Chapter 20
Globalization, Regional Development, and the Evolving Local University Role: The Case of Vestfold, Norway

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20.1 Introduction

The competitiveness of firms and regions in a globalizing economy rests on their ability to continuously develop and exploit specialized knowledge assets. The development of such assets is contingent on the activities and networks maintained by individual firms (Giuliani 2005); on the composition of the industrial structure (Boschma and Iammarino 2009; Frenken et al. 2007); and on mechanisms that enable knowledge to flow and recombine between activities. As products and processes are becoming increasingly complex and the global division of labor deepens, firms are forced to draw on a wide range of component technologies and complementary capabilities (Rothaermel et al. 2006), and combine leading scientific insights with specialized, experience-based knowledge. Thus, innovation at the firm level is becoming embedded in global innovation networks. These processes link long-term regional development more tightly to the ability to develop and institutionalize an infrastructure for knowledge development and diffusion, which functions independently of whether or not industry maintains local supply chain collaboration.

This chapter investigates the regional development role of a Norwegian university college against the background of actual industry knowledge development and networking characteristics. After a general discussion of conceptual issues, it does so in three steps. First, it investigates how industrial actors in the two

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dominating subclusters of the region develop and use different forms of knowledge, by means of linking heterogeneous internal processes to various external actors groups located in the region, outside it and abroad. Second, it describes processes of transformation and adaption to this context at the university college side, explicitly aimed at reinforcing its role in regional development. Third, it shifts focus back toward how this impact present industrial dynamics, and discusses, how this impact could be reinforced by building on the transformation that has already occurred. Particular emphasis is put on the electronics industry, as this has received the strongest education and research attention from the university college. Several references will, however, be made to the engineering cluster, for purposes of comparison.

The township of Horten and the surrounding county of Vestfold is located on the Western shores of the Oslo fjord, approximately one hour by car from the capital city of Oslo. It is hosting a set of specialized electronics and engineering firms (Asheim and Isaksen 2002; Onsager et al. 2007). The evolution of the electronics cluster illustrates the interplay between external inputs, and the cumulative development of knowledge assets at the regional level. During the 1970s, Vingtor Radio transformed itself into a leading developer of ultrasound technology, in close cooperation with Norwegian Technical University in Trondheim (basic technology provider) and the medical science community at University of Oslo (lead user). This formed the basis for what is now GE Vingmed, ultrasound center of excellence for the US multinational General Electric. Another local company, Simrad, used sonar technology developed by Norwegian Defense Research Establishment (NDRE) outside Oslo as the basis for diversifying into fish finding technology. Norcontrol was set up as a joint venture between three companies based outside the region, for the purpose of developing maritime automation and system surveillance equipment. Spin-offs have included now US-owned Park Air Systems (aviation traffic control systems) and Seagull AS (software for on-board training of ship crew). Aktieselskapet Microelectronic (AME) was founded on sensor technology developed at leading Norwegian universities and research institutes, all located outside the Vestfold region. Out of AME grew companies now known as Norspace (communication satellite switching systems), OSI Optoelectronics, and Sensonor (micro-mechanical sensors). Sensonor managed to early position itself as a collaborative partner of the European auto manufacturing industry, partly because it was among the first to develop process technology enabling production of low-cost airbag release and tire pressure sensors. It has later given birth to what is now Memscap AS (high-end sensors for e.g. aviation use) and Ignis Photonyx (optical components for telecommunication equipment). The Electronic Coast collaboration network (EC-Network) now consists of a stable population of 36 member firms, which operate in diverse international markets. Some of these operate on similar or related technological platforms, i.e. ‘microelectromechanical systems’ (MEMS), and are supported by research and education programs in this field at the regional university college. A larger group of companies have traditionally operated based on bordering component manufacturing and advanced production technology; but this common denominator is weakened due to downscaling and outsourcing. Few companies are now in direct competition with each other.

20.2 Methodology

The empirical analysis is based on interviews with managing directors and R&D executives in eight firms, conducted in two rounds. The first round covered three of the largest and most mature actors within electronics, and focused on issues spanning from overall competence upgrading to the organization of specific innovation projects. A survey questionnaire was then developed, and sent to the 42 member firms of the Electronic Coast and Engineering Coast networks. The survey obtained a total of 31 responses, equal to a response rate of 74 %. Information obtained on mechanisms for competence upgrading were used to group firms according to their "mode" of learning and innovation (Jensen et al. 2007). Five follow-up case-studies were then conducted to ensure a sample, which covered both clusters and each of the different modes identified. Interviews have also been conducted with key personnel at Vestfold University College, in addition to numerous informal conversations and the use of material documenting relevant internal strategy processes from late 1990s until present.

