties to help with special matters like contracts and filling in funding applications. According to SUAS R&D strategy credibility in the region offers a chance of being a proactive actor in the field of education, R&D, innovation and strategy development. (Laine 2004a, Laine and Lähdeniemi 2007, Laine 2008b) Stakeholders were involved in the development of the technological strategy. Representatives of the senior management of regional industries were interviewed and some participated in working groups during a period of several months. The strategic components are shown in a pyramid form (Figure 5-1): at the bottom of the pyramid are the educational programmes, then the main technology areas and rapidly growing sectors, and, at the apex, the four key areas

for R&D. The strategy is updated annually and includes a clear action list with designated responsibilities. (Laine 2004)

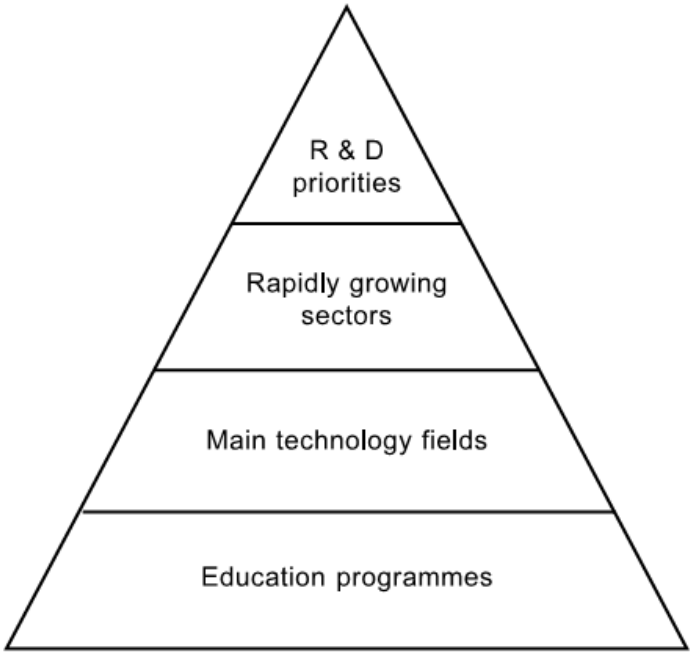

Figure 5-1 Technology strategy pyramid (Laine 2004a)

According to the research the strategy based actions in interaction create a sustainable basis for interaction. The strategic ripeness is created in action and sensing changes in technologies, knowledge and development potential of both SUAS and its partners. Interaction can develop into knowledge and innovation partnership with the partners with the most impact. Teachers and students are a central resource (Ibid.). Innovations are mainly practice based and knowledge is circulated between actors in the context of applications. Long-term research is still required in creating new knowledge on which future applications will be based. Applications in turn create new multidisciplinary fields for research – such as welfare technology, for example. After the technology strategy process was completed, a regional technology strategy was also developed. The development process for this regional technology strategy proved a highly effective means of 'embedding' the activities of UAS in regional development plans. It also enhanced the UAS's understanding of the regional context in which it operates and of the other significant players in the region. The strategy also constitutes a marketing tool for customers, potential partners, funding organizations, students and personnel. (Laine 2004a)

Satakunta UAS combines practice based and science based knowledge for innovation. Problems and opportunities are the starting point and research knowledge is used in combination with application knowledge, tacit knowledge, trial and error innovation process, and experiments are used to create knowledge combinations to tackle the challenges. The utilisation of knowledge combinations requires absorptive capacity,

networking, collaboration competencies and substance competence from Satakunta UAS. (Laine 2004b)

Research and development is organised so that teachers and faculty personnel have an important role in the activation of the research projects and the execution of the projects. The incubator for student entrepreneurs is also integrated into the education process. This emphasises the fact that research commercialisation and entrepreneurship are integrated as main elements into the work of faculties and not as separate functions handled by staff in dedicated units. Research and development projects are a part of teachers' work and a part of studies for the students. The curricula are developed to be flexible. That makes it possible to integrate research and development projects into studies. Teaching and R&D have therefore a strong interaction. (Laine and Lähdeniemi 2007, Laine 2008b)

The organisational structure of research and development is low. Actions are organised as projects and project organisations are built for specific projects. Most projects have steering groups with customers and stakeholders to control their content, results and budget. Internal funding mechanisms in SUAS are mainly used for testing the feasibility of ideas or to do research or develop new promising areas. (Laine 2004b, 2008b) Projects and programs are funded by firms and public funding. There are two regional foundations that give seed-type funding for innovative projects. The main sources of funding are EU, ministries and specialised national innovation funding. Funding is not strongly diversified and this can be seen as volume and resource fluctuation. It hinders building large programs and hinders starting applied research based on earlier project results. It also makes the impact of the actions smaller than they could be with more diverse funding. (Laine 2008b)

The research and development strategy in SUAS fosters a culture where all members of the staff can do research and take part in collaborative development projects with external partners and also transfer their research results into education. It motivates collaboration models that support multidisciplinary research. Teachers and researchers can team up with people from other faculties and their partner organisations. The strategy fosters personnel to publish their research results in publications and circulate their knowledge also in seminars and workshops. It creates systematic quality control mechanisms for the research and development projects and their management. The strategy also fosters proactive work to detect the future needs of the environment. Foresights help to focus research so that the created knowledge is based on the needs of partners and stakeholders. This helps to commercialise knowledge internally and externally. (Laine 2008b)

Important areas are covered with annual awards to bring up positive results and role models to motivate potential participants. There is a "Student Entrepreneur of the Year"

award in Satakunta UAS for entrepreneurs, given every year. The meaning of the award is to emphasise good models of innovative and successful entrepreneurs. The awards are given in personnel meetings to show the importance of entrepreneurship and to collaboratively celebrate the success of the entrepreneurs. Awards are also noticed by the local media and they build a positive image and make the enterprise accelerator more known across the region. There is also a "Project Action of the Year" award that is given annually for personnel for significant activities and outcomes in projects. For teachers there is a "Teacher of the Year" award. (Laine 2008b)

Satakunta UAS uses several ICT based tools to help turn strategy into actions and to help the management of actions. The balanced scorecard with R&D metrics is used to make strategy turn into practice. Web based project and knowledge management software such as intranet and extranet solutions are used. Projects are evaluated in standardised ways before seeking funding and after the project execution. Satakunta UAS has also developed evaluation tools and impact analysis to evaluate and define the impact of its R&D actions (Laine 2008b, 2009, Lähteenmäki-Smith et al. 2006, 85, 87-96, Saurio and Heikkinen 2004, 84, Saurio 2003, 130). Project portfolio management is used to make management or R&D more systemic instead of single project optimisation. Databases like customer database, knowledge management and project reporting databases facilitate general managing, managing knowledge and marketing. Still the knowledge management and the usage of knowledge could be more effective by means of transferring and combining knowledge internally and externally and detecting and better utilising opportunities to start new research or create generalised knowledge. (Laine 2008b) In software development, for example, these innovation technologies used by teachers and students are simulation and modelling software, virtual servers, software development and project management tools, software project management tools, open source development sites that support collaboration and task management, social media collaboration tools for knowledge creation and sharing, and open source software.

The effectiveness in resource utilisation and knowledge creation is sought by increasing interaction between processes (Laine and Lähdeniemi 2007). The model is described in figure 5-2. In UAS the main resources are in education process. Students and teachers participate in the projects. In return, new knowledge from R&D updates the teaching content and creates new contexts for learning when projects are executed. Also, the personnel can upgrade their knowledge of special fields of industry within the projects. The basic knowledge for the students is built in the education process. Entrepreneurship is also based on that knowledge. Mentoring done by the personnel and offering laboratory facilities for rent also support entrepreneurship. Entrepreneurs are found among the students. (Laine et al. 2007)

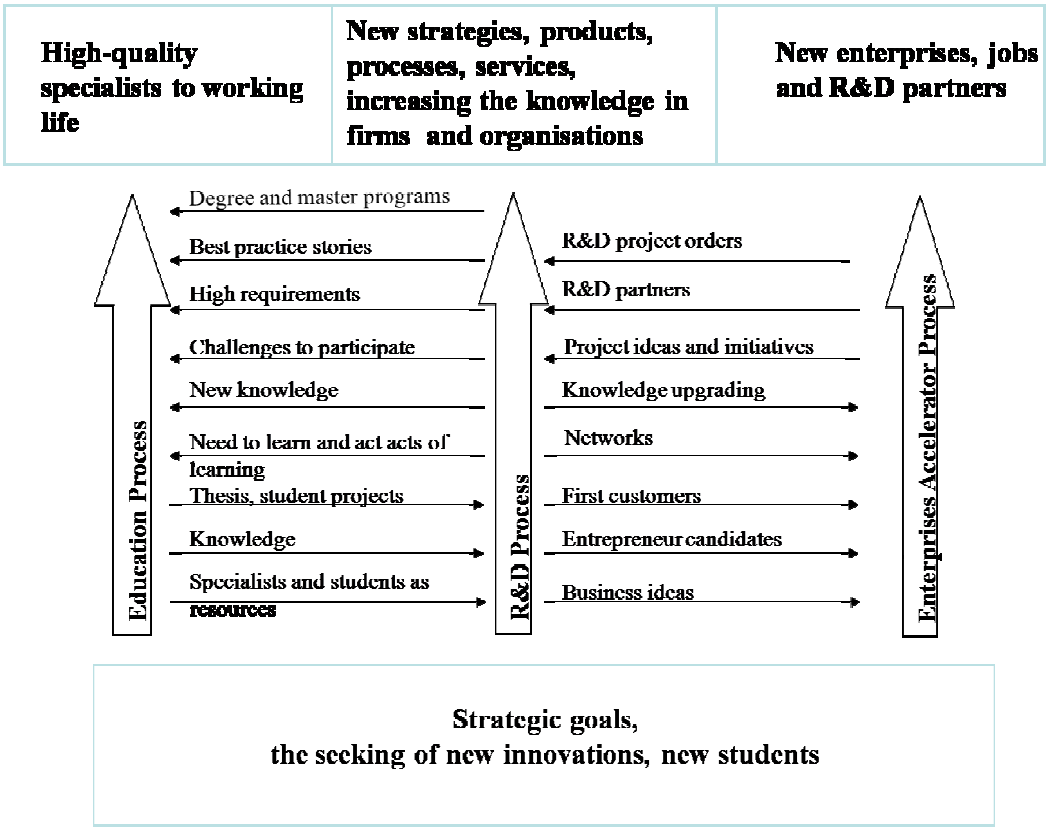

Figure 5-2 Internal interaction (Laine and Lähdeniemi 2003, 2007, Salminen and Kajaste 2005,86)

Enterprises started by students are also learning environments for the entrepreneurs, and entrepreneurial knowledge adds new content to the learning process. True entrepreneurship cases are also used in teaching as examples for all students. Most of the mentors who support students are teachers of Satakunta UAS. R&D projects add to the understanding of the future entrepreneurs' competencies, help to recognise new business opportunities and embed the students to regional industrial and knowledge networks. (Laine et al. 2007) New knowledge created in a project can be part of the core knowledge of a started new enterprise. The enterprise accelerator creates ideas of new research topics. R&D process creates insights to industries, helps to recognise business opportunities, and embeds students to industrial clusters (Laine 2004a, b, Laine 2008b).

5.2 Clusters, Networks and Partnerships

Cluster development is used to improve the impact by using synergies and combining detected needs and opportunities. This consists of three elements:

1. the development of the existing clusters by transferring knowledge and technology,
2. the improvement of the collaboration of the clusters to foster innovation and

3. the creation of a new knowledge intensive cluster that serves the other clusters and adds dynamics to development. (Laine 2004a)

The regional development of clusters is often development of a micro cluster, where usually five to ten most potential firms are selected and their knowledge and technology gaps are analysed, and after that focused research and development projects are started. These anchor firms may connect their subcontractors and networks to the development. One medium size firm can easily bring 20 smaller firms with it. (Laine 2008) The cluster can consist of several firms using the same technology in different sectors of an industry and perhaps also in different applications. Mobile communication and radio frequency identification are examples of this. Same technologies can be used by many firms despite of which cluster they are connected to. They can develop new products, processes and services together because they do not compete with each other. (Laine 2004a, 2007, 2008b) In Satakunta there is no hard regional competition, at least not in all fields of industry. This, in turn, creates better possibilities for co-operation within the clusters. Collaboration and interaction between the clusters creates more potential for innovation.

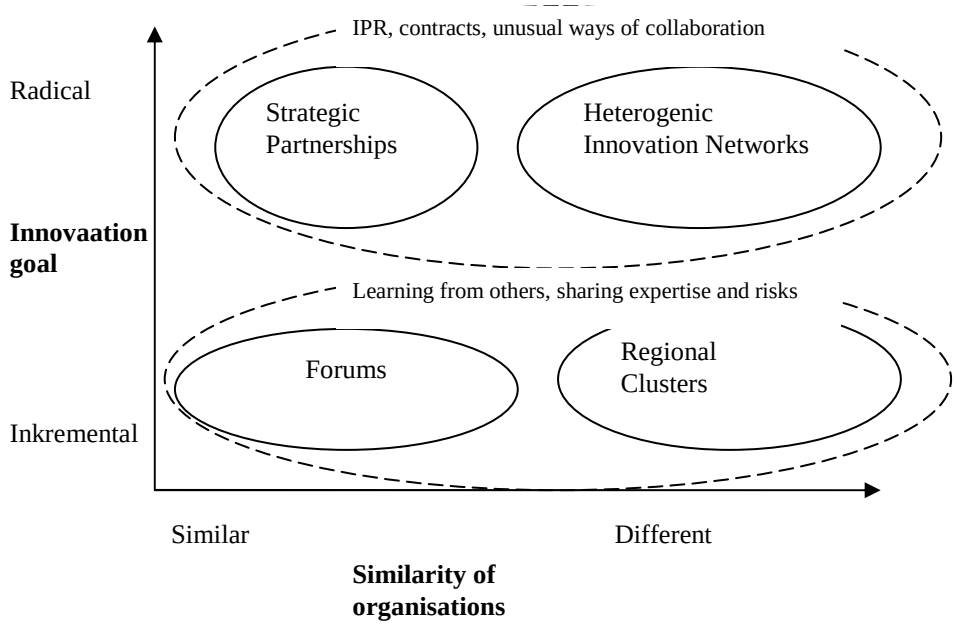

Figure 5-3 The role of clusters, partnerships and networks in innovation according to innovation goals based on Tidd et al. 2005,413 (Laine 2007)

The KIBS firms are important for cluster development. KIBS have an important role as innovators and transfer agents. They can adapt knowledge and technology that is not seen as important by large firms because these are not in their core. KIBS that have a large customer base also transfer knowledge between regions. This role is important for Satakunta as a region with a small higher education sector. Regional circumstances

favour practice based incremental innovation. This is based on development history, culture and the ways of innovation. Managing clusters and networks is a challenge because value networks are complex, as can be seen in figure 5-4. (Laine 2007, 2008b, 2009)

Large projects need several other actors with complex but balanced networks. Sustainability requires that all actors find complementary knowledge and added value from the network.

