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THE DEVELOPMENT OF COLLECTIVE COMPETENCIES IN THE CONTEXT OF NEW HIGH TECH VENTURES

Theme: The Social Processes of OL and KM

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Abstract

This paper want to explore the development of collective competencies in the context of new high-tech ventures. New high-tech ventures face many problems in developing a new technology especially when they are established as research-based spin-offs. Even though technological competencies are critical in the start-up phase, new ventures have to focus on the market in order to succeed. This success is dependent upon the ability of the entrepreneurial team to coordinate different knowledge bases during different phases from foundation to commercialization, which can be described as the ability to develop collective competencies. An emperical study of a new research-based spin-off invovled in developing a new technolegy will be used to illustrate the development of collective competencies during the first year after start-up.

Introduction

New high-tech ventures face many problems in developing a new technology especially when the start-up is based on commercialising a spin-off from the universities. The concept of academic spin-off or research-based spin-off has been used to characterize these firms, as they are fundamentally different compared to other high-tech start-ups (Claryss & Moray 2001). It is obvious that scientific and technological competencies are critical for those new ventures in the start-up phase, but meanwhile they also have to focus on the market in order to succeed (Boussouara & Deakins 1999; Teece 1988). This success is depending on the ability of the entrepreneurial team to coordinate different knowledge bases during different phases from foundation to commercialisation, which can be described as the ability to develop collective competencies (Frohm 2002). Entrepreneurial teams play an important role in developing successful new high-tech ventures as it is argued that in order to succeed it is essential that individuals combine their "abilities in teams" (Vyakarnam, Jacobs et al. 1999: 154). Even though entrepreneurial teams are acknowledged to be important to secure growth and success in new high-tech ventures, much of the literature about innovation implies more or less explicitly that a knowledge base exists in the organization either as individual specialized knowledge or as collective knowledge embodied in group routines (Ravasi & Verona 2001). This is not the characteristic of new high-tech ventures as the foundation team in the initial stages only posses some of the competencies, which seem to be crucial to secure the success in developing, manufacturing and commercialising the innovation.

One of the underpinning assumptions behind the idea of innovation is that entrepreneurial teams - which combine different personalities, knowledge and skills -, are more likely to accomplish an innovation than a homogeneous team. This however, does not take into account the growing size of the entrepreneurial team. Already in the first period after the start-up, the development of competencies is complicated by the introduction and recruitment of additional members to the entrepreneurial team (Venturelli 2001). However, if individuals are to be able to collaborate they need to develop a certain degree of mutual knowledge to make it possible to conduct even the simplest activity in a coordinated way (Holmquist 1999). Although the new venture is able to attract and secure competent staffing and members with complementary skills, they must develop a shared understanding or collective mind (Weick & Roberts 1993).This is not only a social process of team-building, because people who work closely together can hold different conceptions of their work (Westelius & Askenäs 2001), which makes it difficult to understand how to collaborate with others. To explore the development of collective competencies it is important to consider the dynamic nature of the growing entrepreneurial team in order to understand collective competencies as something emerging during the innovation process between members of a rather heterogeneous or cross-functional team and between newcomers and experienced workers.

There is a number of empirical and theoretical studies on collective competence, which this paper wants to elaborate. Even though they have different perspectives as to what constitutes collective competence and how it develops in varied contexts, they all agree that collective competence can be seen in relation to collective action undertaken by several individuals working together for a common purpose. Based on these studies, collective competence can be seen as an ability to make sense, skilful interaction, or patterns of heedful interrelations (Cook & Yanow 1993; Hanson 2000; Weick 1993, 2001; Weick & Roberts 1993). I first want to outline these different ways of understanding collective competence in order to explore how collective competencies can be seen in the context of new high-tech ventures. Based on an ongoing empirical study of a new internal corporate venture involved in developing a new technology, the concept of collective competencies will be used to illustrate how collective competencies developed during the first year as the entrepreneurial team were involved in simultaneously developing, manufacturing and commercialising a new technology.