20.3 Conceptual Framework

20.3.1 Industrial Knowledge Development and Innovation

Economists from Adam Smith and onwards have conceptualized development as a process which generate an ever-expanding range of differentiated products and technologies (Knell 2008). As the stock of knowledge available for recombination diversify (Grossman and Helpman 1991), the opportunities for new technology development exponentially grow. 'What firms do 'is therefore identification, coordination, and integration of diverse external knowledge inputs (Kogut and Zander 1996). These are identified through ongoing processes of innovation search. Intentional and unintentional exposure to information defines the search spaces of corporate enterprises (Katila and Ahuja 2002). Evolutionary theorists (Nelson and Winter 1982) have argued that the more diverse the search space is the better are the effects of the alternatives selected. Empirical studies have found the impact of innovation search on subsequent technological evolution to be contingent on spanning organizational boundaries and product domains (Rosenkopf and Nerkar 2001) and to be improving with the diversity information sources used (Laursen and Salter 2006). It is pointed out that the use of mature technologies from outside own sector boundaries can provide as strong an impetuous to innovation as new technologies developed by own sector (Katila 2002). Successful search may trigger the need for subsequent collaboration. Collaborating firms gain access to the tacit components of their partners' knowledge bases, and new knowledge is created which add to the stock of knowledge held by the firms involved. The different actor groups with which collaborative relationships may form differ in what knowledge and problem-solving capabilities they may contribute, at what stage of the innovation process. The successful identification of alternatives through search and transfer of knowledge through collaboration is dependent on absorptive capacity. This capacity is defined partly by the existence of prior related knowledge, which forms the basis for interpretation and transformation. It is also partly defined by the knowledge systems established and operated by firms, which form the basis for attention allocation, communication, and subsequent internal individual or collective learning.

The knowledge systems maintained by firms reflect their dominant 'mode of innovation' (Jensen et al. 2007). The core of the 'science-technology-innovation' (STI) mode is R&D departments of firms, linked externally to recruitment of highly skilled individual researchers, the use of epistemic communities as search space and collaboration with science system actors. The outcome is explicit knowledge, which—importantly—travel well but require adaption to contexts of application before it transforms into innovation. The strength of the mode lies in its ability to draw on and push disciplinary frontiers, explore fundamentally new knowledge independent of specific contexts of application and provide the basis for radical innovations. This is also its Achilles heel; as it is less able to mobilize and develop the knowledge necessary for its output to transform into large-scale industrial application. This means that it does not easily, in itself, translate into industrial activity (Karlsen et al. 2011). The core of the contrasting 'doing-using-interacting' mode is learning work organizations linked to external value chain actors in various forms. This model manages to mobilize and link experience-based knowledge originating in different parts of the organization and value chain; thus ensuring that a stock of knowledge which is context-specific and application-oriented continuously evolves. This sustains an ongoing stream of incremental innovations along established technological development paths and drives the development of highly specialized knowledge assets; but for the same reason comes with the danger of lock-in. Thus, at both firm and regional levels it can be argued that science-based and experience-based knowledge are complementary; in that the impact of either one on firm innovation or regional dynamics is reinforced by the co-existence of the other.

The activities of individual firms in a regional setting may contribute spillovers into the regional system, which then, depending on the diffusion and absorption capacity of the system as a whole, are made available to other firms or used as basis for new firm formation. But as the process of specialization and diversification of inputs available occur on an international scale, geographically bounded search, collaboration and knowledge transfers create a potential for lock-in (Narula 2002) to diminishing return paths. The high cost of establishing extra-regional linkages may combine with the low marginal cost of continuing to use existing ones (ibid); causing actors to over-search local environments (Katila and Ahuja 2002) which do not contain the technological novelties or complementary capabilities needed to sustain innovation-based industrial dynamics (Bathelt et al. 2004; Graf 2010). The successful establishment of regional firms as knowledge and information gravitation points in global networks (Coe et al. 2008; Herstad et al. 2010) increases their individual exposure to information and knowledge diversity, hence increasing both innovativeness and economic performance at the firm level and creating a potential for richer regional spillovers. But it comes with less attention toward local collaborative linkages.