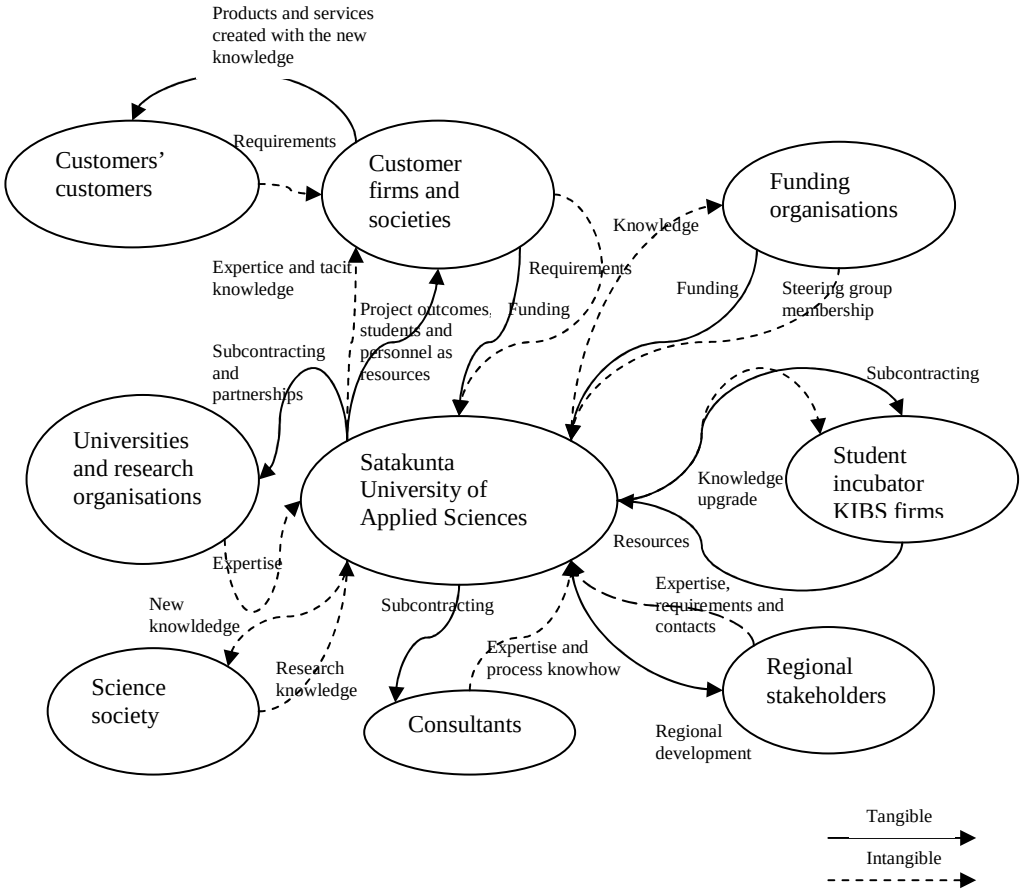

Figure 5-4 A typical value network of a large R&D project (Laine 2007, 2008b)

Regional cluster development can also been seen as a knowledge management (KM) task. In the KM the following areas have been identified:

1. Indentifying needs of knowledge and technology in the cluster
2. Generating knowledge and technology combinations by utilising networks
3. Identifying the created knowledge
4. Reflecting for learning
5. Sharing good practices
6. Increasing partners' ability to adopt new knowledge
7. Adapting knowledge to the target and context
8. Publishing generic knowledge and methods. (Laine 2004a, 2008c)

The process starts with identifying the needs of knowledge and technology in partner firms. This may be done in several ways: in meetings and firm visits, cluster meetings, by email or social media tools. This is followed by knowledge and technology acquisition for these needs. Networks, databases, virtual networks, communities of practice and knowledge communities are used as knowledge sources for combination. It is important to identify the created knowledge and make it explicit and to adapt the knowledge to the context of application. Actions and collaboration add to the firms' adaption capability. Reflecting for learning happens in action and in project evaluation phases. Non-confidential knowledge is published in appropriate forums and generic knowledge and methods are created by simplifying and generalising the used models (Laine 2009). In problem solving multidisciplinary and cross-organisational R&D teams have been noticed to be effective. These teams have reported that artefacts, prototypes and demonstrations are important tools in creating common understanding of vision, goals and contexts (Laine 2007b). For example, it is difficult for a multidisciplinary project team to innovate new services based on emerging technologies if they do not understand what the technology is capable of. If demonstrations and prototypes make technologies more understandable the innovation is more likely to succeed.

Cluster development, networking and KM lead to strategic partnerships with the most active network contacts. The partnering process consists of a notification of a pool of potential partners and the creation of partnership with Satakunta UAS has developed the framework for partnership with its partners. The same model can be used with private and public organisations and clusters. Partnerships are future-oriented collaborations that use several elements of the interaction model to benefit both parties. (Laine 2007, 2008) The main features of the partnerships are the following. The partnership starts with a meeting with the senior management and strategy-level thinking of the goals. Both acute and future needs of partners are covered. Time frame for partnerships is several years. Partnerships are based on a contract with a list of contact people, milestones and responsibilities for actions. Theses and student projects are some of the tools that are used in knowledge creation. R&D&I project activation is also included. Third party funded projects are an option. Direct contract projects are part of activities.
Supporting the training planning and the execution of plans is included. Training can be arranged so that personnel from the partner organisation and Satakunta UAS participate in training. Recruitment info and excursions to firms for students can be arranged. There are collaborative activities like the training of personnel and seminars. Regular review and evaluation of actions takes place, usually in 6-month periods (Laine 2009, Malinen et al. 2009, Leino 2009). Possible partnering process with firms is described in Figure 5-5.

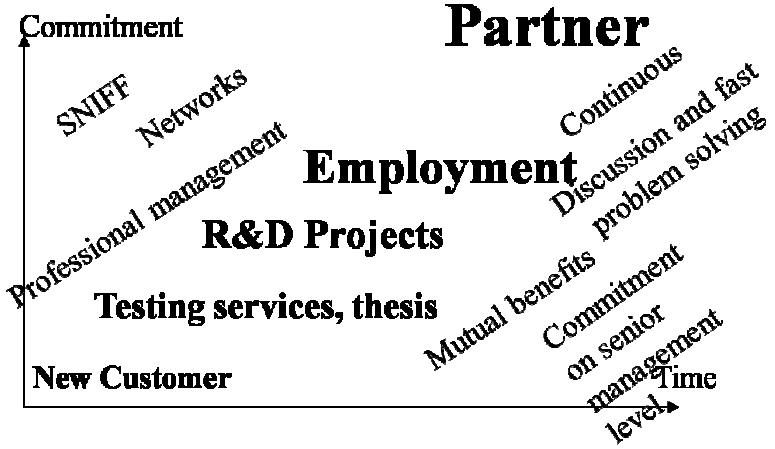

Figure 5-5 Partnership process for firms with Satakunta UAS

The process can be several years long.

5.3 Integration of the Innovation Chain and Utilisation of Technology

This subchapter describes how innovation chain can be integrated by combining innovation based on science and practice. It also explores the partnering process and impact maturity model that improves impact on the region. It still explores the utilisation of innovation technology to enhance innovation creation.

One of the main tasks is to make the innovation chain more integrated as is described in figure 5-6 (Laine 2004a). Integration refers to the simultaneous utilisation of science and practice based knowledge as a source of innovation. More connections and different knowledge combinations from multiple sources mean more possibilities for innovation and also increase opportunities for diverse types of innovations. The linear science based way to innovate is to start applied research after basic research. The best results will be transferred to product development. Introducing basic research results to product developers will give them ideas about more radical innovations in products, services and technologies. These needs are then studied in applied research. So, applied research plays an important role also in this model. Basic research gives solutions to problems faced in applied research and product development, but not often works as a starting point for innovation. Most innovations are practice based and the initiation is in problems or opportunities rising in the use of technologies and services, using complex systems and knowledge intensive interactions between actors (Jensen et al. 2007). Solving problems and exploring opportunities requires often also acquisition or creation of scientific knowledge. Collaboration and knowledge shearing in the whole chain is important to accelerate learning and creation of innovations. (Laine 2004a)

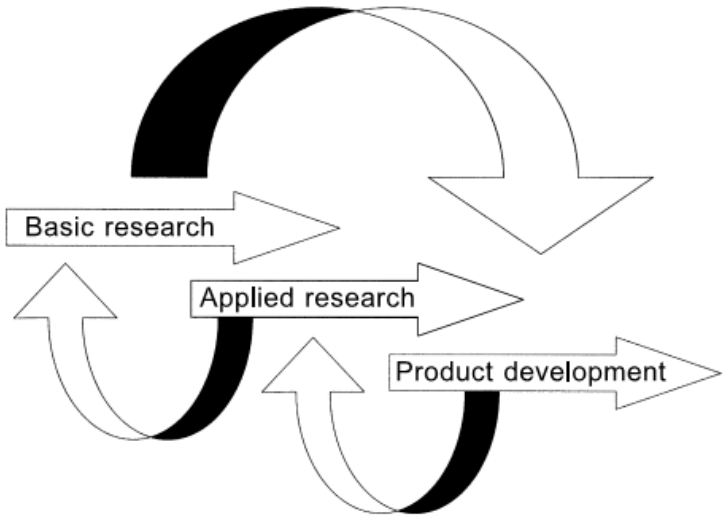

Figure 5-6 Integrating the innovation chain by combining science based and practice based innovation (Laine 2004a)

The natural role of a university of applied sciences is where research resources are diminishing but commercialisation of innovation is not yet strongly resourced (Figure 5-7). This equals to the applied research phase and the early product development phase. The roles of different actors can overlap which in turn secures the sustainability of the whole process if there is appropriate interaction between the actors (Laine et al. 2007).

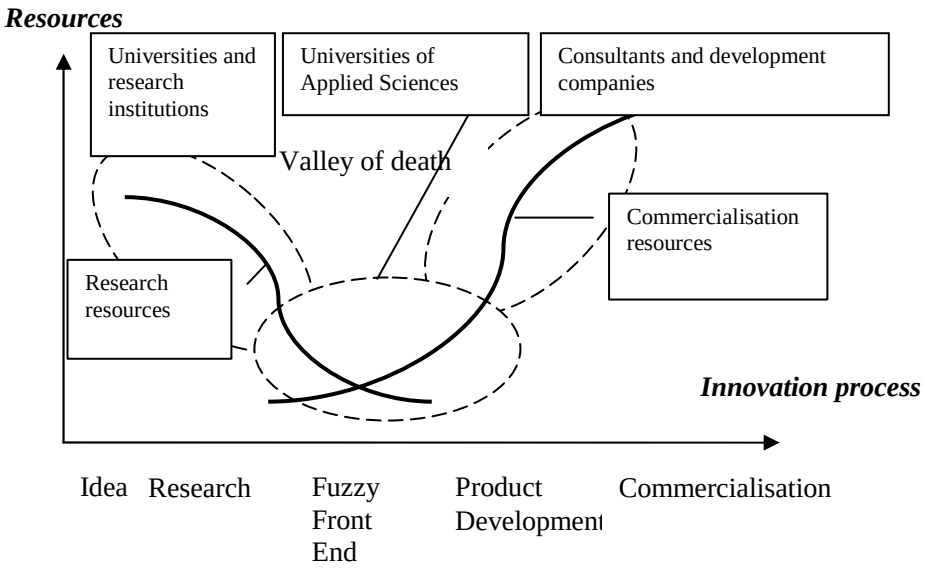

Figure 5-7 The role of Satakunta UAS in integrated innovation process (Laine 2007, adapted and developed from Markham 2002, Ramstad 2008, 77)

The development model of UAS R&D&I activities from ad hoc projects to international innovation networks is described in Figure 5-7. The model was originally published in Laine and Lähdeniemi (2001) and later developed further by Lähdeniemi and Saurio (Saurio and Heikkinen 2004, 22). The model was used as an evaluation framework in research by Saurio and Heikkinen 2004 and Marttila et al. 2007. Also the different roles of students were added in Saurio and Heikkinen 2004 (62). Figure 5-8 shows that the model has five levels: the initiation of ad hoc R&D projects, the development of competences, the creation of strategic competence, the more structured involvement in regional development and the utilisation of international collaboration in regional development (Laine and Lähdeniemi 2002, Saurio and Heikkinen 2005).

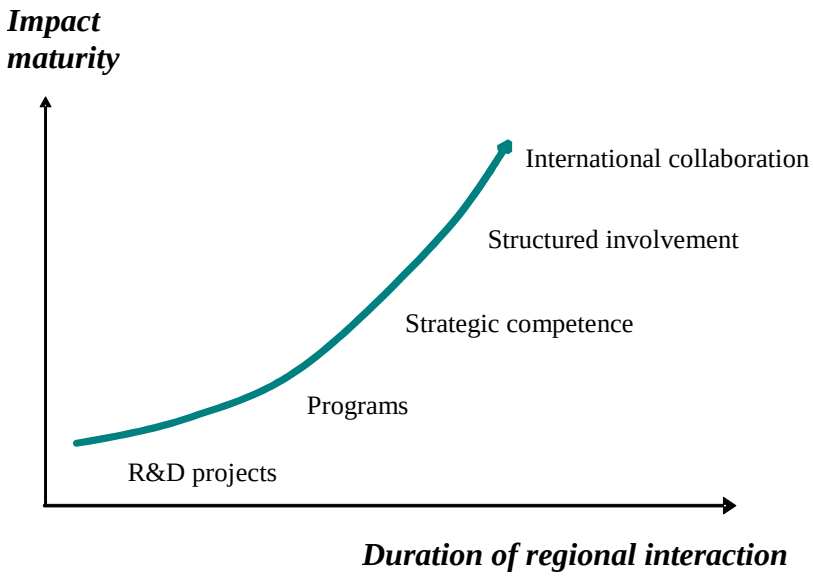

Figure 5-8 The improvement of impact maturity in time (Laine and Lähdeniemi 2002, 2007, Saurio 2003, 92, Saurio and Heikkinen 2004, 22)

On the first level R&D projects are more of the ad hoc type and start based on the detected needs of firms in the region. On the second level the projects are combined to larger programs for better manageability and resource allocation. On the third level strategic competence is gained based on earlier actions and more active involvement in strategy processes. This makes it possible to create more structured involvement in the region in stage four. On the fifth level international strategic partnerships and network connections are utilised to create and transfer knowledge. (Laine and Lähdeniemi 2002, 2007, 232-233, Saurio and Heikkinen 2004, 17)

5.4 Knowledge Creation, Learning and Systemic Approach

Knowledge creation processes were found to be long-lasting. The development path of infra red technology in Satakunta UAS is presented as an example in Figure 5-9. The first infra red camera investments were made in 1988. After that several phases have followed. The main events have been investments in new technology, organisational development, accumulation of knowledge, offering new services for industry, recruitment of new people, coordination of large programs, finding new application areas, transferring new knowledge to education process, and the development of opportunity recognition capability by developing absorption capacity. The development of a core competence is a slow process. When the core competence is developed, new application areas can quickly be entered by applying the same core to new areas as seen in Figure 5-9.

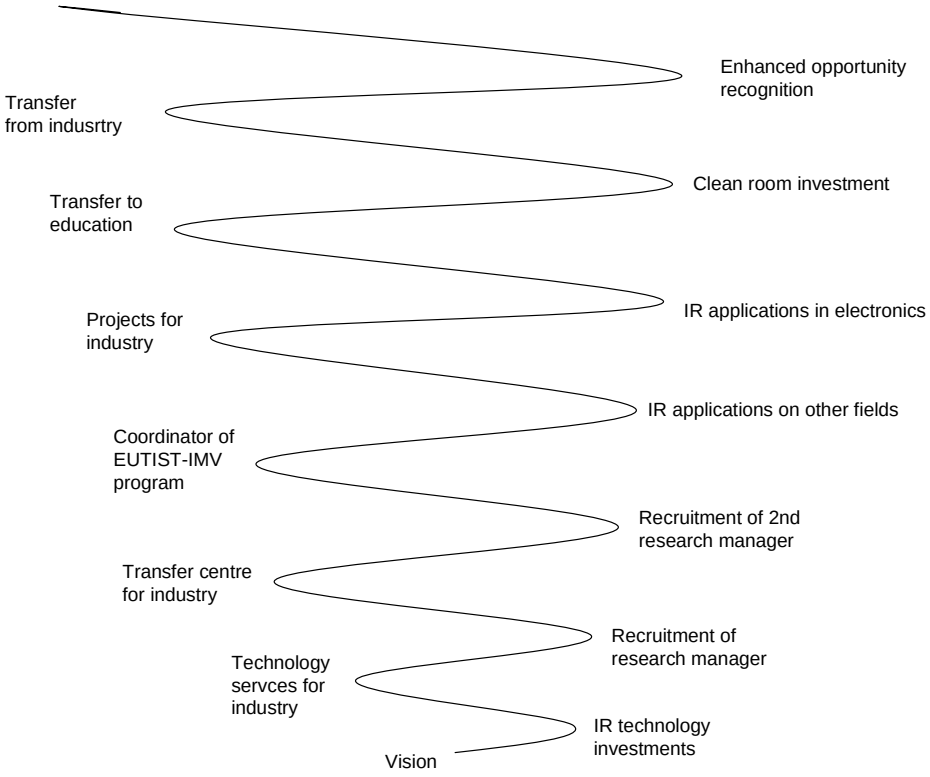

Figure 5-9 Knowledge creation path spiral of infrared technology applications research, also presented in Saurio and Heikkinen 2004 (48)

A new process to create innovation was developed between Satakunta UAS and its partners. It is based on partnerships and trust. When the strategies and development potential of the regional partners are known, higher education can seek for new innovations for the partners. The innovations are based on nonlinearities in technology and customer needs. These new ideas are fitted to the strategies and development potential of the partner firms. The word SNIFF (Searching New Innovations For Firms) is used to describe this. The SNIFFering process is described in Figure 5-10.

