Global customer driven innovation – where does that leave the local HEI?

"We do not produce anything – we merely screw things together"[1]

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Abstract

How can a small, regional university college with limited resources play a constructive role towards a much larger, internationally oriented industry? This study investigates how a regional higher education institution (HEI) approaches its surrounding industry. The study starts out by mapping the characteristics of cooperation between the regional HEI and the industrial actors and by categorizing modes of innovation within the industry.

Findings in this study show that cooperation between the regional (HEI) and the regional industry is scarce, and the mapping shows that cooperation with R&D institutions is scarce in general. The main source of innovation and development for these companies is in the relation between the companies and their customers. This competence is built over years in a stepwise development, indicating that the most important innovation mode in the Kongsberg cluster is incremental and experience based and characterized by the Doing-Using-Interaction (DUI) mode. However many of the products delivered by the Kongsberg companies have components with very advanced technology, thus indicating a STI mode. These hi-tech components are partly developed in-house, partly bought internationally, and partly developed together with industrial partners. Most companies in this study attribute their success to their ability to put together complex systems that meets customer demand, and this knowledge seems to be based on the DUI innovation mode.

The regional university approaches industry through both educational programs and research collaboration. It has, however, not succeeded to any extent in addressing the more technology demanding research needed in the industry, and the effort to establish a regionally based research activities in the university has not yet gotten sufficiently industrial support. The

[1] "We do not produce anything – we merely screw things together" (Løwer Andersen, Datarespons").

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reason may be that the core competence of the industry of developing advanced systems meeting customers' demands, as a DUI competence, is not seen as a researchable area by the industry.

Introduction

Regional industry and regional R&D institutions, like Higher Education Institutions (HEI), are seen as main actors in the regional innovation system (Isaksen & Asheim, 2008). Regions will vary as to where and to what extent innovations and development take place, as well as to the extent of cooperation between the R&D institutions and industry. HEIs work in shaping their roles as partners to the industry and, particularly when located in a region with advanced and globally competitive industry, struggle to find ways to contribute to innovation and development. In this study this is approached through studying innovation processes in some Kongsberg companies in Norway, with its pertaining Norwegian Centre of Expertise - Systems Engineering and the subcontractor development project LUP. Further, two initiatives undertaken by the local HEI, Buskerud University College (BUC) are studied: 1) the industrial masters program in systems engineering and 2) the efforts to establish a research institute in systems engineering. Through studying these initiatives we aim to increase knowledge on the role of the regional HEI in regional innovation, and we pose the following overall research issue:

What role do regional HEIs play in regional innovation and in the development of industrial clusters?

This proposition will be studied through the following sub-research questions:

1. What characterises the HEI – industry cooperation in the region?
2. What type of innovation mode dominates the regional industry under study?
3. To what extent is the existing university – industry cooperation operated within the core competence and dominating innovation mode the regional industry?

Cooperation regional HEI - industry

The regional innovation system

Isaksen and Asheim (2008) distinguish between three categories of regional innovation systems; and this distinction is mainly made along the dimension of the role of the regional HEI. These categories are 1) Territorially embedded regional innovation networks, 2) Regional networked innovation systems, and 3) Regionalised national innovation systems.

Table one shows these three analytical categories with pertaining characteristics:

Table 1: <title> (developed from Asheim & Isaksen, 2002; Isaksen & Asheim, 2008)

	Industry characteristics	Characteristics – Regional R&D institutions	Characteristics of interaction
Territorially embedded regional innovation network	Low degree of knowledge intensity, low educational level		Low degree of interaction – limited to producing/ recruiting new candidates
Regional networked innovation system	DUI innovation mode Innovation and learning mainly through customers, suppliers.	Regional institutions reaching out to regional industry – through facilitation and external funding.	Interaction initiated and facilitated; top-down or bottom-up, often publicly funded
Regionalised national innovation systems	Nationally and internationally involved regional clusters. STI mode of innovation	Have little interaction with regional industry on R & D	Low degree of interaction – limited to producing/ recruiting new candidates

A close interaction and collaboration between HEI and industry, breaks with the more traditional linear coherence or dynamics, where the HEI is seen as the supplier of knowledge and the industry as the costumer, where the customer is responsible for putting the knowledge into action – making use of it. Knowledge creation as a joint effort between the two adds a third task to the already existing two missions of the HEI: teaching and research.