Collective competence

In Hanson's (2000) studies of collective competence, he uses the concept of skilful interactive action. Skilful is - according to Hanson - the requirement of competent individuals, which have the necessary technical knowledge and skills in order to accomplish the common task of the group – the individual's technical competencies. The combination of several individuals' technical competencies constitutes a mutual knowledge base for collaboration. Even though the mix of technical competencies is fundamental for a group to undertake collective action it is not sufficient in order to act as a competent group. Hanson (2000) states that social competence - which refers to the culture, routines and rules shared by the team -, is essential in explaining competent group performance. Consequently, collective competence is often regarded as a way to explain skilful and successful performance of a team, workgroup or organization (Cook & Yanow 1993), but some of the important contributions to the theory stem from studies of collective incompetence and takes departure in the failures (Weick 1993, 1995; Weick & Roberts 1993). By taking departure in both studies of success and failure makes it more suitable to discuss and theorize about the ability to make sense, patterns of heedful interrelations and skilful interaction.

"The basic idea of sense making is that reality is an ongoing accomplishment that emerges from efforts to create order and make retrospective sense of what occurs" (Weick 1993: 635). In a study of the Mann Gulch fire disaster, the death of 13 out of a crew of 16 smokejumpers is seen as a collapse of sense making (Weick 1993). Most of the smokejumpers were not able to create order and make sense of what was going on, as they experienced a novel and dangerous situation that resulted in the disintegration of the group and resulted in a fatal outcome. If individuals are not able to make sense out of a reasonable and meaningful situation, they will act as individuals and not as a group. Even though the crew was created from highly skilled and trained smokejumper, they did not have any shared experience as a group. As Weick explains "they were mainly tied together by pooled interdependence" as " they did not come together around the same activities in the same time and place" (1993: 647, 632).

The importance of shared experience is fundamental in collective sense making (Boyce 1995). The concept of collective sense making can be seen as the process whereby groups interactively create social reality, which becomes the organizational reality" (Boyce 1995: 109). Collective sense making makes a group or organization focus to reach unity (Boyce 1995). This is evident in the example of Hungarian soldiers lost in a snowstorm in the Alps, as they were able to make sense out of a map they suddenly discovered and finally found the way back to camp (Weick 1995). Even though it was a map of the Pyrenees, it calmed the soldiers and made them able to create a collective order and act upon the map – "they were able to enact a collective competence" (Orlikowski 2002: 253).

Skilful interaction is seen as the way the work is carried out in practice between several individuals cooperating or collaborating for a common purpose. In a study of flute makers, Cook and Yanow (1993) argue that collective competence can be seen as the capability of the workshop to make flutes which over the years still have the same original sound despite the fact that flute makers over time leave the workshop. Although the work of making a flute is separated into several different individual tasks, only the workshop is capable of making the whole flute. The interaction - which takes place during the manufacture of a flute - is collectively learned "so the knowledge needed to make the flute has not been lost to the organization as evidence in the sameness of the play and feel produced by the workshop over the years" (Cook & Yanow 1993: 381). Collective competence can then be seen according to the way the several subtasks are carried out by several individuals contributing to make a flute.

Weick and Roberts (1993) describe collective competence on an aircraft carrier, which is an organization that requires almost continuous reliability in order to avoid catastrophes. They develop the concept of a collective mind to explain the performance of an organization, as "patterns of heedful interrelations of actions in a social system" (Weick & Roberts 1993: 357). The collective mind is manifested as the "actors in the system construct their actions (contributions), understanding that the system consists of connected actions by themselves and others (representations), and interrelate their actions within the system (subordination)" (Weick & Roberts 1993: 357). Even though Weick and Roberts clarify that the coordination of activities on an aircraft carrier is visible and explicit, the timing in which the streams of activities unfold during flight operations has to be coordinated between several individuals placed all over the ship and in the air. If this is done in an orderly and competent manner, "the individuals act as if they are a group" (Weick & Roberts 1993: 360).

The stories about smokejumpers, soldiers, flute makers and an aircraft carrier all deal with explaining different constitutions of collective competencies although they do not use this expression. What seems to be important is that collective competence has to relate to an activity in a system and concerns the interaction between several individuals in that system (Bramming & Madsen 1999). For that reason, I use the concept of domain to describe the activities, which constitutes an area for collective competencies such as making a flute. A domain is only a taxonomic (Orlikowski 2002), but necessary in order to explore what constitutes collective competence.