Opportunities can be identified by detecting the nonlinearities of development (Hamel 2001). Fast changes dominate the slow ones. The understanding of customer needs and strategic goals of partners combined with the development potential of partners are an important part of the framework. Scanning research knowledge simultaneously with previous subjects makes it possible to make a systemic analysis and creation of creative combinations of knowledge and technology for innovations at appropriate target levels. According to target level, incremental, disruptive etc. applicable networks and knowledge, the sources are activated (Laine 2004b). The SNIFFering process is an application based innovation process. It begins with understanding the customers' needs, strategic goals and development potential of partner firms in the region. It is followed by the detection of nonlinearities in technologies and market knowledge that create opportunities for innovation. It is further enriched with the scanning of research knowledge to support innovation. Analysis and new combinations of collected and created knowledge lead to potential product, process and service innovation proposals for partner firms (Laine 2004a).

Innovation process of KIBS firms was studied in the research (Laine 2004b). Small KIBS firms use practise based innovation model with constant improvements and experiments. Strategy is often emerging but vision can provide long range direction and accelerate learning. Customers and higher education are important partners for innovative KIBS firms. Interaction enables active search, strategy selections and key customer involvement in implementation. Constant evaluation, reflection, knowledge combination and effective communication between actors accelerate learning in innovation. (Laine 2004a, 2008b)

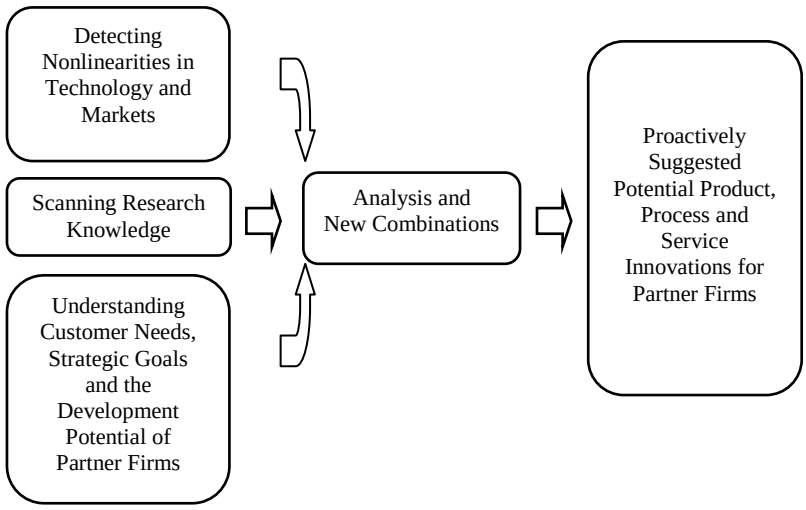

Figure 5-10 Searching New Innovations For Firms (SNIFFering) process (Laine 2004)

KIBS firms use a complex set of diverse innovation management tools (Laine 2008a). They also develop deep collaboration with Satakunta UAS in partnership cases and are

willing to try new methods, like social media in innovation management. These tools and methods may be generalised and diffused to other firms in the region. (Laine 2008a)

The research indicates that small KIBS firms looking for growth can benefit from several types of innovation and tools to achieve them. It is suggested to combine tools and processes from at least disruptive innovation, open innovation, systemic innovation, incremental innovation and even radical innovation as well. A systemic approach is needed not only in innovation process but also in combining the tools and methods. Small KIBS firms should be careful with systemic innovations because they do not usually have enough resources to make the systemic change happen to make the large diffusion of innovation possible. In Figure 5-11 a simplified model of KIBS firm innovation process is described. (Laine 2008a)

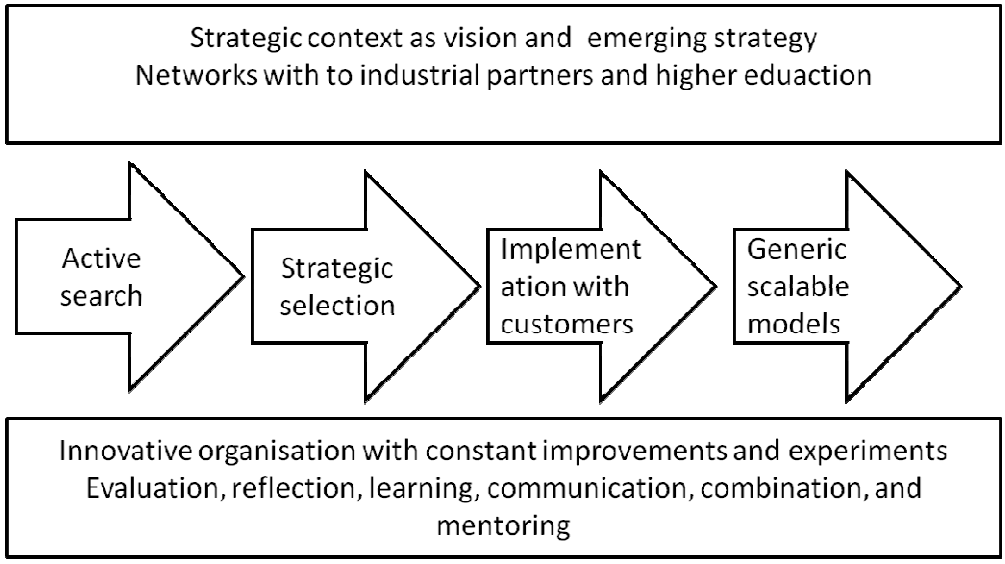

Figure 5-11 Innovation process model of a KIBS firm (Laine 2008b)

According to case studies and the theory of disruptive innovation the study suggests that one possible innovation process for disruptive growth in a small KIBS producing web based services may be as following:

1. detecting disruptive technologies, markets and changes as opportunities,
2. idea generation and enrichment with partners and innovative customers,
3. screening and selection based on (emerging) strategy,
4. fast concept development with most innovative customers,
5. first launch of new service as “simple but working”,
6. improvements based on first customer experiments,
7. creation of generic niche application,
8. second launch for all potential niche customers,
9. incremental innovation with new customers and
10. return to step one. (Laine 2008a)

The process is an application combining the disruptive innovation theory (Christensen et al. 2004) and crossing the chasm model (Moore 2002). Although this process is described as a linear one it is actually interactive and iterative. Interactions happen within the phases between actors involved both within the phases and between the phases. In phases 1, 2, 4, 6 and 9 ICT tools like social web tools are suitable. Step 7 enables growth. In step 7 new features can also be added to make the application more attractive, like in the case of systemic innovation. The business model in this step should be scalable. From step 10 there is also an option for returning to step 7 to create new niche applications. That could not be proved by the cases. The model uses open innovation only in idea generation. The case firms studied used open innovation also in commercialisation by launching a free basic version of a service and charging for additional features. Trust creation is found to be essential from the point of view of knowledge creation for innovation. Credibility and acceptance of new technology and processes are also important issues for marketing. Niche management is needed in entering the market and niche applications in crossing from innovative customers to mainstream customers. Processes are often long-lasting so patience and also, in many cases, a positive cash flow from other sources or external funding are needed. (Laine 2008a)

Higher education can also transfer technology and the capability to transfer it to KIBS firms in the following sequence. Higher education institution first starts interaction with a large industrial firm and transfers specific technology knowledge to it (1). Higher education actively supports the student incubator by mentoring (2) and new potential adopters of technology and knowledge are born (3). Technology and knowledge is transferred to KIBS firm (4) and the firm starts to produce services based on transferred knowledge and technology for the large firm (5). This may require support from higher education by embedding entrepreneurs to their networks, creating niche service areas in collaboration and supporting the creation of first reference contracts. Later higher education no more transfers the same knowledge and technology directly to industries (6) because KIBS service firms will do it. The sequence is presented in Figure 5-12.

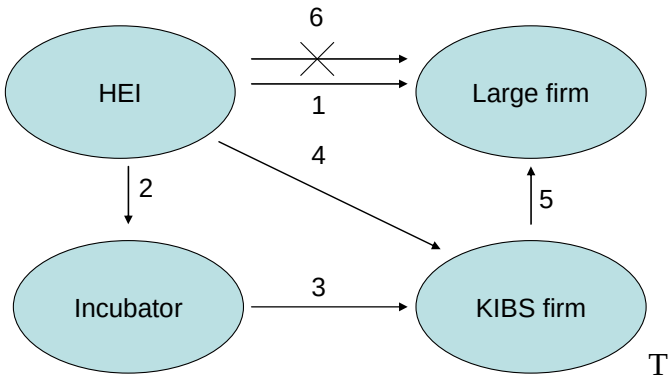

Figure 5-12 Transfer of technology transfer competence and a seed of core competence to a KIBS firm

The cluster innovation process starts with an active scan of needs among cluster participants (Figure 5-13). These activities can be firm visits, brunch meetings, surveys, feedback from earlier projects, group and cluster meetings, seminars and workshops, social web tools, regional and organisational strategy processes, advisory boards, chamber of commerce cluster meetings. Based on the needs scan and analysis draft proposals are created by UAS. This is followed by the activation of potential actors and usually also by filing a new project proposal for funders. If the activation leads to positive results actions are started. Actions may be firm specific, group specific or actions for the whole cluster. The analysis of outcomes and impact analysis are used in new proposal creation in the beginning of the next process of a similar type.

Research and development based and practise based innovation processes are described in Figure 14. Applications research and development activities create new ideas. If they are actively scanned they can be further developed into project proposals that can be enriched with firms in local clusters. Then the enrichment is based on the needs of cluster firms. In the practice based model challenges and changes rise from new ideas if they are seen as opportunities. Ideas can be further developed by actively scanning existing knowledge and the emerging research areas. This can be enriched by network connections in order to develop new product, process and service ideas and business concepts. The following phases are similar in both processes with resource evaluation, risk analysis, detailed concept development, plans and actions.

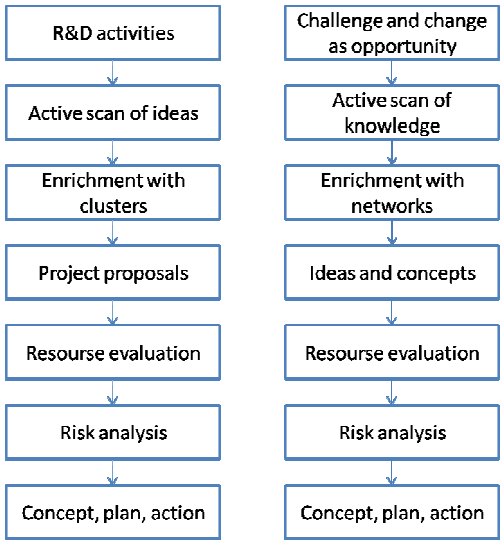

Figure 5-13 R&D and practice based innovation processes (R&D process based on Laine and Lähdeniemi 2009a, Sandelin 2005, 26-27)

In Figure 5-14 knowledge asset creation and asset types are described. It is important to use all types of knowledge to keep knowledge creation sustainable.

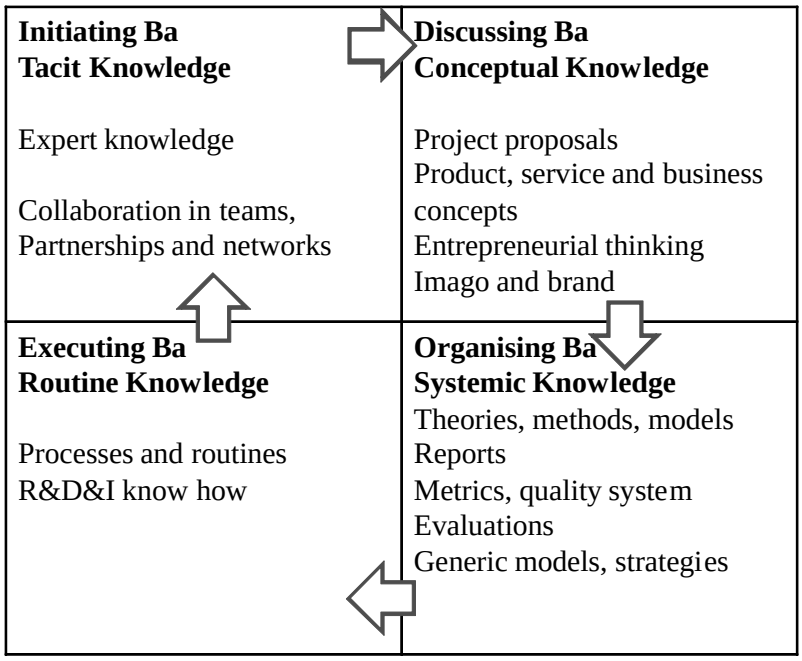

Figure 5-14 Creation of RDI knowledge assets in a cyclic clockwise sequence and asset types in innovation interaction based on SECI knowledge creation model by Nonaka (Nonaka and Takeuchi 1995, Nonaka et al. 2000)

To bring a more systemic approach to innovation, Satakunta UAS launched the Innovation Learning Laboratory concept. The Innovation Learning Lab combines learning and innovation processes. In practice, innovations and research are done in networks so only a part of actions are done in the laboratory itself but the laboratory will have a central role in the creation of a systemic approach. International partners are called to bring in their contribution so that the laboratory works both on regional and international levels. (Laine 2008) There are several activities and goals for the laboratory, such as to combine the best methods used in the co-creation of innovations so far and to develop methods further and to create new ones with partners, students and teachers. It is also important to create more opportunities for students to participate into innovation processes and to learn from them. In the lab the students can take manageable risks in a "safe" environment. (Laine 2008) The lab can also make a concrete landmark and make Satakunta UAS actions in the field of innovation more visible for students, teachers and partners. It can accelerate learning by giving examples of successful and less successful projects and by collecting artefacts from projects and by creating demonstrations to make the created results more concrete and understandable. It can have innovation contests to find new innovations and innovative persons. (Laine 2008c)

The Innovation Learning Lab Concept is also an opportunity to attract university partners to integrate in the innovation chain (Laine 2004) and industrial partners for applications research. Interaction with firms also creates opportunities for studying

innovation processes and their management in partner organisations. It also helps to study new ways to innovate in interaction and to manage innovation, like using social media and other web-based tools in the innovation process, mass collaboration, open innovation and open source, customer based innovation and the creation of innovative culture, to name a few of them. It can integrate the created innovation technology and develop new technology as well. It may also find new models for funding research and innovation. It can introduce experts from partner organisations as special guest speakers to share their expertise. The Innovation Learning Lab is a new concept that is started on a project base. First innovations and new models are already seen but it is too early to say more about the benefits of using the model. (Laine 2008c)

In a systemic approach the strategy has diverse levels. It is based primarily on regional needs but also has strong connections on national and international levels. Actions based on the strategy are proactive and include dynamic competence development based on the detected changes. Organising and culture support actions. Teachers and students have an important role. Internal and external interaction are both effective. Both systemic and social networking is used to utilise strong and weak connections. Knowledge management supports new combinations of knowledge from diverse sources. Open innovation model is used inwards and outwards. Learning is built into the system and lessons are learnt from own actions, methods and strategies but also from others and also shared actively. (Ibid.)

Integration of the innovation chain supports science and practice based innovation simultaneously. Cluster development and interaction of clusters activates actors and creates interpretations for detected changes in the environment. The creation of knowledge intensive business service firms adds impact when KIBS firms are embedded into clusters and their innovation processes. Innovation processes and tools are utilised and their application is researched to develop them further. SMEs deserve simple tools for their use. (Ibid.)

Partnerships and trust are created on individual, team and organisation levels. Training, coaching and mentoring are used to support actors. Renewal happens by learning in actions on strategy, method, project portfolio, project, dissemination levels. Learning is accelerated by ICT, incentives and collaborative learning. Teachers and students are central actors. There should be diverse ways to activate students and teachers and diverse participation opportunities for teachers and students. (Ibid.)