In the triple helix framework, HEIs are the leading actors in regional innovation systems. Etzkowitz and Leydesdorff refer to the universities' role in reorganization and transformations induced by new technologies and states that "University research may function as a locus in the 'laboratory' of such knowledge intensive network transitions." (Leydesdorff & Etzkowitz, 2001, p.109). The Triple helix model s based on the knowledge society, and communication and negotiations between institutional partners "increasingly reorganizes the underlying arrangements." (Leydesdorff & Etzkowitz, 2001, p.109). In the Triple Helix approach a tri-lateral network between state, industry and academia is the base.

An ideal typography of the triple helix network occurs when the three actors in the network meet in overlapping arenas like networks or hybrid organizations. (Leydesdorff & Etzkowitz, 2001) The three actors are seen to be in three different contexts of values, cultures and institutions and the aim is not that they become equal, but that they relate dynamically to each other. This study raises the question of whether they also differ in their approach to innovation and learning? "The Triple Helix development model focus on creating intermediary mechanisms that play a broader role than in developed environments." (Dzisah & Etzkowitz, 2008, p.105)
A regime where people from the three parties circulate, is seen as the important part of the actor relations. "The actors from the different spheres negotiate and define new projects. Thus, a Triple Helix dynamics of university-industry-government relations is generated endogenously"(Leydesdorff & Etzkowitz, 2001)

Innovation modes

The perception and approach to learning and innovation is a foundation and common meeting ground for the HEI and the regional industry. In this study, innovation is regarded in a broad sense along the following definition *"All innovation begins with creative ideas . . . We define innovation as the successful implementation of creative ideas within an organization. In this view, creativity by individuals and teams is a starting point for innovation; the first is necessary but not sufficient condition for the second"* (Amabile, Conti, Coon, Lazenby, & Herron, 1996). The approach to learning and innovation is mapped in this study along the dimension of innovation modes. The STI and DUI modes of innovation are analytical concepts, which are constructed as ideal types. These models will probably not be found in pure forms in specific industries. Some hybrid forms of the two modes of innovation will rather exist in specific industries; however, industries can be dominated by one of the modes.

The STI mode of innovation is salient in firms dominated by theoretical or scientific (analytical) knowledge (Coenen & Asheim, 2006; Lorenz & Lundvall, 2006). The innovation activity occurs, in particular, in in-house R&D departments, in research intensive small firms, and in universities and research institutes. The main external innovation partners of firms are universities and research institutions. The aim is to create fairly radical innovations (Lundvall & Johnson, 1994: 27). The innovation activity often takes place in specific projects that may involve researchers in different parts of the world. The researchers are often members of the same epistemic communities (Knorr-Cetina, 1999) and have similar knowledge bases (Amin

& Cohendet 2004). Since the theoretical knowledge is codified, it is in principle ubiquitous and global.

The STI mode of innovation is mainly linear; i.e. knowledge flow from universities and research institutions to be commercialized in new start-ups or used in existing firms. The simplicity of the linear model makes it a powerful social construction that is easy to understand. The model demonstrates where public resources should be invested in order to increase the innovation output, and the model highlights the connection between basic research and innovation. Analytical knowledge is thus regarded as a product that can account for innovative success. However, the simplicity of the linear model is also its Achilles' heel. The model is just too simple; it does not reflect the complexity of the knowledge creation and innovation process (Massey et al. 1992).

As regards institutional support, industries dominated by the STI mode of innovation often need to cooperate with advanced universities and R&D-institutes. Cooperation can take place over long distances. However, some firms benefit from geographical proximity to advanced R&D environments, to obtain early access to new scientific results and to recruit higher educated workers. Such factors contribute in explaining why new, knowledge intensive industries, like biotechnology, often cluster close to research universities and other research institutions (Cooke 2002, pp. 130-131). This points to the fact that industries dominated by the STI mode of innovation need R&D cooperation with universities, and that regional universities in order to match this will need competitive expertise and relevant PhD-programmes. Policy tools aimed to stimulate the commercialisation of research results is also relevant in this case.