The case of Bio-sense*

*All names, products, locations and customers gave been disguised.
Bio-sense is a way to illustrate how the development of collective competencies emerged during the start-up of a new venture as the members of the entrepreneurial team mainly focused on developing a new technology but at the same time they were preparing for manufacturing and commercialisation. The case wants to focus on the development of collective competencies to explore 1) how they linked the technology to the market, 2) the collaboration between the employees as they were involved in coordinating the different activities and 3) the collective mind.

All the employees who were involved in the new venture during the start-up were all professional academics in management, physics, biology and chemistry, which makes it at multi-disciplinary team as several academic disciplines are involved (Mccallin 2001). They were primarily working within the main activities of design, process, characterizing and biological test as shown in table 1. During the start-up, these people make the entrepreneurial team but are planed to transform from a research team into a management team, who will be responsible for R&D, Manufacturing and Marketing when the venture grows. This case only concerns the research team, as to focus on the collective competencies, which were essential to develop the new technology.

Table 1 The construction of the entrepreneurial team according to professions and activities	
19Y7 Summer Pre-start Initial screening	Inventor (John 1) Inventor (Jane 1) Business Developer (John 2)
19Y7 Autumn Start	Inventor (John 1) Design, Process, Characterizing Business Developer – Executive Director (John 2) Commercialization
19Y8 Winter	Engineer - Nano & Micro technology (Jane 2) Process, Design Biologists (John 3) Biological test
19Y8 Spring	Inventor (Jane 1) Design, Process, Characterizing, IPR
19Y8 Summer	Engineer - Micro Mechanics (John 4) Process, Patent (Up-scale production) Chemist (John 5) Biological test (New ways) CO Inventor leaves the company (Jane 1)
19Y8 Autumn	Business Developer get promoted to CEO (John 2)

Pre-start - the history of Bio-sense

Bio-sense was established in 19Y7 as a research-based spin-off with investments from a Danish corporate venture capitalist (CVC) that over the years have been involved in developing new businesses especially in connection to the high-tech industry. The spin-off was based on a project at a university, which had been working with the advanced technology since 19Y1, but it was not until 19Y4 that the project actually began to focus on developing biosensors. Only one of the two inventors who held the patent became fulltime member of the new venture from the start and the other only worked as a consultant for a short period later on. A business developer from the CVC was appointed as temporary Executive Director for the new venture but gets promoted to CEO autumn 19Y8. The Business Developer had been responsible for conducting the initial screening together with the two inventors before the CVC agreed to invest in the project. The screening mainly focused on clarifying the potential in the technology and identifying a market for the new technology. Based on the screening, a Business Map was constructed to give a strategic overview of the potential in the technology and identified the product, market, competitors, IPR and an overview of the resources needed to commercialise the new technology.

Start - Linking the technology to the market as collective sense making

Linking the technology to the market can be seen in accord to collective sense making. The start-up of a research-based spin-off is often based on one core technology, which has to be further developed before it is ready for commercialisation. The importance of linking the product design to customers need is therefore essential in order to commercialise a new product (Dougherty 1992), which underlines the ability to focus on the market. In the literature of entrepreneurship it is often argued that the entrepreneur starts by “conceptually envisioning a new business reality and then starts to concretely enact it on the market through committing other actors to the process.” (Johannisson 1998). The ability to vision the nature of the market (O'Connor & Veryzer 2001) constitutes a domain for collective competencies in order to make sense of the linking between the technology and market possibilities. Bird (1989: 328) states that “visioning directs action by drawing in a desired future state into the existence of one’s self and others.”

In the first period after the start-up, John 1 worked alone in the laboratory with the development of the biochip, which eventually has to be build into a simple portable and inexpensive instrument – a reader – in order to function. The reader is an instrument, which has to be used together with the biochip. Even though the Inventor worked alone, the improvement of designing and producing a biochip was based on sense making according to the potential market for the biochip, which he had made with the business developer.

“Right from the beginning, we were convinced that the biochip could be used everywhere. This was a problem because eventually you have to get a clear focus. The business developer then analysed the market – more or less systematic – and realized that the best opportunities were in the area of X-market. This sounds also very reasonably because we can produce the product according to the demands related to the X-market: the product is portable and capable of conducting between 10-100 different analyses, the chip is disposable and the price is fair. Also the volume of X-market has great importance” (Jane 1).