5.5 Knowledge Intensive Entrepreneurship

This subchapter models and explores the role of KIBS firms in interaction. It describes the Enterprise Accelerator which is an incubator process for students that want to become entrepreneurs during their studies in Satakunta UAS. It also describes and models the mentoring process that supports the entrepreneurs and introduces the entrepreneurship study module.

The Enterprise Accelerator is an innovative pedagogical educational choice of combining research and development, entrepreneurship and studies in higher education. It creates opportunities for students to become entrepreneurs during their studies. Students have a possibility to establish their own business or to take over an existing business by succession and business transfer. The third option is to join the accelerator activities with an enterprise which may have been established before the studies.

Research and development projects with the industry are a means for the students to try out their entrepreneurial competencies. They can build teams, analyse problems and risks, create new solutions to problems and improvements to products, services and processes, sell ideas, plan actions, implement plans, evaluate results, handle risks, deal with economical issues. They can succeed, fail, and learn from both of them. Most entrepreneurial students are willing to take risks in projects, to have more responsibility such as being project managers, and they identify business opportunities based on the needs of industrial partners. Projects also serve in scouting entrepreneurial talents.

The most active way to further support entrepreneurship in Satakunta UAS is the enterprise accelerator process. The function of the process is to encourage most entrepreneurial students to start their enterprises during their studies and offer support during the development of the enterprise during their studies. Studies are then based on a personal study plan. The goal is that at the moment of graduation entrepreneurship would be an equal choice to other careers. R&D projects as a part of education can enhance learning. They also create an investigative learning approach for the students and create a foundation for an investigating and developing working approach for them. (Satakunta UAS Strategy 2010, Laine et al. 2007).

The enterprise accelerator model is based on *the controlled acceleration* concept by utilising study time to gain knowledge on which the knowledge intensive entrepreneurship is based on. It has the following basic elements: a collaboration contract always starts the process. The focus is on expertise, niche strategy and R&D competence. The development of business skills is leaned in practice. Starting the firm enables marketing. The development of personal confidence is important for young entrepreneurs. The business model is based on networking and the co-creation of value instead of aggressive competition with existing firms. The active scanning of changes

serves as a source of opportunities. Dialogue with a mentor helps in seeing the business from different views, in reflection, and in the development and balance in personal life. The business is accelerated during the studies to be a true alternative at the point of graduation. There is a planned soft landing exit and optional partnership after graduation. (Laine et al. 2001, Laine 2004a, Laine et al. 2007)

Research and development projects with industries are a means for the students to build their expertise and try out their entrepreneurial competencies. Most entrepreneurial students are willing to take risks in projects, want to have more responsibility such as being project managers, and they identify business opportunities based on the needs of industrial partners. The most active way to further support entrepreneurship in SUAS is the enterprise accelerator process. The function of the process is to encourage most entrepreneurial students to start their enterprises during their studies and give support during their development of the enterprise during their studies. Studies are then based on a personal study plan. The goal is that at the point of graduation entrepreneurship would be an equal choice for other careers. R&D projects as part of education can enhance learning. They also create an investigative learning approach for the students and create a foundation for an investigating and developing working approach for them. (Laine et al. 2007, Satakunta UAS Strategy 2010)

Characteristics of user based student projects are the following. A project is set up to solve a real problem that requires a solution. Project has a true customer that wants to utilise the results. Students are fully responsible for the project and its results and the project manager is also a student. Teachers support the process and share their expertise when needed. Training and coaching is offered based on the needs of the project. Knowledge gaps will rise during projects, fast and focused training is often needed. Collaborative learning is supported during the project with regular meetings and the sharing of knowledge and experiences. Students earn credit points from the projects. Similar project studies do not fit for all students and they are sometimes hard to combine with study plans, therefore flexible project study courses and flexibility in study plans are needed. Successful projects will also charge the customers, although money is not the main motivator. Learning is the main motivator. The project is always based on a written contract that has guidelines for timing, goals and resources.

The Enterprise Accelerator process in Satakunta University of Applied Sciences has created over 170 knowledge intensive entrepreneurs of various disciplines since 1997 (Satakunta UAS 2009). At the present time, more than one new enterprise is launched every month. The process was originally started for engineering students. Activities have extended to other disciplines like social and health care, business and administration, communications and tourism and even fine arts.

The closest support for the student entrepreneur is offered by the mentors from the university. The mentors are researchers and teachers from Satakunta UAS and some of them are also experts specialised in generational replacement processes. The mentors coach the student entrepreneurs in the process of developing the business idea. The mentors also guide the students in the planning of their personal study plan for professional and entrepreneurship studies. The process encourages collaboration on regional, national and international levels. Participation in the R&D processes of the university helps the entrepreneurs enter clusters and networks and help to see the opportunities for new knowledge intensive businesses. Mentors play different roles according to the students' needs. Working with the student's own goals is the key element of the process.

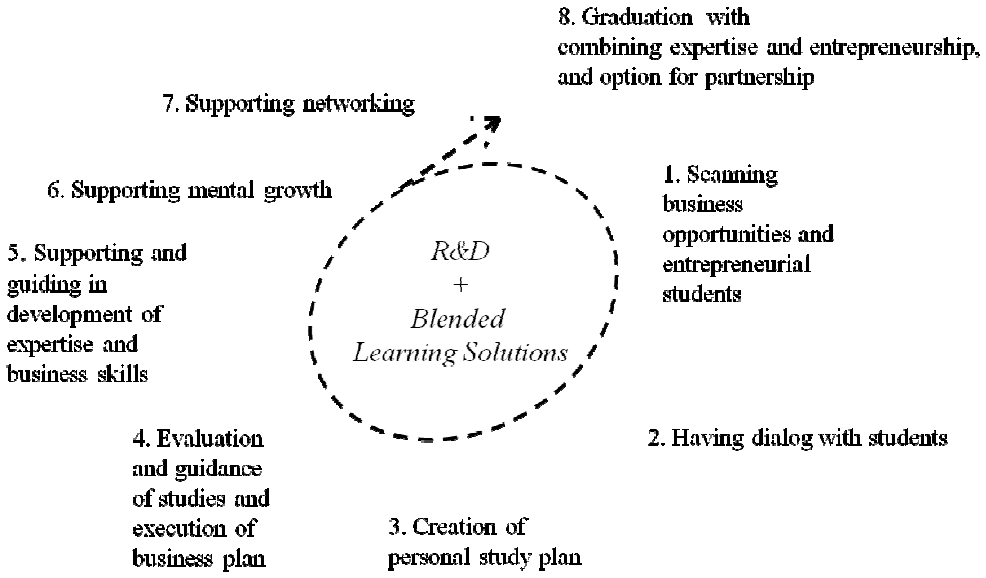

Figure 5-15 Tasks of mentors in the entrepreneur mentoring process (Laine et al. 2007)

The Enterprise Accelerator uses blended learning solutions for entrepreneurial learning. They are a combination of traditional classroom learning, e-learning, project based learning and mentoring. The learning process is supported with a personal study plan which is tailored for every entrepreneur's needs. A well-designed personal study plan and interactive learning methods can develop focused entrepreneurial competencies. If the process starts in the early phase of studies there are more possibilities for the students to develop their competencies as an entrepreneur.

A student's enterprise with its challenges of service development, marketing and customer relation management is a real learning environment during the studies. Theoretical studies support practical entrepreneurial experience in enterprise, and the enterprises' problems and experiences are also transferred to classroom learning situations and some of them are also as basis for new research and development

projects. Some of the enterprises become partners of the university (Lähdeniemi, Laine & Kainu 2006). In those situations the enterprises bring their knowledge to R&D projects and can gain more competence and become connected with other actors in the region and nationally and even internationally. Mentoring plays an important role in the learning environment context. A mentor helps students to evaluate business ideas, create business plans, start their business and develop it systematically, make personal study plans that support the entrepreneurial development and competence creation. Mentors also help entrepreneurs to create balance with family life, studies and entrepreneurship. The process is based on face-to-face meetings and the evaluation of the entrepreneurial process (Laine et al 2007).

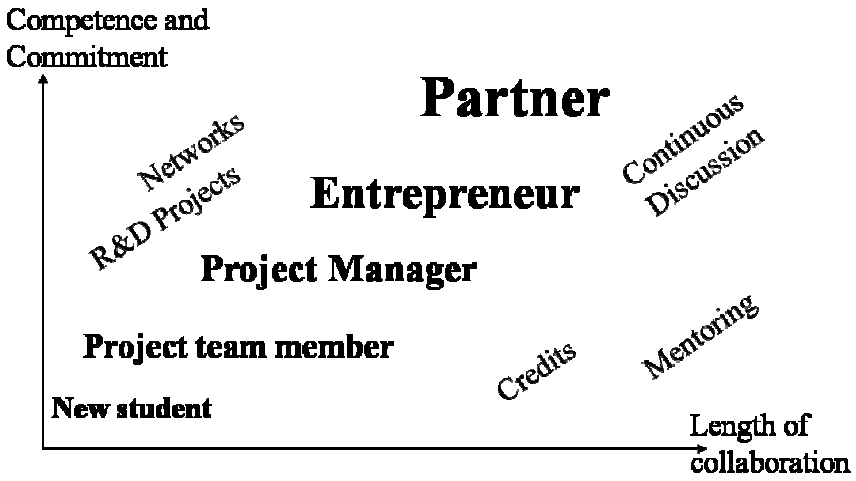

FIG. 5-16 Student's potential development process from a new student to a partner of SUAS

In 2006 a survey was conducted about entrepreneurship for the personnel of the faculty of technology and maritime management. A web survey was sent to the whole personnel of the faculty of technology and maritime management in Satakunta UAS. 52 percent of the personnel responded, equalling 88 persons. According to the answers the accelerator's role as part of the regional development role of Satakunta UAS is important and is also evaluated as excellent. There is a great interest towards the development of entrepreneurship as part of the basic role of Satakunta UAS but the current state is evaluated as not excellent. This suggests that there are still unused resources and possibilities to increase effectiveness and impact. The use of enterprises as learning environments is seen as important but there are still possibilities to further improve this kind of studies. The teachers see that their degree programs can create entrepreneurship if teaching arrangements can be further developed. This suggests that

there is still a need to increase interaction with industries and project learning. (Laine et al. 2007).

Satakunta UAS has developed special training programs for students and personnel in entrepreneurship and innovation. For teachers and other personnel the training consists of fostering entrepreneurship, teaching entrepreneurship and mentoring entrepreneurs. Fostering entrepreneurship means explaining what entrepreneurship is and how it can be empowered among students. Teaching entrepreneurship consists of how entrepreneurship and entrepreneurial competencies can be taught. The mentoring part is about how entrepreneurs can be mentored by teachers. In Satakunta UAS 18 teachers are trained to mentor entrepreneurs. This means that in every location of Satakunta UAS there is at least one person who works as a mentor. This makes it easy for the students to get in touch with mentors.

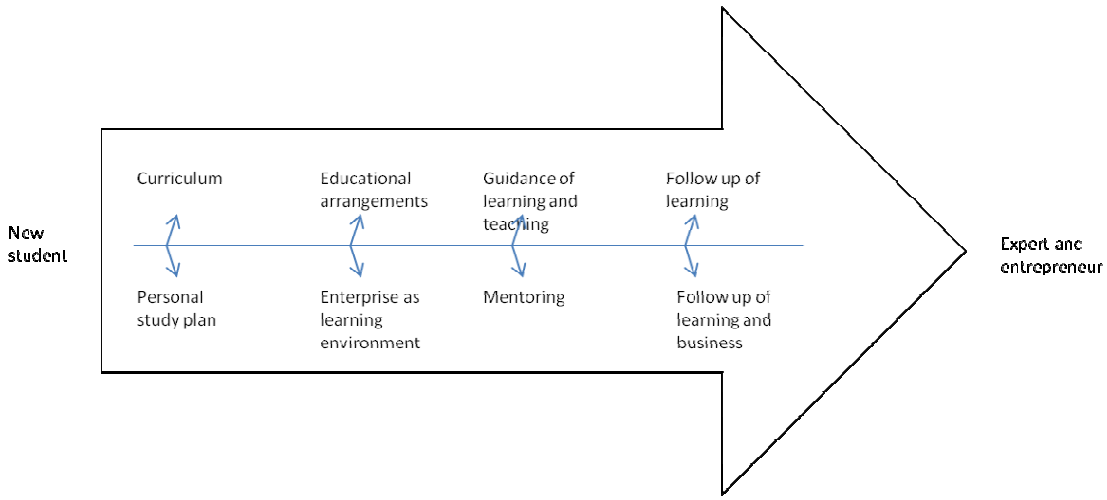

Figure 5-17 Entrepreneurial process for students to create KIBS firms (Laine et al. 2007, Salminen, H. Kajaste, M. (eds.) 2005)

A student's enterprise with its challenges of service development, marketing and customer relation management is a real learning environment during the studies. Theoretical studies support practical entrepreneurial experience in enterprise and the enterprises' problems and experiences are also transferred to classroom learning situations, and they are also as basis for new research and development projects. Some of the enterprises become partners of the university (Lähdeniemi, Laine & Kainu 2006).

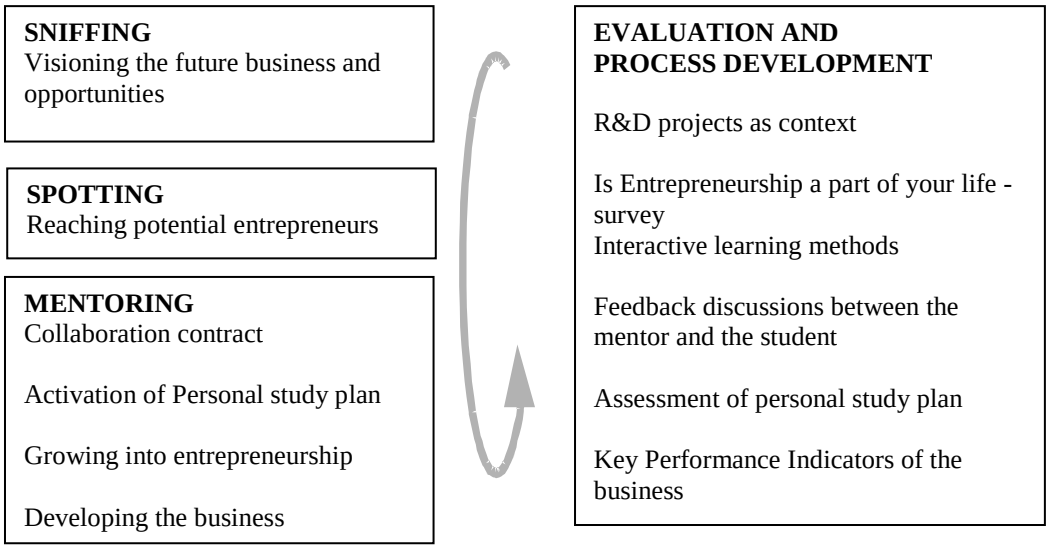

FIG 5-18 Elements of mentoring (Laine et al 2007, Salminen, H. Kajaste, M. (eds.) 2005)

After signing the collaboration contract the students can sign in on a 15 cp module called "Student as an entrepreneur". These studies offer support in developing the business idea and plan, managing the startup. In addition to this the students gain access to an entrepreneur toolbox in the same eLearning environment. (Laine et al. 2007, Salminen and Kajaste 2005). There is a virtual learning environment for all Satakunta UAS students based on the Moodle Open Source platform where students can study 15 credit points regardless of their study program. In addition to virtual studies there is a toolbox for entrepreneurs and teachers to use in different phases of their opportunity exploitation. All students have a possibility to study 15 credit points about entrepreneurship in a virtual learning environment. (Laine et al. 2007)

The bachelor students collaborating with the Enterprise Accelerator have an opportunity to select a study module Student as an entrepreneur of 15 cp as virtual studies. There is a similar opportunity for master level students as well. The module aims to give the student competence to recognise business opportunities, create business plans and start entrepreneurship already during the studies. The student can focus her knowledge according to the needs of the business. The student can add competence by participating in R&D projects with the regional industry. When executing entrepreneurship the student learns to apply knowledge in practice. The student learns to know the Enterprise Accelerator system and its possibilities. There are studies both for bachelor and professional master students. Listed below are the courses, descriptions of the courses and their supposed learning outcomes for students.(Ibid.)