The DUI mode of innovation is salient in firms dominated by experience based or engineering (synthetic based) knowledge. Innovations are mainly incremental changes in products and processes. The crucial knowledge base in innovation processes is a combination of the employees' education and work life experience. The knowledge base is developed through problem solving in-house by individuals and teams of workers. Firms cooperate in particular with customers facing new problems and suppliers in innovation activity (Jensen, Johnson, Lorenz, & Lundvall, 2007b). Firms' learning processes are diverse; varying from a trial and error process towards the classical experiment, depending on the routines for learning in firms. Doing, using, reflection and interacting are the main elements in the learning process

(Kolb 1984). The knowledge from the learning process is experience based and is shared as tacit knowing in specific relationships between employees in-house and with some customers and suppliers. The knowledge flow takes place along the value chain between customers, producers and suppliers and crosses regional and national boundaries.

Innovation modes in academia and in the regional industry

The active role of the university may have two forms; first to translate research into economic growth (STI) and second for low- to medium-tech companies an educational role is recommended for the university (Etzkowitz, Webster, Gebhardt, & Terra, 2000). What roles can the regional HEIs undertake in relation to regional industrial actors? The university's role in relation to a high-tech company in DUI-mode is not discussed, should it be to develop an STI-mode in the companies or should the education be developed to fit the hi-tech companies. Yet another role may be to participate in the codification of the DUI knowledge. There are indications that companies that combine DUI and STI are more innovative. (Jensen, Johnson, Lorenz, & Lundvall, 2007a)

Due to the fast changing environment and demand for new knowledge and new products, the regional university cannot be in the front edge of all theoretical disciplines. Also, it takes a long time to establish new studies and change the theoretical content of existing studies, even though this road has been made shorter through the different and recent reforms within the university and college sector. A closer connection to industry will contribute to keep the college up to date (Brulin, 1998). However, only few scientific results are instantly usable in practice, and we cannot expect a linear supply relationship of usable knowledge from university or college to industry (Brulin, 1998:11).

Questions arise when the three actors of triple helix are not homogenous neither in size, level of advanced knowledge nor in other factors necessary to motivate for or develop common capabilities. What motivation should for example a small regional university have to invest in making itself useful for a large international hi-tech company? What are the incentives needed to make the spheres of these actors overlap and be a driving force in innovation?

Kongsberg – a knowledge cluster

The focus of this study is the industrial cluster in Kongsberg organized through the Norwegian Center of Expertice in Systems Engineering, and the local HEI is Buskerud

University College. The Kongsberg cluster currently comprises over 110 knowledge based companies, several of which are world leaders in the demanding industries like subsea, maritime, automotive, aircraft, defense or aerospace industries. Many of the core companies grew out of civilian divisions of Kongsberg Våpenfabrikk (a weapon factory), which was restructured in 1987[3]. Diverse selection of companies, with reference to number of employees, annual sales, employees' educational level and level of export – to mention some. The majority of the companies do not define that they have single employees that work predominantly with R&D. The core competence considered to be "Putting together advanced technologies for international clients" (Isaksen, 2009:1157).

The Kongsberg cluster is situated in the administrative region of Buskerud in Norway. Buskerud is characterized by below national level scores on education and R&D activity on a general level – with the exception of Kongsberg, which scores above average on both of these indicators. R&D activity pertains largely to activity going on within the industry. Apart from the regional HEI, Buskerud does not have an independent research institution.

Two main occurrences of particular interest took place during the period of this study, between the regional HEI and the surrounding industry. The first was the formalization and accreditation of a new Master degree in Systems Engineering at the regional HEI. This is developed in close connection to the Norwegian Center of Expertise-Systems Engineering, which was established in 2006 (Isaksen, 2009). The Norwegian Centers of Expertise is a national program with the objective to let already established and successful industrial clusters develop even further through the development of better cluster dynamics and better cluster actors, like for example the regional university.

The second incident was the process of establishing an independent R&D institution in the Kongsberg region. This was a more difficult and lengthy process which still is not finished. In both of these processes the regional industry and the regional HEI were partners, and the regional industry was involved in several ways. In the master program the companies employ the students for a three year period and the students work as engineers while they attend the master program. The industrial companies were intended as partners in the research institute, but declined to participate since they felt that the institute in order to be impartial could not be

[3] (http://www.innovasjonnorge.no/TP_fs/Infoark%20Kongsberg_engelsk310107.pdf).

owned by the industry, but by the regional university alone. The results of the mapping of the HEI and industry cooperation and the innovation modes will contribute to illuminate and understand the significance of these two incidents.