Even though it from the start was very clear that this new biochip was pointed towards the X-market, the focus became much more clearer as a biologist (John 3) was employed in summer 19Y8 and became the fourth member of the research team. John 3 had many years of experience in conducting analysis based on XXX, and could see that the biochip was able to change the way analyses normally works in X-market.

“It would make it easy for X-customer to respond quickly and deliver the result immediately. Then they do not have to send an X-test to the laboratory and wait for an answer” (John 3).

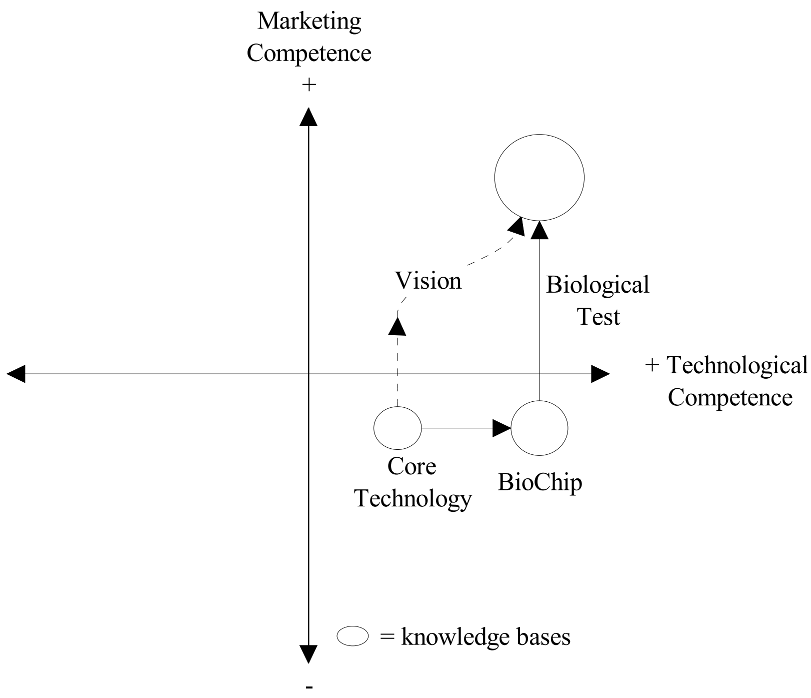
“At the first time we thought of using the technology in connection with YYY – it is very fancy to work with YYY, but in the area of XXX it seems more appropriate because the customers will save time in performing analysis. Working with YYY is very complicated, as you have to work with Y instead of X” (John 1).

This can bee seen as a major change in collective sense making, as it became clear, that the biochip would be more appropriate in an area, where it would improve X-analysis and save time for customer and their customers. At the same time, the fascination in delivering a “smart solution” to all customers was partly abandoned but was still considered to be important as a way of developing the biochip for new customers later on. The importance of collective sense making in relation to identify the customers and understand how they can use the biochip lead to the linking of technology to the market (Dougherty 1992). But to cite Hanks & McCarey (1993) “Visions without action is dreaming; while action without vision is a shot in the dark.”

Developing collective technological competencies through interaction

The collective competence to produce the whole biosensor made it necessary to coordinate the independent activities in design, process, and characterising and biological test. In the beginning, the focus was mainly on coordination between design, process and characterising, as this was essential for the existence of the venture. The construction of a biochip was based on developing the core technology into a functional and reliable biochip, which is necessary for developing the biosensor. This implies that there are three important milestones to construct the biosensor: They are 1) developing the core technology, 2) developing the biochip, and 3) developing the biological test as can be seen in figure 1.

Figure 1. Milestones and knowledge bases in developing the Biosensor.



During the early start, John 1 experimented in the physics-lab to optimise the processes and identify the recipes, which should be used to make the biochip. The recipes were only altered very little after the first newcomers were engaged. The activities during processes are considered as routine for the employees working in the physics-lab. Even though the new physics Jane 2 & John 4 who entered the new venture did not know the technology, it was very easy to carry the task out, as they were used to work in physics-labs as they both had worked in R&D departments conducting basic research.

"It is one of our principles – if you want the technology to function, then you are better of using the same procedures during production. If you change too much at one time, you cannot be sure of anything. When we changed to another material, we had no sense of what we were doing. If we are changing something important or too much, we must accept that it will take 6 month to get on top again" (John 1).