Table 5-1 Entrepreneuship study module in Satakunta UAS

Part of module	**Main goals and content**
Recognising business opportunities, 3 cp	The student recognises business opportunities and evaluates her own entrepreneurial competencies. The student can evaluate her own entrepreneurship and business plan compatibility and receive feedback from experts. Based on evaluation the student can describe the business idea of her enterprise and create a supporting draft personal study plan.
Writing a business plan, 3 cp	The student understands different juridical business forms and revenue logic and perceives the basics of her own business. The student is able to create a business plan and evaluate it critically and receive feedback from experts.
Setting up a business, 3 cp	The student masters the basics of running a business and the juridical process of starting up a business. She understands its revenue logic and is able to start the business in practice.
Running a business, 3 cp	The student is capable of running a business in practice, collaborate with the main stakeholders and focus knowledge according to the needs of the business.
Business development, 3 cp	The student is able to manage the business. She recognises the trends of the field of business and the competition situation. The student is capable of developing knowledge and skills and able to acquire expert knowledge according to the needs of the business.
Setting up a business, 6 cp (for professional master students)	The student has set up a business and started it according to a business plan. Planning and setting up a business. The student is capable of taking actions as an entrepreneur, focusing knowledge with seminars and literature.
Business development for student enterprise, 6 cp (for professional master students)	The student has developed her business in the enterprise as a result of innovation, development or change process. The student is capable of updating a business plan, guide a strategy process, create product, service or process innovations and manage change processes.

There are similar types of studies for professional master students. The module for master level students is different because master level students have at least three years of work experience after their bachelor studies. There is an “Entrepreneur of the year” award in Satakunta UAS for entrepreneurs given every year. The meaning of the award is to emphasise good models of innovative and successful entrepreneurs. The awards are usually given in large personnel meetings to indicate the importance of entrepreneurship and to collectively celebrate the success of entrepreneurs. Awards are also noticed by

the local media and build positive image of the enterprise accelerator and make it better known in the region.(Laine 2008c)

5.6 Knowledge Combination

According to research Satakunta UAS has diverse roles in fostering innovation. These roles are knowledge creator, knowledge transfer activator, knowledge integrator and combiner, and collaborative innovator (Laine and Lähdeniemi 2007). The research models 15 tools for innovation interaction. All parts of the created model support new combinations of knowledge between participants to foster innovation. In Table 5-2 there is a short summary of the combinations. The parts of the model are listed and their support for knowledge combinations is described shortly. Learning and systemic approach bind parts of the model together. It is also a source for renewal.

Evaluation, learning and systemic approach are embedded in diverse actions as modelled in Figure 5-19. They are done in the strategy process, annual reviews, partner meetings, portfolio analysis, R&D meetings, results and dissemination analysis and as parts of the quality system in internal and external evaluations.

Table 5-2. Elements of the interaction model support new combinations of knowledge

Part of systemic interaction model	**Knowledge combinations supported**
Strategy	Strategic knowledge development, regional needs, trends and weak signals, interpretation, core competences and critical mass in knowledge creation
Teachers and students as actors	Resources, sustainability and renewal, expertise and fresh views
Culture and awards	Culture supports collaboration and awards bring up examples for inspiration
Innovation technology	Fast combination of diverse knowledge sources, fast experiments, effective collaboration, virtual experiments with simulation tools, fast sharing and integration of knowledge and experiments
Internal interaction	Knowledge and resource integration between processes, combinations of tacit and explicit knowledge
Clusters and networks	Needs and experiences of regional firms, Satakunta UAS knowledge and experience, new knowledge from networks
Innovation chain integration	Basic research and applications research, practice and applications research
Impact maturity	From ad hoc combinations to strategic combinations, regional, utilisation of national and international innovation networks

Strategic partnering	Different time frames, acute and strategic needs for innovation
Knowledge combination	Recognising knowledge gaps and producing needed knowledge, combining application and research knowledge
Disruptive growth	Emerging disruptive technologies and trends, customer feedback, experiments, creation of generic niches
Enterprise Accelerator	UAS education process and KIBS firm knowledge, regional networks
Mentoring	Mentor personal knowledge and experience, KIBS firm entrepreneur, local business networks
Entrepreneurship studies	Explicit and tacit knowledge, mentor experience and entrepreneur knowledge
Learning and systemic approach	Renewal by learning, systemic approach, partners, knowledge, best practices, models of collaboration

Evaluation and learning focus on strategy, methods, partners, the project portfolio, outputs and outcomes, and dissemination. (Laine 2004a, 2008c, Laine 2009) Strategy process in itself is a collaborative learning process with stakeholders. Strategic learning happens when the strategy is updated. Changes in the strategy affect partner selection and the contents of partner contracts. Partnerships guide the started projects. During the project execution learning happens in learning by doing, evaluation phases, and project meetings. Outputs, outcomes and dissemination define what kind of projects will be started in the future.

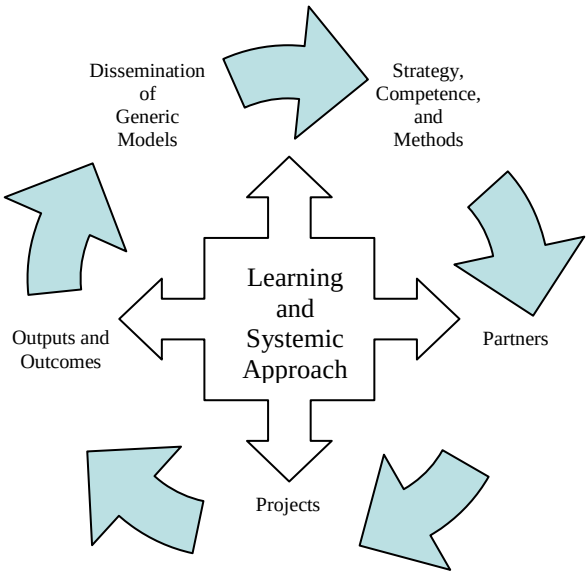

Figure 5-19 Learning and systemic approach as a central element of the model

According to research (Laine et al. 2008) renewal of higher education happens in four phase cycles that is presented in Figure 5-20.

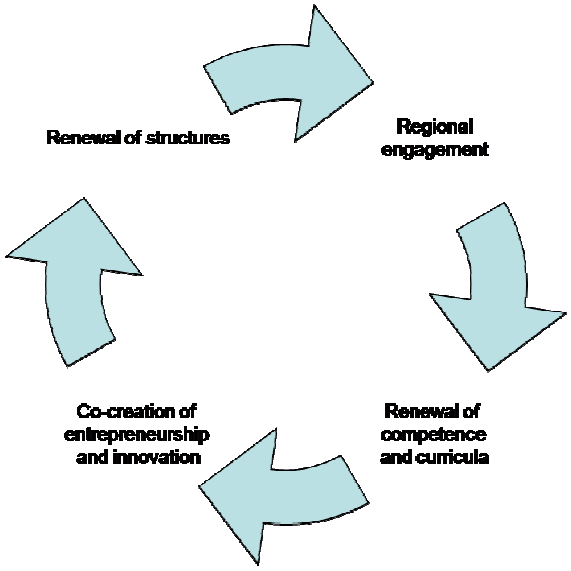

Figure 5-20 Renewal wheel of interaction (Laine et al. 2008)

Regional engagement leads to the renewal of competence and curricula. Renewed competencies and curricula enable the co-creation of entrepreneurship and innovation. Enhanced co-creation also leads to the institutionalisation of best practices and the renewal of structures. The renewal of structures in higher education is often a slow process.

The open innovation process for higher education and industry interaction is described in Figure 5-21. Open innovation process begins with dealing with the partners' challenges and seeing changes as opportunities. Emerging technologies are studied and experimented in the core areas of research in Satakunta UAS. The SNIFFering subprocess is used to understand the development potential of regional partners and to combine new research knowledge and technology with the needs.

The technology strategy, content of research programs, the regional and national strategies affect which projects can be executed. Project pre-evaluations are a practical way for making this selection. External funding opportunities also affect which projects can be selected. In project execution the participation of teachers and students is essential. The results must be tangible. Problems must be solved, new products, services and processes created. New entrepreneurs, firms must be created. Artefacts and models enhance diffusion. Learning is enhanced by interacting and experimenting. In value capture phase models and knowledge are disseminated.

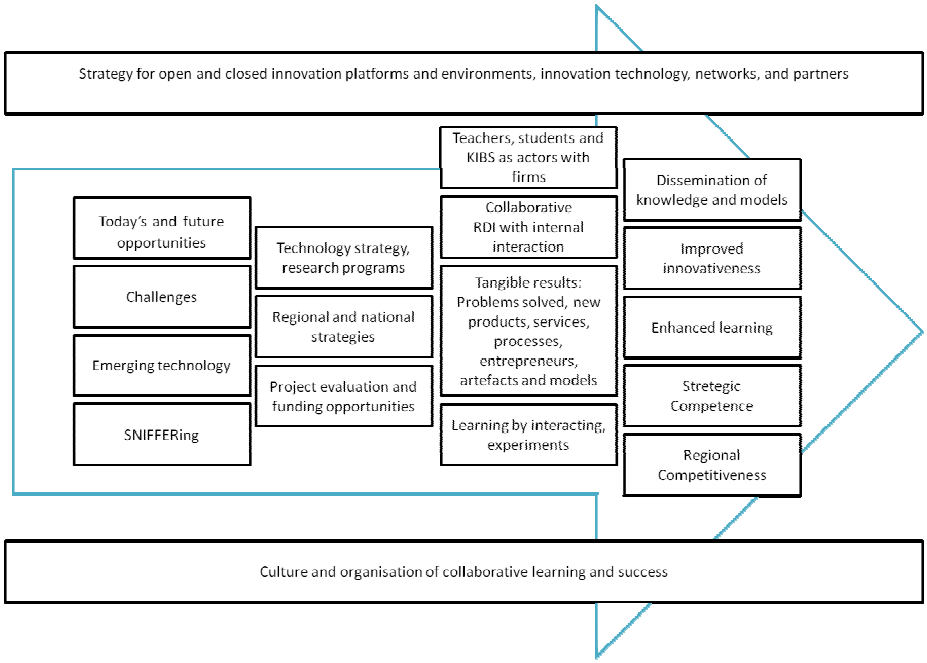

Figure 5-21 A process for higher education and industry open innovation based on innovation process general model in Tidd and Bessant 2009

Active work leads to improved innovativeness, it enhances learning and strategic competence. Altogether the regional competitiveness is improved.

5.7 Summary

Based on the Satakunta UAS case study the research suggests the following formula for the systemic approach in interaction between higher education and industry for innovation and entrepreneurship. Firstly, higher education should detect the needs of regional industry and create strategies for innovation and entrepreneurship. Secondly, it should build connections in forms of regional clusters, networks and partnerships to enhance needs analysis and idea enrichment. Thirdly, it should integrate the innovation chain combining innovation based on application and science, and effectively utilise technology to create and integrate knowledge from diverse sources. Fourthly, it should support collaborative knowledge creation and learning to accelerate innovation. Fifthly, higher education should support the creation of knowledge intensive entrepreneurship and also integrate these entrepreneurs to regional clusters and its innovation networks. Sixthly, all efforts should support the creation of new knowledge and knowledge combinations for innovation. Elements of the model should support the integration of practice based and science based knowledge and effective knowledge circulation in the innovation chain between diverse actors in order to create new innovations.

6 Evaluation of the Systemic Innovation Model

In this chapter the model created in this research is evaluated. The outcomes of using the model are described. The sustainability of the model is also evaluated in order to see how the process and the model itself support the continuation of the model. The results from external evaluations are also presented.

It is important to model the innovation process because it is one of the most important processes in all organisations. In this case modelling supports the change to open innovation process where external knowledge is considered as an important addition to internal knowledge. It also helps in developing interaction between higher education and industries, which is seen as an important task not only in Finland but also globally. Modelling is important because it gives a deeper understanding of interaction, innovation, and KIBS entrepreneurship as its essential element. It is a way of sharing knowledge with other actors and learn from them. Modelling makes the development of interaction possible. It also makes it possible to use models in communication with personnel, customers and stakeholders.

The created model is pragmatic and it has practical importance. Interaction, partnering, enterprise accelerator and mentoring are constantly used by Satakunta UAS. There is a pragmatic goal to create new enterprises and innovations with the model. The enterprise accelerator is transferred with modifications to other faculties of Satakunta UAS. The virtual learning environment and mentoring models are used by all faculties. The created model is generic. It tries to capture essential elements that are transferable. It is pragmatic. Its meaning is to guide actions and aim for improvement of interaction between internal process, between higher education and KIBS, and higher education and clusters. The model is also systemic. The parts are separate but connected with interactions. Model works on organisational and intra organisational levels. In strategy context modelling is seen as means for management to free energy for creative new solutions and improvements when models have been built.

The results concerning KIBS firms are viewed by entrepreneurs before publishing. In these reviews only non correct facts were corrected, not the models. Results of the interaction between internal processes are evaluated by teachers and managers of Satakunta UAS in its strategy process. The process interaction model is also included in the R&D&I/Competence strategy of Satakunta UAS. The results are presented in several national evaluations as well. Process interaction, Enterprise Accelerator and mentoring models are evaluated by Finnish Higher Education Evaluation Council in national evaluations. Several UAS and universities have benchmarked the interaction and Enterprise Accelerator models of Satakunta UAS.

Partnership agreements are made with private and public organisations. None of them has ended after evaluations so far. Several public and private organisations actively want to create partnerships with Satakunta UAS. In this case the hard market test applies. The disruptive growth model is used by a partner firm. In this case the weak market test applies. Innovation tools are used by entrepreneurs. The disruptive growth model was tested with a KIBS firm. The firm reported later it still used the model with small modifications and that it also works with a single large customer organisation. Scenario models created during the research are also used by the case KIBS firm. It also still uses the original vision for its business, created with a mentor. Several other examples exist where organisations are willing to apply parts of the created model and apply its outcomes. Thus several parts of the model fulfil the weak market test. Utilising the model causes significant development in the volume of the actions and the amount of the KIBS firms started by students.

The research process lasted several years. The theoretical framework is built parallel to case studies as an iterative dialogue process. New findings motivate the investigation of new theories and new theories motivate more research. During the research models and best practices of higher education and industry are investigated. They are then added by completing theories from knowledge management, organisational learning and innovation management. Main theories in use are innovation management theories about innovation creation and innovation processes, entrepreneurial theories about opportunity recognition and, knowledge management and learning organisation theories. Theoretical framework building is challenging because of the richness of theories applicable. The created model is systemic, realistic, pragmatic and normative.

The parts of the model are separate, but they interact. There are no clear linear causalities in the system, except in single parts of the model, and in innovation and entrepreneurial processes. Therefore its development is a challenge. Complexity theories emphasise the finding of positive development cycles, like students as an actor in R&D&I, student entrepreneurship, KIBS development, and partnerships. This also emphasises finding positive collaboration on the region. According to the complexity theory, systems are sensitive to their initial conditions. Therefore, applying the model in other environments may not produce the same level of results. Although the system is complex it should appear simple to motivate people to act in it. This is to eliminate bypass effects where people choose other ways to proceed because they think that the systems created are too complicated or will not work properly. Bringing students to the core of innovation and interaction is novel in models. In this research students are involved and central actors in almost all parts of the model. The research is also close to innovation and action research by its method. The constructive method is selected because the main goal is to model interaction and not to change people’s behaviour.

The model is not separate from regional and national and international levels. They are connected to the model through strategy and networks. National and global innovation systems and development trends add to the systemic nature of the model. Although the model emphasises interaction with KIBS, the collaboration with large firms and traditional industry is done in cluster actions. As knowledge intensity rises in all fields of industry, the models created with KIBS firms will be applicable to other firms as well. Also other regional actors like development organisations and public organisations are part of collaboration networks (Laine 2007). The research has many practical implications for organisations and managers for combining learning, entrepreneurship and innovation in higher education in interaction with the surrounding region. The challenges are very similar in all UAS in Finland, but also on a general level in the whole higher education sector in Europe.