Methods

A case study was selected as the methodological approach. Miles and Huberman define a case as "a phenomenon of some sort occurring in a bounded context" (1994:25). This embedded case study was part of a larger comparative case includes two levels of analysis; the single organizations and the industrial cluster. The main purpose of the study is to gain knowledge on the relation between the regional HEI and the regional industry in order to contribute to theory on regional development and conditions for regional development.

Data was collected through semi-structured in-depth interviews and a survey. The survey was sent out to and returned from fifteen companies. The units are theoretically sampled and can be fitted in a selection frame that contrasts them along two dimensions: (1) Companies as part of LUP (Supply-cooperation with the purpose of serving the large cornerstone industries in the Kongsberg cluster) and (2) the partners of Norwegian Centre of Expertise in Kongberg. The selection was performed in an attempt to capture several links of the value chain.

Informants from five of these companies were interviewed in semi-structured interviews lasting from 60-90 minutes, and the request went out for informants that were interested in HEI-industry cooperation and innovation issues. The selection of informants was left to the companies to decide.

Qualitative data were analyzed using the software: Nvivo, where data were coded using pre-constructed and process-constructed codes. Quantitative data were analysed descriptively using SPSS, and used as support for the analysis of the qualitative data. The interviews have been analyzed according to categories and themes derived from the research questions and from theory, in particular along the dimensions of form and frequency of interaction and of innovation modes.. This has, however, been done in such a way that additional interpretations and associations could emerge quite freely.

The small number of firms and the large internal differences undermine the use of averages and majorities, and it is limited as bases for generalizing and further studies are needed. The aim of the study is however, to increase our understanding of the phenomenon.
The threat to descriptive validity was met by researcher triangulation, both in the sub-team in the region and in a larger team of researcher from four different regions. The threat to theoretical validity was met through collecting data from several sources (Burke Johnson 1997). In order to ensure reliability the procedures are documented. However, the qualitative assumption of an ever-changing world makes replication difficult.

Findings and discussion

Although the location of the Kongsberg cluster has historical roots, the informants often feel obliged to explain why they are located in this region and for instance so far away from the ocean – since the several of the very advanced products are for off shore operations. The idea of concentrated and advanced technological knowledge is part of the explanatory model; as well as the attractiveness of the cluster itself and being close to the large actors. With extensive use of information technology for communication, geographical proximity still seems to matter. As one of the informants remarks; even few kilometres can create a long mental distance:

Quote:

> Q: Yes, because you said that you started up at Høvik (…) is this actually why you are here?
> A: Yes, it is not far from Høvik to here.
> Q: No?
> A: In kilometers it is very short, but in mental distance it is far.
>
> (Løver Andersen, Datarespons)[4]

NCE-SE defines itself as a competence cluster. The core competence is the ability to develop and produce complex systems applications for demanding environments such as deep sea oil and gas exploitation, space, automobile applications and so on. This is supported by our informants with statements such as: "We do not produce anything – we merely screw things together" (Løwer Andersen, Datarespons), and "We have defined our core competence as being our ability to merge technology and knowledge to meet complex challenges" (Jan Kopperud, KDA).

In regard to describing this cluster according to the categories defined by Isaksen and Asheim (2008), only half the companies in the study have employees that work principally with R&D

[4] All quotes were given in Norwegian and are translated by the authors.

and there are large internal differences between the companies in the study in average educational level. The small number of firms and the large internal differences undermine the use of 'averages and majorities'. However, the qualitative data from the interviews supports the characteristics that classify these companies as situated between 'territorially embedded regional innovation network' and regional networked innovation system(see table 1). The interaction between the industry and regional, national, and international R&D institutions is scarce and in the survey this kind of cooperation is predominantly regarded as of "less importance". None of the companies put it down as "very important". This is the same for cooperation when universities and colleges are specified as partners. In the next section we describe cooperation with the regional HEI more in detail.

What characterises the HEI – industry cooperation in the region?