The activities involved in the process of producing the biochip can bee seen as a fundamental knowledge base for collective competencies among the physics team (John 1, Jane 2, & John 4), as the several different recipes involved in the making of the biochip is made explicit and is fully known to everybody. This also made the coordination between design and biological test simpler, as the reproducibility of biochips has become very high. But the combination of the multidisciplinary made it necessary, not only to develop a shared meaning among the members to develop the sensor ((Bouwen & Steyaert 1990), but also to develop a common understanding between the different disciplines in order to collaborate. Especially when John 3 - the first biologist - became part of the development team. John 3 had to understand how the biochip worked before he was able to develop the biological test.

"When we hired a biologist (John 3), we first had to give him a feeling of the difference between noise and signal. John 3 had a lot of experience in his own field, but we had been working with this technology for many years, so we had to make experiments in the bio-lab together so he could get familiar with this new technology. During these experiments we realized that the size of the biochip has to be changed. We had been focusing on optimising the biochip, but during the experiments we realized that we had to optimise the chip according to application" – the way the X-customers works with XXX analysis. (Jane 1)

The different knowledge bases in relation to design, process, characterising and biological suggest, that the development of a biosensor can be seen according to pooled interdependence, but in order to develop the whole biosensor, the physics and biologists had to develop a shared understanding as they are mutual interdependent. According to Hanson, this underlines the importance of social competence in order to act as a competent group (Hanson 2000) but also the importance of overlap between the individual's knowledge bases.

Collective mind

In the literature of team working it is argued that the collective mind can predict team performance (Sapsed, Bessant et al. 2002). According to Weick and Roberts, the collective mind is something that characterises organisations that continuously require reliability and have fully developed mental processes, because they have may have spent more "time and effort on organising for controlled information" (1993: 357). One might argue that in new high-tech ventures it is essential to spent time and effort on organising for controlled information in order to secure progress in the development. However, the situation that they have to act on is based on the outcome of numerous experiments, which takes place in developing a new technology. Even though they are able to acquire knowledge form different sources: social networks, scientific literature etc. they have to turn it into practice. As John 4 said during a meeting: "I saw some very interesting results at a conference, but how they had accomplished it was not obvious." The collective mind in Biosensor is based on two rules "If you want something to function you better base it on something you know how to do." and "Quick and dirty."

"The quick and dirty is a way to make a quick experiment to clarify if we are going in the right direction" (John 2).

"I call the quick and dirty for proven principle. But it is not considered as final result but something, which needs more attention. I have often experienced, that a single success during a project have made the researchers continue based on one single success without closer attention. And suddenly, this had a fatal outcome for the whole project" (John 1).

The phenomenon of the collective mind in Biosensor takes place during the weekly meeting, when they follow up on the test they have done. The quick and dirty is not always based on patterns of heedful interrelations between the members, but on one occasion they made a breakthrough in understanding the combination of design and biological test. They saw an image of the biochip – an actually could see the how the design and test functioned together. The spontaneous dialogue that unfolded between the different members during that observation appears to be coordinated as the individuals contributed in representation of each other and subordinated to the system. Even though it was obvious to everybody that this was a very important breakthrough, they all had different explanations (or conceptions) as to what actually happened.

Conclusion

This paper has tried to explain the development of collective competencies in new high-tech ventures established as a research-based spin-off. Especially, the importance of the entrepreneurial team as fundamental for understanding the ability to develop collective competencies in order to secure successful commercialisation. Even though I did not have a full story of a successful venture, I have tried to illustrate the development of collective competencies in a new research-based spin-off involved in developing a new technology. Despite most studies try to identify collective competence after the venture has succeeded (Drejer 2001), I suggest that new ventures provide an opportunity to study the development of collective competencies during the innovation process, because it is revealed more and more as the new technology begins to take form. The innovation process is thus seen as the arena for coordination of activities and as an arena for the construction of collective competencies between the different members of the entrepreneurial team.

Bibliography

Bird, B. J. (1989). ***Entrepreneurial Behavior***. Glenview, IL, Scott Foresman.