The created models can be developed further especially follow up and evaluation phases to make model add steering and impact. There may be possibilities to find more causal relationships between the parts of the model. More diversified funding can make model more sustainable. New networks and partnerships are needed to fulfil technology and knowledge needs on the region. Stronger connections to basic research and ability to adapt more research knowledge are also needed to further intgrate the innovation chain. (Laine 2008c)

6.1 Outcomes and Impact of the Created Model

This subchapter describes the outcomes and benefits of using the created model. In general researching and modelling innovation helps to understand innovation and innovation related activities more deeply. It helps to understand the prerequisites of innovation, to create goals for innovation activities, to develop innovation processes, to manage innovation, and to evaluate the results and impact of innovation activities. It enables the systemic development and management of innovation.

The list of success factors in Satakunta UAS includes strong strategy work, the development of focal areas in R&D, flexible repositioning and carrier rotation, critical mass in focal areas, resourced contacting and project preparation work in faculties, exact and rational investments, incentives like vision, mission, personal and team incentives and the infrastructure (Laine 2004a, Laine and Lähdeniemi 2007). One of the major findings for Satakunta UAS is identifying the students as the main resource in R&D&I. Active students connect the personnel to the projects. Positive facilitating factors for students may include calling students to start projects, calling a team of students to run a project, and opening new problem solving contests. All these methods support the students' will to become insiders and their recognition of opportunities in the projects, and learning to be entrepreneurial. Also, the students' enterprises are

potential collaboration partners for Satakunta UAS in R&D (Laine and Lähdeniemi 2007).

The Enterprise Accelerator process in Satakunta UAS has created over 170 knowledge-intensive entrepreneurs of various disciplines since 1997. At the present time, more than one new enterprise is launched every month. The process was originally started for engineering students. The activities have extended to other disciplines, social and health care, business and administration, communications and tourism and even fine arts. In those situations the enterprises bring their knowledge to R&D projects and can learn more and become connected with several actors regionally, nationally and internationally. Mentoring plays an important role in the context of the learning environment (Laine et al. 2007). The application of the model to welfare entrepreneurship is also published (Laine et al. 2008). The study suggests that the existing knowledge gaps can be found and filled. Also, entrepreneurs with a more complete set of skills that fit into the new situation can be created. The study suggests that the process that was originally created for engineering students to create knowledge and engineering intensive entrepreneurs (Laine et al. 2001) also fits to the field of welfare entrepreneurship with some adjustments. The most important basic elements of the process fit the recognised needs in the welfare sector but the welfare context and its special issues still need attention (Laine et al. 2008).

Satakunta UAS has activated and administrated over 100 public fund research and development projects since 1997. Over 160 R&D&I projects were executed together with regional industry and public organisations in 2007. Over 300 firms collaborated with Satakunta UAS in 2007. As a proof of internal interaction between teaching and R&D education processes, about 900 students earned 3290 cps in projects in 2007. Almost all thesis works are ordered by local industry and public organisations.

The Finnish Ministry of Education evaluated the Enterprise Accelerator of Satakunta UAS as a Centre of Excellence in Education 2005-2006. In the Enterprise accelerator the students are encouraged to start their own business during their studies and they also receive support for their entrepreneurship. The closest support for the student entrepreneur is offered by the mentors of the university (Laine et al. 2007). The mentors are researchers and teachers of Satakunta UAS and some of them are experts specialised in the succession processes. The mentors help the student entrepreneurs in the process of developing their business idea. The mentors also guide the students in the planning of their personal study plan for professional and entrepreneurship studies. The process encourages collaboration on regional, national and international levels. Participation in the Satakunta UAS's R&D processes helps the entrepreneurs enter clusters and networks and helps to see the opportunities for new knowledge-intensive businesses. Mentors play different roles according to the students' acute needs and existing knowledge gaps. Working with the student's own goals is the key element of the

process. Mentors also gain insights into regional innovation processes and into knowledge intensive business development. These can also be brought into the teaching and learning processes of Satakunta UAS. (Laine et al. 2007, Laine 2007)

The research found that the students' own enterprises are a good addition to the learning environment and create motivation for students to learn. The enterprise accelerator process is effective in the creation of knowledge intensive entrepreneurship. The students see that the mentoring adds value to their start-up process. The teachers see degree programs as platforms for the creation of entrepreneurship but there is still a need to further develop the study contents and the ways of studying in SUAS so that they would more support entrepreneurship and entrepreneurial learning in practice. (Laine et al. 2007). The Enterprise Accelerator has activated about 170 contract based startup firms. Almost all have also led to a launched enterprise. There are about 300 employees in the startups. The survival rate is estimated at over 90% for Satakunta UAS startups based on Satakunta UAS internal reports.

The following accomplishments have been achieved when using the models: Satakunta UAS was awarded nationally by The Finnish Ministry of Education. Satakunta UAS was awarded as a Centre of Excellence in Regional Impact in 2001-2002 and the Finnish Ministry of Education evaluated the Enterprise Accelerator of Satakunta University of Applied Sciences as a Centre of Excellence in Education in 2005-2006. In an external quality system evaluation SUAS passed the evaluation with positive remarks, and partnerships in R&D were seen as a best practice by a national external evaluation group of FINHEEC in 2008.

The project based Institute of Automation and Information Technologies was seen as an organisational innovation. It was found to overcome several difficulties in collaboration between diverse actors. It used several of the described tools simultaneously, such as strategic collaboration with open discussions, partnerships, cluster innovation process, student and teacher activation (Kosonen 2005). "These communities (The Institute of Automation and Information Technologies, and the larger Automation Industry Research and Development Consortium in Pori) may be defined as *organizational innovations*, through which many difficult borders and barriers among universities, between universities and polytechnics, and between business and universities have been overcome." ... "To summarize the findings, the process of building up an innovation environment for emerging industries calls for new organizational modes, new technology, and innovation culture, as well as actual access to new technology and knowledge, as has been done in the case locations, the Pori and Seinäjoki town regions." Automation industry was the initiator of new organisational modes. (Ibid. 24)

The Finnish Entrepreneurship and Innovation Network for Higher Education (FINPIN) awarded Enterprise Accelerator three times. The Dean of Faculty of Technology and

Maritime Management Matti Lähdeniemi of Satakunta UAS was awarded by FINPIN for his personal work pro entrepreneurship in 2006. Kalle Vuorio, engineer and the first entrepreneur of Satakunta UAS Enterprise Accelerator was awarded as the entrepreneur of the year award by FINPIN network in 2007. The incubator Enterprise Accelerator was awarded as an entrepreneurship supporting structure in 2008. (FINPIN 2009) The Enterprise Accelerator was a novel process when it was started. At that time no other UAS in Finland was creating entrepreneurs in parallel with education with an idea to start the enterprise as early as possible during the studies. Further, the 15 cp virtual studies for all students is a novel solution in the Finnish UAS context. The name Accelerator was used instead of 'incubator' to describe the process that differs from the traditional incubator services, business, knowledge, networks. The key personnel in Enterprise Accelerator are also active in the publication of results in order to share the model and its results. (Lähdeniemi 2009)

If a unit of higher education effectively wants to contribute to regional innovation processes it should create a R&D&I strategy, have an active role in regional innovation strategy processes, create a critical mass of education, research and partners and KIBS firms, use partnerships as drivers of knowledge creation and innovations, and utilise a dynamic network approach as an enabler of innovation (Laine 2008a). This research promotes the creation of all these elements in higher education. Satakunta UAS mentoring model is a novel model. No other UAS have a similar, extensive mentoring system. The virtual entrepreneurship studies of 15 cp are a novel solution in Finland as well. Analysing the impact of the actions is complex. LOGIC model was implied to the Institute of Automation and Information Technologies (Saurio and Heikkinen 2004, 54) and to Enterprise Accelerator (Saurio 2003, 55-68, 130) to study their impact. The created impact maturity model is later combined to innovation creation and support capability of UAS by Saurio and Heikkinen (2004, 75-77). It is further deepened to cover the students' roles in different development phases (Ibid. 84). It is also added by analysing the value adding capability and networking competence. The model is also used to compare the diverse programs' operative, tactic and strategic partnership levels (Ibid 64-66). The impact maturity model was also used by Marttila et al. (2007, 13-14, 72-73). The roles of expert organisations in innovation process were used and supported by Ramstad's (2008, 77) research on the Innovation Generating model for Finnish working life organisations.

Metrics of impact are complex because it is difficult to separate the impact of a single institution's actions, and there should also be qualitative measures for regional impact. It is noted that entrepreneurship and good interaction with industry have much in common. First of all there are changes that take place in technology and society. Changes have to be seen as opportunities. Then there is the time for radical selection. Unconventional methods must be experimented. Risks must be analysed, handled and accepted. Failures happen and they must be tolerated. Promising practises are changed

to concepts that are transferred to other contexts. In Satakunta UAS true partnerships have been created and at the same time over 170 new spin-off enterprises have been started. The most distinguished knowledge has been created in long-term partnerships in focused applications research groups (Laine and Lähdeniemi 2007, Laine 2008b, 2009).

The development of regional competitiveness can take decades but better interaction between higher education and industry can be built in years. When transferring promising practises, both the source and target innovation environments have to be understood and taken into consideration. The best practises in one environment are perhaps only promising practices in another environment (Laine and Lähdeniemi 2007).

This research served the development of Satakunta UAS. The transferability or generalisation of results is not the primary goal of this research as generalisation is not a primary goal in qualitative research. The model is found to be applicable in similar contexts. Therefore the context is also described in this thesis. As the model is complex and systemic the initial conditions must also be taken into consideration because they affect the possibility to reach results with the model.

The modelled processes allow the repeatition of processes and improvements in their quality, outcomes and impact. The documentation of the processes and models is important because people change from project to project and models help in the briefing of new project members as well. Best practices can be evaluated and further developed into a generic niche that can be served for a wider set of customers. This is a similar type of growth model that can be found in small KIBS firms (Laine 2008). Thus this implies that the same type of growth model can be used by higher education and KIBS firms and they can develop models together and learn from each other. Models become interesting for other firms and organisations as well because of the rise of knowledge intensity.

Small KIBS firms created by the Enterprise Accelerator have developed several areas of Satakunta UAS via partnerships, like new technology based applications for R&D&I, ICT infrastructure that supports R&D&I, the virtual learning environment, marketing of projects and their outcomes, public relations, ICT for knowledge management infrastructure and student recruitment, to name some of them. In these cases these firms have offered completing knowledge or technology for Satakunta UAS and created innovative solutions for Satakunta UAS in collaboration with Satakunta UAS.

6.2 Sustainability of the Created Model

There are several factors that add sustainability to the model created in this research. Most important of them are the modelling itself, strategy based actions (Laine 2004a), internal interaction (Laine and Lähdeniemi 2007), KIBS creation (Laine 2008a, Laine et al. 2007), institutionalisation and the position as a successful support structure (Laine 2009), students and professional teachers as central actors (Laine 2008, 2009), diverse projects, combining science and practice based innovation (Laine 2004), partnerships and critical mass (Laine 2004, 2008), and rich external connections (Laine 2004a, 2008b, 2009).

Modelling added to the sustainability of the model because it enables making processes reproducible and the development and sharing of the model (Laine 2008). According to the research, strategy based actions in interaction create a sustainable basis for interaction because the strategy process with regional stakeholders ensures that actions are based on the needs of the region and are proactive (Laine 2004a, Laine and Lähdeniemi 2007, Laine 2008b, Laine 2009). The strategy gives direction for actions and the interactive strategy process, and the updating ensures that the needs of the region are scanned. In general, all external connections in the strategy process support sustainability because they for their part ensure that the strategy remains up-to-date and actions produce value for stakeholders. Regular updating also improves opportunities for recognising emerging technologies and their significance in interaction. Internal interaction also supports the sustainability of the model. Interaction with the educational process and the development of curricula ensures the updating of learning methods and contents (Laine and Lähdeniemi 2007). Some teachers have been involved with interaction for decades. Most graduates will be employed in regional firms and are potential collaboration partners in the future. Their activation rises opportunities for future collaboration with firms. They also add to the absorption capacity of firms when they are employed by firms.

The sustainability of Enterprise Accelerator was noticed by others as well. “The enterprise accelerator is institutionalised and it has justified its position as a sustainable and successful support structure. There were several arguments that supported the given FINPIN incubator award: There is an exceptional simultaneous application of rich learning methods, learning by doing and working life based teaching content, mentoring, personalised teaching, e-learning solutions and utilisation of networks. The enterprise accelerator is also integrated in the curricula so that students can earn credit points from activities concerning the launch of a business and developing the business. The model produces KIBS firms in particular. Due to the usage of the model also growth businesses are expected to be born.” (Levonen 2008) Also the outcomes were noticed. The model produces numerous new enterprises and entrepreneurs and creates plenty of jobs. The rate of startups is exceptional in Finland. A new firm is started every

month. The model gives various modes of support for the startups, like R&D collaboration. The creation of KIBS firms adds to the sustainability of the model because they add critical R&D mass to the region, they adopt new knowledge and technologies fast and transfer them to the region but also between regions and internationally (Laine 2009). There is also an option to transfer transferring competence for KIBS on specific areas. The KIBS firm collaboration is important because KIBS firms can commercialise knowledge and technology not seen important by large firms, they have high absorption capacity and transfer knowledge and technology to their customers (Laine 2009).

Students are embedded in collaboration networks via Enterprise Accelerator (Laine et al. 2006). They have opportunities to team entrepreneurship, succession. International contacts and collaboration are also available and the management team has rich contacts to regional development organisations and funding organisations. (Levonen 2008). Teachers and students as central actors add to the sustainability of the model. Teachers can transfer generic knowledge to teaching and graduates transfer knowledge and the model. New students also create renewal and bring pressure to model the actions so they can be introduced to the students. Projects are unique and they offer opportunities for diverse students, personalities and learning styles. This in turn adds sustainability because the model is not aimed at a specific type of student. Projects are also diverse in their size, goals and fields of industry (Laine 2008).

Combining science based and practice based innovation (Laine 2004) also supports the sustainability of the model. It sees both science and application based knowledge as important sources of innovation and all actors as important potential innovators and supporters. That will constantly bring new knowledge into the innovation processes. Sustaining effectiveness requires reflection from UAS (Laine 2007). There is a need for adding collaboration networks with universities and sector research institutions (Laine and Lähdeniemi 2009). There are emerging ways for new types of interaction like social media applications in the innovation and development of open innovation platforms (Laine 2008, Santonen 2009). External connections and learning are essential elements of all sustainable systems (Laamanen and Tinnilä 2009). In Satakunta UAS learning is built into the model in diverse ways, like in strategy updating, pre and post project evaluations and project meetings with industry.

6.3 Summary

A systemic model creates outputs and impact that are measurable. The model has several elements that are sustainable and the model itself supports sustainable innovation. Parts of the model have been evaluated by external evaluators in several

evaluations. Evaluators have mainly given positive feedback but some development goals have also been set. Parts of the model were used by other researchers in their research, which shows the validity of the model for evaluation in diverse applications. This is “marked based validation” mentioned by Kasanen et al.(1993). It must be noted, however, that in external evaluations the evaluation criteria was not set to evaluate or validate the models created in this research as such. The models presented for evaluators were a part of the evaluation entity.

7 Conclusions and Discussion

The objective of this research was to model higher education and industry interaction in the Finnish UAS R&D&I context. In this research the regional context was Satakunta region in Finland which is a region that has a rich, diverse industrial base and has experienced a structural change and has been able to sustain its competitiveness. Satakunta University of Applied Sciences is used as a higher education case study and the case firms were from automation, ICT and knowledge intensive business service sectors. The research was a constructive qualitative research where models were created and tested.

This research focused on interaction between higher education and industry in innovation and entrepreneurship. Higher education fosters innovation by producing knowledge that sums to the existing knowledge in interaction with industry, combines knowledge from diverse sources and develops connections and new networks and supports the creation of knowledge intensive entrepreneurship. It was found to be important to create models of interaction to better understand and develop it. Experimentation gave insights to the developed models and their application.