Data collected, both through survey and interviews; indicate that there is a low degree of cooperation between the industry in the Kongsberg area and the regional HEI. There is limited contact and the interaction is mainly with the purpose of giving students empirical access. Few of the companies see the regional HEI as a source for recruitment. However, the industry sees systems engineering as a gateway and a door opener to increased interaction. The knowledge base is developed mainly through intra-organizational collaboration and particularly with customers and partners (suppliers). None of informants emphasize the contact they have with R&D institutions and all of them stress the importance of developing and innovating in collaboration with customers. As the following quote is an example of:

> Quote:
> **Qustion: How do they keep up to date?**
> - well, first of all there are good, experienced people at the outset. But there is extensive coursing – they are urged (..) to professional updating in the form of courses which are at – yes, it could be at BUC, it could be at the University of Oslo.
> **Question: Yes, it could be at BUC?**
> - Yeas, it could. Systems Engineering for example. We have had a few who have been up ther and take a course or at least obtained som information. The Norwegian University of Science and Technology (NTNU) in Trondheim arrange quite a few of what they call 'second-helping' courses – so they can attend there (..) – and not to mention our partners; they arrange quite a bit of coursing and information and stuff like that (Løver Andersen, Datarespons).

The industry reports that their contact with the regional HEI is tied to three main areas, named in the order of importance:

1. Contact and cooperation with the goal of giving students access to empirical cases in their bachelor and master thesis work,

2. Participation in connection with the NCE, where the college is one of the partners
3. Participation in networks, like LUP (Supplier network) where the college is sometimes facilitator and sometimes just merely another participant.

   Quote:" There is a plan to develop a forest of local suppliers and elevate them to what they call 'world class'. Even if they themselves are – on knowledge, on productsupply, on infrastructure; meaning logistics on testing, on relationbuilding – conseqently on the whole bit – this meeting place, this is what we want. This was what they wanted and now there are a bunch of suppliers waiting for commissions, right, so there is an expectation-gap." (Løver Andersen, Datarespons)

There is little contact on with the local HEI, except on student project level. The HEI is not used as partner in research and innovation issues. Even though the local HEI is the only non-industrial research actor in the region – this activity is almost solely performed by the industrial actors and their industrial collaborators and customers and to a much less degree through contact with R&D institutions outside the region, like SINTEF[5]

In the Norwegian Center of Expertise – Systems Engineering (NCE-SE), BUC is the main competence provider in the "Knowledge Development" sub project of NCE-SE. Based on this NCE-SE founded the establishment of the new engineering discipline Systems Engineering (SE) at BUC in the form of a master program. SE is a new and developing engineering discipline which has been acknowledged as that only for the past few years. In the development process of the master program and the research agenda in SE it was stated clearly that the core competence in SE existed in the companies of the cluster. This meant that the modus operandi for BUC was to use "industry as laboratory", that is to expose the students and researchers to the industrial reality to develop their knowledge in SE. The most concrete manifestation is the "Industry masters" stretching their master program to three years because they have to be employed in SE related work in the companies during their education.

Through initiatives like NCE[6], the chamber of commerce and supplier collaboration initiative – the industrial body takes charge of issues that normally would pertain to the domain of the public sector. In this instance an example is the establishment and running of an International School in the region. Established to attract international workforce.

[5] The SINTEF Group is the largest independent research organisation in Scandinavia. Every year, SINTEF supports the development of 2000 or so Norwegian and overseas companies via our research and development activity. http://www.sintef.no/Home/About-us/

[6] Om NCE…

In general, however, the cooperation between the regional HEI and the industrial actors in this study appears to be scarce and lack of cooperation with research environments appear to be limited in general – not only regionally. None of the companies in the survey consider cooperation with universities and colleges in general – nor with research institutions as being of crucial importance in their development of the core competence of the company. This is sensational in a cluster that is considered R&D intensive and a spear point in Norwegian industry.

What type of innovation mode dominates the regional industry under study?

The industry's dominating innovation mode is not immediately evident. The Systems Engineering competence in the Kongsberg cluster can be seen as a DUI-mode of innovation. Through the large development projects in the Kongsberg Våpenfabrikk (KV) era (Dynamic positioning systems, F16 jet engines and so on), a Kongsberg engineering culture was developed. Most of the large successful Kongsberg companies today were parts of the old KV. The culture is characterized by the former CEO of KV Rolf Qvenild in five points (Qvenild, 2010):

- Cooperate with the best.
- Core competence built through new demanding tasks.
- All technical problems are solvable – it only costs time and money.
- Matrix- and project-organization with much use of delegation and role changes.
- Competence is moved to the challenges.