Boussouara, M. & D. Deakins (1999). "Market-based learning, entrepreneurship and the high technology small firm." ***International Journal of Entrepreneurial Behaviour and Research*** **5**(4): 204-223.

Bouwen, R. & C. Steyaert (1990). "Construing Organizational Texture in Young Entrepreneurial Firms." ***Journal of Management Studies*** **27**(6): 637-649.

Boyce, M. E. (1995). "Collective Centering and Collective Sense-making in the Stories and Storytelling of One Organization." ***Organisation Studies*** **16**(1): 107-137.

Bramming, P. & P. L. Madsen (1999). ***The Learning Process and the Emerging Nature of Competence***. Institut for Organisation og Arbejdssociologi. København, Handelshøjskolen i København**:** WP-1999.9.

Claryss, B. & N. Moray (2001). ***A process study of entrepreneurial team formation: The case of a researched based spin off***. Gent, Vlerick Leuven Gent Management School and Ghent University.

Cook, S. & D. Yanow (1993). "Culture and organizational learning." ***Journal of Management Inquiry*** **2**: 373-390.

Dougherty, D. (1992). "Interpretative Barriers to Succesfull Product Innovation in Large Firms." ***Organization Science*** **3**(2): 179-202.

Drejer, A. (2001). "How can we define and understand competencies and their development?" ***Technovation*** **21**(3): 135-146.

Frohm, C. (2002). ***Collective Competence in Interdisciplinary Project Context***. Department of Management and Economics. Linköping, Sweden, Linköping universitet.

Hanks, S. & L. McCarey (1993). "Beyond Survival: Reshaping Entreprenurial Vision in Sussesful Growing Ventures." ***Journal of small Business Strategy*** **4**(1): 1-12.

Hanson, H. (2000). ***Kollektiv kompetens***, Studentlitteratur.

Holmquist, M. (1999). "Learning in imaginary organizations: creating interorganizational knowledge." ***Journal of Organizational Change Management*** **12**(5): 419-438.

Johannisson, B. (1998). ***Entrepreneurship as a Collective Phenomen***. RENT XII, Lyon, France.
Mccallin, A. (2001). "Interdisciplinary practice - a matter of teamwork: an integrated literature review." ***Journal of Clinical Nursing*** **10**: 419-428

O'Connor, G. C. & R. W. Veryzer (2001). "The nature of market visioning for technology-based radical innovation." ***Journal of Product Innovation Management*** **18**(4): 231-246.

Orlikowski, W. J. (2002). "Knowing in Practice: Enacting a Collective Capability in Distrubuted Organizing." ***Organization Science***, **13**(3): 249-273.

Ravasi, D. & G. Verona (2001). "Organising the process of knowledge integration: the benefits of structural ambiguity." ***Scandinavian Journal of Management***, **17:** 41-66.

Sapsed, J., J. Bessant, D. Partington, D. Tranfield & M. Young (2002). "Teamworking and knowledge maagement: a review of converging themes." ***International Journal of Management Reviews***, **4**(1): 71-85.

Teece, D. J. (1988). "Capture Value from Technological Innovation: Integration, Strategic Partnering and Licensing Desicisions." ***Interfaces***, **18**: 46-61.

Venturelli, P., Ed. (2001). ***Etablering og udvikling af nye innovative virksomheder - Erfaringer og Udfordringer***. København, Nyt fra Samfundsvidenskaberne.

Vyakarnam, S., R. Jacobs & J. Handelberg (1999). "Exploring the formation of entrepreneurial teams: The key to rapid growth business?" ***Journal of Small Business and Enterprise Development***, **6**(2): 153-165.

Weick, K. E. (1993). "The collapse of sensemaking in organizations - The Man Gulch Disaster." ***Administrative Science Quarterly***, 38(4): 628-652

Weick, K. E. (1995). ***Sensemaking in Organizations***. London, Sage Publications.

Weick, K. E. (2001). ***Making sense of the organization***. Oxford, UK ; Malden, MA, Blackwell Publishers.

Weick, K. E. & K. H. Roberts (1993). "Collective mind in organizations: Heedful interrelating on flight decks." ***Administrative Science Quarterly***, 38(3): 357-82.

Westelius, A. & L. Askenäs (2001). ***Getting to know your job***. 16th Nordic Conference on Business Studies, Uppsala August 2001.