The main assumption was that higher education can have an impact to innovation and KIBS firms have an important role in interaction and innovation. In this research the main research question was: How can higher education have a significant role in the creation of innovation and entrepreneurship? The research searched for a systemic interaction model to create innovations for SMEs, KIBS enterprises and graduates that have knowledge and skills that are valued by working life. The supporting research questions were:

1. *How can interaction with industry be entrepreneurial?* That is how to recognise opportunities and exploit them, and turn reactive action into proactive in regional context? This was examined in Paper 1.
2. *How to add effectiveness and impact of interaction with industry in the region?* This was explored in Paper 2.
3. *What kind of role do KIBS firms have in interaction with industry?* This was studied in Paper 3.
4. *How can the creation of KIBS firms be supported among the students in higher education?* This was exploited in Paper 4.
5. *What kind of innovation management tools and processes can be used by KIBS firms to support their growth?* This was investigated in Paper 5.
6. *What is a systemic model of interaction like and which are its future development needs?* These were studied in Papers 6 and 7.

7.1 Contribution of the Author

The research was based on seven published papers and a summary of the papers. In this subchapter the contribution of the author is described with a summary for all research questions and a review of the research results paper by paper.

How can interaction with industry be entrepreneurial? That is how to recognise opportunities and exploit them and turn reactive action into proactive in regional context? This was examined in Paper [I], that emphasised that in knowledge based economy higher education institutions and specialized research units have an important role in bringing knowledge to the regions. Therefore the first and perhaps most important step in increasing interaction is to understand the needs of the regional industry. Only then a unit of higher education can take clever actions and work in convergence with industries. Actions can be changed from reactive to proactive by increasing interaction and by having collaborative strategy processes. In this paper Satakunta University of Applied Sciences from Finland was used as a case example to describe what practical actions higher education institutions can take to better fulfil the regional expectations and to increase the interaction with industries to ensure better knowledge circulation and utilisation. In this case the context was mainly knowledge application, also called mode 2. The case also showed how entrepreneurial actions can be carried out in practice. The developed models and tools described in this paper were: strategy based regional development, cluster approach in development, partnering process, knowledge management and the searching new innovations for firms (SNIFFering) process. Global competition and knowledge economy affect almost all actions. Therefore the regional actions must be fitted to global competition and knowledge economy context. The researcher was the sole author of the paper.

How to add effectiveness and impact of interaction with industry in the region? This was explored in Paper [II] where an effective model for higher education and industry interaction was created based on literature review and a case study of Satakunta University of Applied Sciences in Finland. In a knowledge-driven economy there is a growing need for deeper and more productive interaction between higher education and industry. The paper described what should happen inside the units of higher education in order to enable more effective collaboration with industries. It requires incentives and a strong interaction between the main processes in higher education. In this paper Satakunta UAS was used as a case study to describe the interaction between the main processes in a unit of higher education. The main processes in Satakunta UAS in this paper were the educational, R&D and entrepreneurial processes. The impact maturity model of interaction was introduced based on experience. Basic guidelines and best

practises were also pointed out. Requirements for effective regional interaction were also listed. The researcher was the main author of the paper.

What kind of role do KIBS firms have in interaction with industry? This was studied in Paper [III] where the role of technology based KIBS firms in the commercialisation of knowledge was examined via case studies. It showed why and how small KIBS firms have an important role in knowledge commercialisation. The paper was written from the point of view of innovation management and the paper was based on a broad conception of innovation. A case study of a technology based KIBS firm, started in the year 1997 in the incubator of Satakunta UAS, was used to bring the theory to practice. The development path of the firm was described as a process and the links to the above factors were addressed. The case study found out how the firm was connected to the value network of Satakunta UAS, how it managed its own innovation process, how the value network of the firm was built and how the configuration of its innovation networks changed during the time covered by research. A scenario analysis was done by using the soft system methodology to find a meaningful future development path for the firm. The researcher was the sole author of the paper.

How can the creation of KIBS firms be supported among the students in higher education? Paper [IV] studied the support of knowledge intensive business firm creation in higher education. It modelled the Enterprise Accelerator process in Satakunta UAS for the creation of knowledge intensive businesses and the mentoring process to support the process. It studied how to combine studies in higher education and the creation of knowledge intensive business firms started by students. Development needs were studied to develop the system further. The students' own enterprises were found to be a good addition to the learning environment. The mentoring process was seen as the most important part of the Enterprise Accelerator process. The students saw that mentoring added value to the start-up process. The study programs were seen as platforms for entrepreneurship. However, the research found that programs could be further developed to enhance the creation of entrepreneurship even more. The researcher was the main author of the paper.

What kind of innovation management tools and process can be used by KIBS firms to support their growth? Paper [V] studied ways of supporting sustainable growth in small high technology firms by managing innovation. The paper examined technology based and knowledge intensive business service firms and their innovation management in Finland. Two cases of small technology based small KIBS firms were selected for closer examination. The paper introduced a meaningful innovation process for a small KIBS firm that takes growth into consideration. In the paper incremental, radical, disruptive, open and systemic innovation were seen from a small KIBS firm's perspective. A growth model that takes them into consideration was created. It investigated diverse types of innovations as a source of growth for a small knowledge

based firm. The study revealed that small firms can benefit from several types of innovations, like incremental, disruptive, systemic and even radical. It studied the required approach in tools and methods. A systemic model was needed not only in process but in utilising tools as well. The paper was presented in High Technology Small Firms Conference in University of Twente, the Netherlands. The researcher was the sole author of the paper.

What is a systemic model of interaction like and which are its future development needs? Paper [VI] noted that global trends and knowledge society also bring their influence to innovation. There was a shift going on from closed innovation to open and networked innovation. Satakunta UAS focused its role in these new paradigms. In general the research and development activities for innovation in Satakunta UAS were guided by national and regional frameworks. The actions were strategy-based on the national and regional innovation strategy and on Satakunta UAS R&D strategy. Teachers and students were the essential actors in the co-creation of innovations. The creation of knowledge and innovating began by identifying the existing and future needs of industrial partners and their customers. The methods in use were the systemic approach, cluster based development, knowledge management for transfer and innovation, integration of the innovation chain, creation of critical mass, and long-term partnerships with collaborative knowledge creation. They help in searching and creating new innovations in collaboration for partner firms and organisations. All this requires a supportive culture, structures and training. There were many benefits in connection to innovation processes and networks, like new knowledge and technology from partners, weak signals detected by networks and partners that help to focus research and education. The paper summarised development gaps on the interaction model. The paper was published in the Industry and Higher Education journal published by IP Publishing. The researcher was the sole author of the paper.

Paper [VII] summed the earlier papers and listed the potential targets for development. It was found that in knowledge-driven economy there was a growing need for deeper and more productive interaction between higher education and industry. The full exploitation of knowledge required strategies, incentives, appropriate processes and a strong interaction between the transferring processes and the main processes in higher education. In a knowledge-based economy, knowledge was more likely to be created in application collaboration. In this kind of knowledge creation process, the knowledge creation, dissemination and utilisation were carried out close to each other or even simultaneously. Also, basic research and applied research can no longer be separated. Knowledge creation was found to be, in many cases, based on a long-term partnership where trust, commitment and mutual benefit can be achieved. This paper explored ways to support and create entrepreneurial actions in higher education to commercial knowledge and technology. It studied the case of Satakunta University of Applied Sciences in Finland. The knowledge management model is further developed into an

innovation knowledge management model. The systemic approach for interaction was developed and presented. Current and future current development needs in interaction were also investigated. Several potential instances for improvement were listed. The created models can be developed further especially follow up and evaluation phases to make model add steering and impact. There may be possibilities to find more causal relationships between the parts of the model. More diversified funding can make model more sustainable. New networks and partnerships are needed to fulfil technology and knowledge needs on the region. Stronger connections to basic research and ability to adapt more research knowledge are also needed to further intgrate the innovation chain. The paper also added the contribution by examining the innovation and entrepreneurship supportive culture in a higher education institution. The paper was published as a chapter in the book *Higher Education Institutions and innovation in the Knowledge Society* published by Arene, the Rectors Council of the Finnish Universities of Applied Sciences. The researcher was the sole author of the paper.

The thesis used a constructive research process model to collect the results from Papers and to wrap up the systemic model for interaction that answers to the main research question: *How can higher education have a significant role in the creation of innovation and entrepreneurship?* According to the research, a sustainable basis for interaction could be created by using strategy based actions. Action and experiments add strategic competence through strategic learning. Strategic learning was found to be created in action and sensing changes in technologies, knowledge and development potential of case UAS and partners. This was also found to encourage turning actions from reactive to proactive. Effectiveness in industry interaction required being entrepreneurial, creating innovative learning partnerships, creating strategic competence and critical mass, and having internally and externally a strong interaction between processes and actors. Partnerships and dynamic networking were needed for enhancing innovativeness. Partnerships were essential in the creation of meaning in the forecasting of change and in goal setting. Dynamic networks were important in finding complementary knowledge and the creation of new knowledge combinations for innovation when goals were set.

Based on research, the systemic innovation management approach was required to be used in the development of interaction. In this approach strategy based actions, regional clusters, partnerships and dynamic networks, integration of the innovation chain, and KIBS firm collaboration were found to be essential elements. Absorptive capacity and collaborative learning, connections to international knowledge flows, finding and integrating completing knowledge, and effective usage of innovation technology were found to be the main supporting elements. Teachers and students were noticed as a central resource in interaction. Their interaction with firms and effective interaction in internal processes were also essential. The model and its elements are presented in Figure 7-1.

In the search of the co-creation of innovations, knowledge management enhanced new combinations of knowledge and experimental knowledge creation, and practice and science based innovation. Learning and renewal were built into the model and that promoted the creation of sustainability of the model. Elements of the model promoted the searching and creating of new innovations in collaboration for partner firms and organisations. The utilisation of the created interaction model also supported the creation of working life competencies and the expertise of students. It was found that KIBS firm creation and development should be supported with the firm's own process supported by training and mentoring. This is because KIBS firms had specific roles in interaction as innovators and in the transfer of knowledge and technology. R&D competence of KIBS firms adds success and impact because it adds to their capability to transfer the latest knowledge and models to their partners. The created models were utilised in the management of interaction and the creation of innovations in collaboration between higher education and firms.

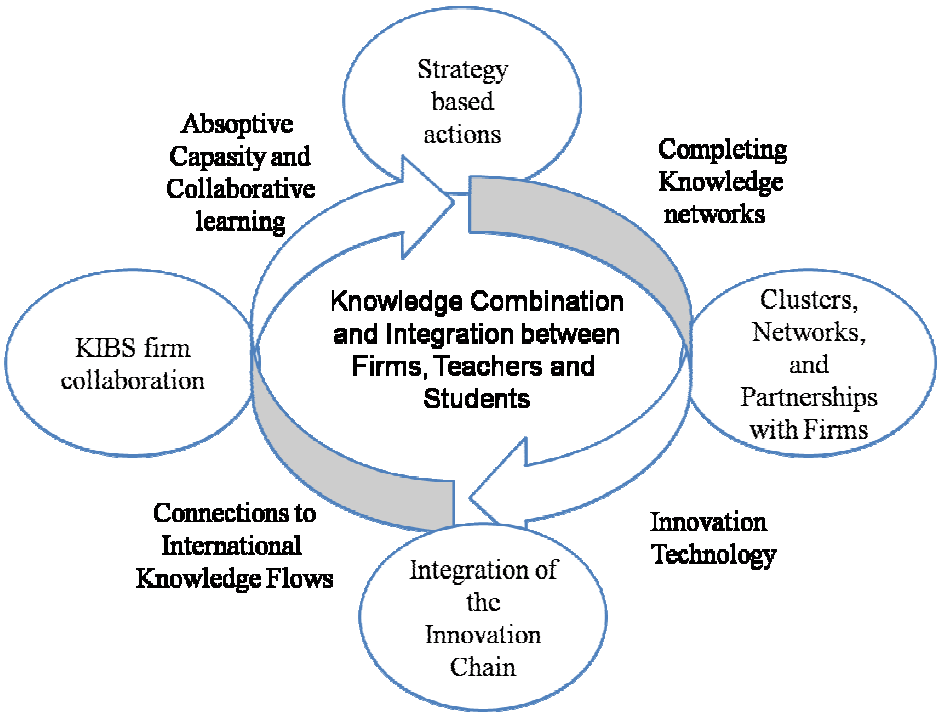

Figure 7-1 Systemic model for fostering innovation between higher education and industry based on Satakunta UAS case study

According to the findings in this research, the systemic model for fostering innovation between higher education and industry had the following properties. An institution of higher education

1. scans the needs of the community and creates a strategy where innovation and entrepreneurship have executable goals and the strategy is continuously updated
2. proactively creates competences and critical mass according to its strategy
3. circulates knowledge between education, RDI and entrepreneurship processes and allows flexible resource allocation
4. utilises clusters, networks, and partnerships in innovation
5. integrates research and application based knowledge with rich experimenting
6. develops processes, tools and technology that support R&D&I project execution, collaborative learning, knowledge creation and combination, to foster diverse types of innovations, and manage the entity as a system
7. runs an incubator for students that actively creates new KIBS firms
8. embeds KIBS firms in an active role in the institution's innovation networks
9. values entrepreneurial personnel that sees opportunities for better research, curricula, innovation and entrepreneurship, and provides the support of senior management
10. recognises students as central actors in innovation and entrepreneurship by participating into R&D&I process in diverse roles and by starting enterprises as part of their studies, and develops curricula and methods according to it

The created model combined properties of Entrepreneurial University (Clark 1997), Engaged Institution (Kellogg 1999) and innovation management theories. Adding the innovation management theory view to the entrepreneurial university research was the main contribution of the work. The second contribution was combining innovation and entrepreneurship as an entity. Usually they are treated separately although they are complementary (Van de Ven et al. 2008, 17). The third contribution was describing a complete pragmatic model for the innovation and entrepreneurship generation between higher education and industry. The research created future opportunities to combine research areas as the model detailed or to use it as an example to make connections with other main research streams.

In the research the process of constructive research was followed. Firstly, a relevant problem was found. Secondly, a general and comprehensive understanding of the topic was obtained. Thirdly, a construction of the solution was created as the systemic model of interaction for innovation and entrepreneurship. Fourthly, it was demonstrated that the solution works by presenting outcomes and the impact of the model. Fifthly, theory connections and the research contribution of the solution were shown, and finally the scope of applicability of the solution was examined. The research followed the process of constructive research presented by Kasanen et al. (1993, 246).

The created models were useful in practice. They could be used in guiding and developing of actions and in evaluation as well. Some parts of the model passed a weak market test and some passed the strong market test. The results were clearly better when using the model compared to not using the model. The created construction is a solution

for a selected problem. The research had both practical relevance and theory connection. Thus the results fulfil the criteria of constructive research. As an entity the research process can be seen as successful although the usage of the results by other actors and researchers will finally show the quality of results.

Marttila et al. (2007) noticed that UAS can have an important role in the emerging fields of industry. It can add critical mass in knowledge and technology searching, collective learning, image building, converging management routines, and in adding trust and control. UAS should add boundary crossing and networking to adapt new knowledge and methods, and start renewal processes also inside UAS. (Marttila et al. 2007, 73-75). This research created practical models on how to add critical mass to knowledge and technology search, how to add boundary crossing and networking to create innovations. These also benefit image building both for UAS and firms.

Clark (1998, 3-8) listed the attributes of entrepreneurial university and they were: strengthened steering core, expanded development periphery, diversified funding base, stimulated academic heartland and integrated entrepreneurial culture. The individuality of development must also be taken into consideration. This research made several practical solutions to these requirements and took the development of the region and actors into consideration. According to Clark there are three requirements for transformation into entrepreneurial university: transformation driving elements, sustaining dynamics and resulting study state of change. (Clark 2004, 173-184). The driving elements are found to be the needs of the regional industry, changes in the global economy and innovation environment strategy process, and an entrepreneurial approach where changes are seen as opportunities. In Satakunta UAS case there were several diverse solutions and interaction is brought to faculties as part of curricula and teaching.

The research supported several existing research results and models in the field of innovation management. Higher education was found to be brought to the centre of innovation systems in knowledge based economy (Etzkowitz and Klofsten 2005, Laine 2009). However, to add its impact, higher education must first recognise its important role (Porter, Laine 2004a, Laine and Lähdeniemi 2007). Research also supported existing research results concerning innovation and innovation processes. The research emphasised that innovation is a process of making new combinations (Schumpeter 1942). The generic model of innovation process and its elements (Tidd et al. 2005, Tidd and Bessant 2008) were found to hold true and the model was applicable in KIBS firm's innovation process (Laine 2008). Nonlinearities were found to be a central source of innovation and business opportunities (Hamel 2000, Bessant et al. 2005, Druker 1998, Laine 2004a,b). The theory of dynamic competences (Teece et al. 1997) seemed to apply in interaction. The complementing theory of knowledge and the recombination of knowledge as a source of innovation were also supported (Hardagon 2003, 31-52). The

corridor principle in opportunity recognition and path dependence in development seemed to apply to KIBS firms started by students of higher education (Ronstadt 1997, Teece et al. 1997, Laine 2004b, Laine et al. 2007).