This is may be a glorification of the KV era, but can be seen as the Kongsberg engineering community's own definition of their innovation methodology, which in our interpretation is DUI. In the interview with Inge Vikesdal in Bandak, originally Kongsberg based – now situated in Telemark, many elements of this work is found in their development of new markets and products, strategic alliances and company purchases.

Although there are major innovations following the Science-Technology-Innovation (STI) mode (Berg-Jensen, Johnson, Lorenz, & Lundvall, 2007), the core of industry knowledge is to put these STI based innovations within electronics, computer science and material science, together in complex systems. This competence is built over years in a stepwise development, indicating that the most important innovation mode in the Kongsberg cluster is characterized

by the Doing-Using-Interaction (DUI) mode (Berg-Jensen et al., 2007). This domination is most evident in the areas that the companies describe as their core areas, while in supporting areas STI modes are more present. As one informant[7] states:"Our sub-contractors are important in innovation and development. In France we have one who delivers jet-engines, which is a large part of our product. But we also have Raufoss, a much used partner in the areas they know. In that field we do not interfere, we just buy it from them." He continues: "We have resources in-house and the Defence Research Establishment, but our subcontractors have to contribute in their areas. We just send a request or a specification on something we think we want solved, and then sometimes we get some good subcontractors."

This is supported by data from the survey where most of the companies where all the companies regard cooperation with customers as either "very important" or "fairly important", while cooperation horizontally is only regarded as very important by a few. Almost all the companies in the survey consider "information and ideas based on experience gained through the daily work in the company" as 'very important' as a source that influences innovation in the company. While the question of the importance of information and knowledge from regional, national and international R&D institutions is not regarded as 'very important by any of the companies. As one of the informants state below, systems engineering is interesting and the academic environment is of interest.

> Quote:
> - No, competence on what is called systems engineering; you could call it the more academic approach to the field. We are good at systems engineering, but of course we have had some people who have attended lectures or courses or some stuff and they have really realized: Ooops, there is a lot more to it than what we have considered, in a way. So I have understood that this enviromnent is of interest to us. (Løver Andersen, Datarespons)

However, recruiting directly from the regional university is still a foreign thought:

> Quote:
> - No, that is when they want a very special project done – or something. It cannot be completely ruled out, but no – it would be very rare to employ someone right out of BUC (Løver Andersen, Datarespons).

In the survey there is a clear tendency to state customer relations as the main source of ideas and information that influence the innovative activities in the companies. Similarly customers are rated very highly as external collaborators' importance for R&D activity (as the quotes below are examples of), whereas collaboration with HEIs regionally, nationally or internationally is to be found at the other end of the scale.

Quote: Yes, definitely. And everything we do is customerdriven. No products of our own. But not without excetption – we do sell products from third parties. Products that neither we nor the customer has own the property rights to. In that case we are purely a distributor of products,

[7] Jan Kopperud KOG

but we often connect it to broader systems so that we have a propriety in a way. (Løver Andersen, Datarespons)

Quote:
- You do not have a special department that you call Research, or? You do not use Research as a name?
- No, we call it development.
- Well, there are some very fine grained borderlines there

To what extent is the existing university – industry cooperation operated within the core competence and dominating innovation mode of hence the regional HEI and the regional industry?

When regional HEI approach the industry within the core fields of their enterprise: offering education and connecting industry and student projects, the cooperation appears to be successful. The establishment of the new master degree in Systems Engineering is an example of an extension of the core activity of the regional HEI. At the same time this meets the demands and requests of the regional industry. The degree was developed in close contact with the regional industry. In this program the students are taken on as part-time engineers in the partner companies. While they work they learn Systems Engineering at the regional HEI, and the HEI encourages both the students and their colleagues in their companies to bring cases from industry to the courses at the HEI. In addition the courses are attended not only by the students, but also by participant with long experience from industry. They attend the courses in order to learn Systems Engineering. This brings in the industrial experiences and culture to the students and professors at the HEI and makes the courses a learning arena both for the industrial actors and the academics.

Additionally, the regional HEI enters the arena of the industry on the industries' terms when the students are connected with companies through student projects or through thesis work. This way they avoid the potential clash of innovation modes.

In the second incident, however, the establishment of an independent R&D unit in the region; the differences in approach to innovation – or diverging innovation modes, surfaces. Since the master program in Systems Engineering was perceived as a success the next natural step was to initiate research on Systems Engineering in Kongsberg. The process of establishing a research institute was initiated in the NCE project and was at the outset seen as a necessary and positive process. One of the few Norwegian research institutes that the industry in Kongsberg use, SINTEF, was invited into the process with the regional HEI. The establishment of an independent research institute was first stopped when one of the largest

companies withdrew from the process. Among the reasons given was that it was not in their charter to own research institutes. Other reasons were that they disagreed with the establishment process and several other smaller issues. Later SINTEF withdrew from the process and gave the lack of willingness to invest in strategic research on part of the regional industry, as a reason. The local HEI then commissioned a report on the possibilities of establishing research activities. The message from the companies was clear, the regional HEI should do it alone and they would support them from project to project. This is the status today.

Conlusion

The overall research question in this study has been: *What role do regional HEIs play in regional innovation and development of industrial clusters?* Due to the extreme customer focus that the industrial actors have, it is difficult for the regional HEI to positition itself as a partner in innovative operations. This is also due to the mode of innovation, which within the industry appears to be mainly DUI; whereas the academic institution has a diverging approach to innovation. Success is obtainable when the regional HEI operates in its core competence areas.

Limitations and suggestions for further research

A single case study is a limited base for generalizing, and further studies are needed.

The study raises several issues for further studies.

References

Amabile, T. M., Conti, R., Coon, H. J., Lazenby, J., & Herron, M. 1996. Assessing the Work Environment for Creativity. ***Academy of Management Journal*** 39(5): 1154-1184.

Asheim, B. T., & Isaksen, A. 2002. Regional Innovation Systems: The integration of local "sticky" and global "ubiquitous" knowledge. ***Journal of Technology Transfer***, 27(1): 77-86.

Berg-Jensen, M., Johnson, B., Lorenz, E., & Lundvall, B. Å. 2007. Forms of knowledge and modes of innovation. . ***Resarch Policy***, 36(5): 680-693.

Brulin, G. 1998. ***Den tredje uppgiften. Högskola og omgivnad i samverkan.*** . Stockholm: SNS Förlag & Arbetslivsinstitutet.

Coenen, L., & Asheim, B. T. 2006. Constructing regional advantage at the Northern Edge. In P. Cooke, & A. E. Piccaluga (Eds.), ***In Regional Development in the Knowledge Economy***: (84-110). London Routledge.

Dzisah, J., & Etzkowitz, H. 2008. Triple helix circulation: the heart of innovation and development. ***International Journal of Technology Management and Sustainable Development***, 7(2): 101-115.

Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. 2000. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm, . ***Research Policy***, 29(2): 313-330.

Isaksen, A. 2009. Innovation Dynamics of Global Competitive Regional Clusters: The Casee of the Norwegian Centres of Expertise. ***Regional Studies***, 43(9): 1155-1166.

Isaksen, A., & Asheim, B. T. 2008. Den regionale dimensjonen ved innovasjoner. In A. Isaksen, A. Karlsen, & B. Sæther (Eds.), ***Innovasjoner i norske næringer. Et geografisk perspektiv***. Bergen: Fagbokforlaget.

Jensen, M., Johnson, B., Lorenz, E., & Lundvall, B. 2007a. Forms of knowledge and modes of innovation. ***Research policy***, 36(5): 680-693.

Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. Å. 2007b. Forms of knowledge and modes of innovation. ***Research policy***, 36: 680-693.

Knorr-Cetina, K. 1999. ***Epistemic cultures: how the sciences make knowledge***. Cambridge, Mass.: Harvard University Press.

Leydesdorff, L., & Etzkowitz, H. 2001. ***A Triple Helix of university-industry-government relations "Mode 2" and the globalization of "national" systems of innovation***.

Lorenz, E., & Lundvall, B.-Å. (Eds.). 2006. ***How Europe's Economies Learn: Coordinating Competing Models***. Oxford: Oxford University Press.

Lundvall, B.-Å., & Johnson, B. 1994. The learning economy. ***Journal of Industry Studies***, 1(2): 23-42.

Miles, M. B., & Huberman, A. M. 1994. ***Qualitative Data Analysis. An Expanded Sourcebook*** (2 ed.). Thousand Oaks: Sage.

Qvenild, R. 2010. The Kongsberg stories. Kongsberg: Norwegian Centre of Expertise - Systems Engineering and Buskerud University College.