Learning is a central element of innovation in organisations and innovation systems was found to be true in the case (Nonaka and Takeuchi 1995, Lunvall 1992, Etzkowitz 1998, Laine 2008b, 2009). This also emphasises the importance of absorptive capacity (Cohen and Levinthal 1990, Zahra and George 2002, Laine 2008a,b). The systemic approach in managing innovation was found to be essential (Tidd et al. 2005, Laine 2007, 2008b, 2009). A collaborative learning model could be used in studying, and the guiding of the innovation process was found to be true in KIBS firm interaction (Siltala et al. 2007, Laine 2007, 2008a). The importance of primary feedback as a source of strategic learning was supported (Cunningham 1994, 34, Laine 2004a,b, 2007). The importance of actions and experiments was noticed because they develop strategic competence (Christensen 1997, Laine 2004a, Laine and Lähdeniemi 2007). The strategy is a complex issue in UAS because of multiple stakeholders (Toikka 2003, Laine 2008b, Laine and Lähdeniemi 2007, Mertanen et al. 2008).

The importance of incremental innovation for firms seemed to be true in the cases studied (Lemola 2009,186, Laine 2004a,b, 2007, 2008a). For startups the regional niche or disruptive innovation offers opportunities. These at least semi-radical innovations are important for small new KIBS firms. (Laine et al. 2001, Laine 2004b, Laine 2008a, Laine 2009, Laine et al 2007, Heinonen and Kovalainen 2009). Causal relationships can be found in single innovation processes and entrepreneurial processes (Laine et al. 2001, 2007). It also found the importance of network management complementing knowledge in innovation (Tidd et al. 2005, Hardagon 2003, Laine 2006, Laine 2007, Laine 2008, Laine 2009). The successful innovation processes studied in the cases seemed to have several phases and also changes in goals during the innovation processes. (Van de Ven et al. 2008, Laine 2008a). Network analysis was done based on a method introduced by Allee (2003). Networks seemed to be balanced and KIBS firms had an important role in them (Laine 2004b, 2008b).

Ramstadt's findings of diverse but blurring roles of actors in innovation process (Ramstadt 2008, 185, Laine 2007) and the existence of valley of death in knowledge commercialisation (Moore 2002, Laine 2007) were found to be true as well as findings about the relations of collaboration, knowledge sharing and innovation (Miles et al 2005, 48). The importance of trust in collaborative innovation creation was strongly noticed (Miles et al. 2000, Laine 2004a,b, 2008a,b). Different interests could lead to effective collaboration when all actors were also searching for solutions based on their own interests (Ramstad 2008, Laine 2007). There is a need to evaluate partnerships in action (Ring and van de Ven 1995, Laine and Lähdeniemi 2007).

Findings about the elements of innovative learning community seem to hold true in the case of Satakunta UAS (Hokkanen 2001,189-198). The knowledge creation process model and the model of hypertext organisation where innovative organisation consists of line organisation, project teams and supporting information technology structure was found to apply in Satakunta UAS case (Nonaka and Takeuchi 1995,166-171, Laine 2004b). Knowledge creation and innovation happened mainly in teams and tacit knowledge had an important role in it (Nonaka and Takeuchi 1995, Laine 2007). According to the innovation generating model there was a need for the simultaneous development of knowledge structure of actors and the object developed (Ramstadt 2008, Laine 2007, 2008b). Reflexive learning was needed meaning self-reflexivity, reflexive benchmarking and reflexion on relationships (Ramstadt 2008, 35, Laine 2007, 2009).

KIBS were important actors in innovation networks and systems (Kuusisto and Mayer 2003, Miles 2003, Laine 2008a). Small firms recognise and value disruptive innovation Christensen (1997, 2003, 2004, Laine 2004b). Small technology based firms, also KIBS firms, find it difficult to create and diffuse systemic innovations (Maula et al. 2007, Laine 2006). Niche management is needed in KIBS development (Lemola 2009, Laine 2008b, Laine et al. 2001, Laine et al. 2007). Research also supports the need of a niche application for KIBS in transfer from innovative customers to mainstream customers (Moore 2002, Laine 2004ba, 2008a).

Research found the following frameworks useful in the development and analysis of innovation interaction: Entrepreneurial university concept (Clark 1998) as a general principle guiding interaction and its development, Triple Helix collaboration on regional and national levels, Engaged Institution concept (Kellogg 1999) and Responsible Partnering as a general guideline for partnering (RP 2005, 2009), Stokes framework (1997) for knowledge creation and Markham's (2002) valley of death model as general frameworks for knowledge creation and innovation chain integration, process and best practices in higher education and industry interaction (Barnes et al. 2002). The research also supports the management innovation implementation of best practices (Hamel 2007, 227-229). Hamel's notes about systemic development were found to be true in interaction development. It required small changes to be done to the system and observing what happens and making actions based on the observed impact to the system (Laine and Lähdeniemi 2007). This also fits to the systemic thinking theory and to the theory of complex systems.

7.2 Implications to Practice

The research suggested several implications to practice. The institutions of higher education should take a proactive role in their region. This means being active in the regional strategic developing processes and act as a “seeker” that finds valuable knowledge and creates innovations for strengthening and creating new markets for the regional firms. Qualified regional partners and dynamic national and international networks are useful in this process. Students and teachers should see interaction with industry as an opportunity. Firms should see interaction also as a strategic issue.

Several potential benefits were found from using the model for different actors. By applying the model the following benefits may be obtained. Students have an opportunity to participate in projects and learn in diverse ways to build competencies that are needed in working life. They can team up with experts in other organisations and become embedded in networks. It serves the development of their expertise. There is an opportunity to become an entrepreneur during the studies, start a business and learn to grow it. At the same time the students can gain competence that supports entrepreneurship and innovation, especially R&D&I competence. Interaction with industry offers diverse roles for students from routine expertise to adaptive expertise.

The entrepreneurial students can create a sustainable business during their studies that is a true alternative for other careers. They learn project management and leadership in practice, gain credibility as an entrepreneur and an expert. This adds to the possibility of self-employment at the point of graduation. After graduation the students can build an optional partnership with higher education. (Laine 2004a, 2004b, 2007, 2008b) Teachers and other personnel have an opportunity to participate in interaction in roles of project manager, expert and mentor. They can develop personal competencies in R&D&I and mentoring, learn insights from diverse fields of industry and see theories and models in application context. They can create new contents and contexts for teaching and have experiences of success with students. (Laine et al. 2007)

Higher education institution has an opportunity to create networks and partnerships. It can also have partner entrepreneurs as active alumni. It gains strategy insights in industry in general and large firm partners, regional SMEs and KIBS in particular. It gets involved with innovation processes on organisational, regional, national and international levels. It can develop R&D&I competence into a core competence with active development and consistence. It can build a positive image of the region, nationally and internationally. It gains competitiveness among potential future students. (Laine 2004a, 2008b) The interaction offers opportunities for feedback from firms and partner organisations for strategy and curricula development. It can increase and diverse external funding, develop absorptive capacity and strategic competence and define and develop focal areas of R&D&I. The interaction supports creation of general and specific

competencies. The institution can build a framework for the management of interaction and regional impact. Using the model enables creative management and actions (Laine 2004a, 2008b, Laine and Lähdeniemi 2007).

For SMEs and large firms the usage of the model offers new views for development and knowledge for innovation. It can grow into a co-creation of innovations with higher education by combining several knowledge sources and experimenting. It can have students as development resources and potential future employees. Firms can participate in discussion for the development of region and higher education as part of it. They can give input for curricula and competence development. They can create a potential partnership with higher education for sustainability and systematic approach. It can find new network partners and knowledge sources. KIBS firms can start the co-creation of innovations with higher education. They can also co-create expertise with higher education. They can develop a business niche and search growth with the help of higher education (Laine 2008a). They can build other networking options like international connections. They can build a partnership with higher education to add sustainability and build a systematic approach.

Using the model also creates challenges. Higher education and firms may not use the same language, detect changes and interpret their meaning together with firms. Therefore trust creation may fail, there will be no free sharing of knowledge and no new innovative solutions created. Lack of tangible results may lead to frustration and end of relationships. Tangible results and interpretations of changes make relations sustainable. Higher education may even be seen as a competitor for SME firms because they become active on its core areas of knowledge. Therefore it is important for higher education to transfer to new knowledge areas when KIBS firms or other firms become active on new knowledge areas. There may be difficulties in the teachers' resource allocation and transitions to tenure project positions may fail. Therefore also interaction between processes and transfer to teaching may fail. That in turn hinders knowledge sharing and the creation of new knowledge combinations. Some teachers may feel that combining teaching and projects is too difficult. All teachers do not necessarily agree with strategy and quality principles and that may cause a lack of actions and a lower quality of actions. Balancing between confidentiality and a half open environment in higher education may also fail. Informing about realistic time plans and a possibility of failure fails and external partners have unrealistic expectations for projects and think that failures cannot happen. The temptation of an academic drift makes UAS small universities. The fear of tertiary drop hinders practical actions or makes them less valued compared to academic outcomes.

Firms and industry in general should create commitment on senior management level to start collaboration and give a strategic direction for it. There could also be discussions of long range involvement and strategic issues where higher education is also included

in the discussions. More firms should give open innovation a chance. They should see the emergence of open innovation as an opportunity and higher education as a potential knowledge and technology application source. Higher education should create a strategy for interaction and update it regularly according to changes in its environment. It should consider diverse ways of interaction to find the ones suitable and effective in the local context. It should seek for diverse channels of funding to support the sustainability of actions. Higher education should connect to global knowledge flows and search the best partners on focus areas.

The role of students and teachers was centric in this model. Therefore the understanding of their internal and external motivation and the creation of appropriate incentives are key issues if the model is to be applied and developed. Low entry and diverse role models to participation are needed. It should support teachers and students to change towards interaction and entrepreneurship. It should create diverse actions and also avoid conflicts between traditional teaching and entrepreneurial actions. It should build of strengths in both and build interaction between them.

Policy makers should see the funding of small KIBS service development as important because KIBS firms have an important role in the regional innovation system and they also transfer knowledge between regions. KIBS can also add to the offerings of large firms in the region and add to their competitiveness. Policy makers should see the development of UAS as an institution and sustainable actor in innovation networks. They should fund knowledge creation and free sharing between diverse actors to create motivation for open innovation.

The model was a simplification already by the definition. The most general and important parts of the model were described. The model was also context dependent. It was based on a single case study in Finnish UAS and higher education context. It has to be adjusted to the organisational strategy, culture, initial conditions, surrounding innovation system and legal frameworks. When applying the model in other contexts it may require some re-innovating. This is also partly because the model is still complex although it is a simplification, and users tend to innovate new ways to apply it. Actors should be aware of the blurring roles of actors, open and closed modes of innovation and ICT’s role as a generic source of innovation.

The model was created for an organisational level although a team level is important in learning and innovation. The models were based on the subjective opinions of the participants. There were differences in actions and views of single individuals even in the same organisation. Some parts of the model may be considered speculative because they were based on the subjective view of the actors involved in the research process. Although they seemed to be true in the case organisation they may not work similarly in other organisations. Therefore implementing the parts of the model to other

organisations is needed to validate the generalisation of the model. Also national and regional context and starting conditions affect the results obtained when using the model.

In general, innovativeness in higher education shows a continuous renewal and better sensitivity to changes in the environment, and also the capability to act based on detected signals and to create graduates that get employed. It also shows better interaction with external partners and in networked co-creation of innovations and entrepreneurship. It adds regional impact and R&D&I interaction to the region (Laine et al. 2008).

7.3 Directions for Future Research

In the future it will be important to build open innovation models for SMEs and small KIBS firms. Experiments and quantitative research with other units of higher education will be needed to see if the models can be generalised. There will also be a need to study legal issues like contracts and immaterial property rights especially in the case of open innovation to ensure win-win situations for diverse actors. Concerning higher education it will be interesting to study more deeply students as innovators. It will also be interesting to study the motivation of teachers and students to participate in interaction with industry. It will be as important to study the motivation of firms to open innovation.

The research has set a foundation for experimentation based practical models of interaction in innovation and entrepreneurship between higher education and industry that combine an entrepreneurial university concept and innovation management theories. Other researchers with different contexts will be welcomed to the field. Sustaining co-operative innovation requires the re-innovation of collaboration models (Laine 2008). Therefore researching the interaction is important in the future also.

This research used the organisation level as a view point. In the future it would be important to focus on the team level as well because most of the knowledge and innovations are created on team level. Also, it is important to have practical open innovation models for KIBS firms and SMEs to be studied in more detailed ways. The model presented in this paper is one possible solution and is based on a single case study. Other creative and systemic combinations should be created in other contexts to make comparisons to this research. Also, field tests in other contexts with the created model would tell if the model works in other contexts. An interesting way to proceed would be using institutional theories to study interaction for innovation. It would also be interesting to find more causal relationships between parts of the model in the creation

of innovations. Also the measurement of innovation management is a future research topic. This can be done by using innovation management evaluation or by creating testable hypothesis based on the models introduced in this research. The creation of innovations in higher education also requires innovative pedagogy. It should also be studied and developed more deeply in the future.

7.4 Summary

Fostering innovation between higher education and industry requires a systemic innovation management approach. The systemic approach in innovation management was found to be important both for the creation of interaction and for the development of interaction. In the systemic approach strategy, partnerships, dynamic competence development, and rich experiments had an important role and were used simultaneously. In the search of the co-creation of innovations, knowledge management and effective internal and external interaction enhanced new combinations of knowledge and experimental knowledge creation to create practice based innovations.

Research had implications both for theory and practice. The created models can be utilised in the management of interaction and the creation of innovations in collaboration between higher education and firms. The results are used in collaboration between Satakunta UAS and its partners with positive results in innovation and entrepreneurship in the region. The model can be considered as a managerial innovation because in it several aspects of innovation were combined to create a new approach. The model was systemic, pragmatic and normative. The research modelled several processes to add the combination of knowledge in the innovation process. The modelling was a generalisation because it was a simplified description of reality and the research tried to capture the most essential parts of the phenomenon. The research was found to have several theoretical contributions and practical implications. The results were able to be generalised in similar environments and organisations, but it was also found that they should be used with care because the initial conditions also affect the results that can be achieved. Also, the complexity of the model makes generalisation difficult.

Until this research was carried out, there were not many research approaches that combined the different views of entrepreneurial university, and entrepreneurial university concept was not connected to mainstream research streams (Rothaermel et al. 2008). Therefore this research was an important addition to existing research by combining entrepreneurial university concept and innovation management theory and combining entrepreneurship and innovation. The research also revealed interesting new research streams for the future. During the research the role of innovation in interaction

was increased so much that R&D has become R&D&I or RDI in Finnish Universities of Applied Sciences. Even so, that innovation defines how research and development should be done and innovation defines strategy, not vice versa.

There was a gap in experimental innovation research and a gap in combining entrepreneurial university concept with other mainstream research (Rothaermel et al.2007). Open innovation required new models while the innovation paradigm is changing from closed innovation to open innovation and entering other industries than large firms based on high technology (Chesbrought 2003). Experiment based innovation research was not used enough especially in the creation of new practical tools and processes. Open innovation paradigm required new models that promote the application of open innovation in practice (Sørensen et al. 2010). This research created new models and new ways for executing open innovation processes between higher education and industry. It was shown that higher education can take an active approach and start making strategy based actions.

In the future the interaction between higher education and industry will be even more important because higher education will be one central actor in innovation processes in the future as well, because of the raise of complexity, abstractness, knowledge intensity and a need for faster learning in society. There are pressures for higher education to be even more productive and innovative than before, and to have even more impact on its region. On the other hand, nations, regions, clusters and firms face an increasing need for competitiveness, and interaction with higher education is one means to respond to those pressures. This further emphasised the importance of this research and its results.

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