This raises the question of what regional knowledge diffusion mechanisms which remain in play, and thus explain observed clustering tendencies. As experience-based, tacit knowledge predominantly moves through face-to-face interaction with people (Lam 2000), and the majority of job moves occur within regions (Boschma et al. 2008), recent work emphasizes the role of labor market mobility (Eriksson and Lindgren 2009) and personal network formation (Agrawal et al. 2006; Dahl and Pedersen 2004). Research has found clusters of similar or related economic activities to be associated with particularly high degrees of labor mobility (Eriksson et al. 2008; Malmberg and Power 2005); found firms to be able to absorb more diverse competencies if they are recruited locally (Boschma et al. 2009) and pointed to the importance of mobility between research-conducting firms and those which do not (Maliranta et al. 2009). Another important mechanism is spin-offs, i.e. the establishment of new firms to commercialize ideas originating in industry or research communities. These tend to cluster around their parent firms, and can provide strong growth impetuous into the regional system.

Regional knowledge diffusion is intimately interwoven with the composition of the industrial structure, i.e. the set of firms between which knowledge diffuse. Agglomeration economies (Beaudry and Schiffauerova 2009) arise from a high degree of specialization, and the formation of a ‘thick’ and highly specialized labor market, a common supplier infrastructure and a common research infrastructure upon which technologically similar firms may draw. Cognitive proximity—similarity of activities—combined with co-localization is said to foster trust conducive to information sharing and collaboration, and enable local spillovers to diffuse and be absorbed with little friction. However, homogeneity substantially reduces the likelihood that these spillovers may enter into combinations which are truly novel, and increases the likelihood of negative technological lock-in. It also comes with the risk of competition between firms operating in similar markets; and of exogenous business cycle shocks upon the cluster as a whole rather than individual firms only. Others have therefore argued that diversity rather than specialization in the regional industrial structure is more conducive to knowledge diffusion and innovation. Diversity provides the basis for knowledge diffusion between technologically different activities, and hence for so-called urbanization economies. Diversity is assumed to ‘(…) facilitate more radical innovation as knowledge and technologies from different sectors are recombined, leading to completely new products or technologies’ (Frenken et al. 2007). But diversity comes with the risk of fragmentation (Tödtling and Trippl 2005) caused by cognitive distance

(Nooteboom 2000). Recent work has therefore pointed toward the role of information exchanges and knowledge diffusion between activities which are technologically related, and the mechanisms needed to accelerate processes of reconfiguration in their intersection (Asheim et al. 2007; Cooke 2007; Hargadon and Sutton 1997).

There are several reasons why new firm formation and labor market mobility are insufficient for the purpose of achieving cross-sector knowledge diffusion and exploration of potential new combinations; the primary of which is the tendency of labor markets to form segments around similar activities (i.e. activities identified as related to begin with). Hence, they are more likely to diffuse knowledge between such similar activities that contribute to the exploration of linkages between them. Further, excessive mobility may destroy valuable firm-specific knowledge, hamper the knowledge accumulation of individual firms, and reduce their willingness to invest in competence upgrading (Combes and Duranton 2006). The more specialized knowledge firms are dependent on, the more detrimental can excessive mobility be. Third, in clusters where several firms operate in similar markets, they may share the same business cycle fluctuations and downsize collectively. When this is the case, business cycle fluctuations do not assist in the redistribution of people and knowledge between firms but may rather result in knowledge workers moving from the region. Forth, whereas firms in high velocity sectors may compensate for the outflow of own personnel into the labor market by inflows of competences and ideas from it; firms operating based on more specialized and cumulative knowledge base may see the recruitment of new personnel primarily as a generator of costs related to firm-specific training. Last, new firm formation through spin-offs assumes specific knowledge, technology, and market opportunity conditions which may deviate from those of the industry in question. Although, these occur frequently in sectors such as biotechnology and ICTs, and provide an important basis for the commercialization of world-leading research in such fields when necessary seed and venture capital is present, the rate of new firm formation varies substantially across academic fields, industries, and with different underlying knowledge and opportunity conditions (Breschi and Malerba 1997; Malerba and Orsenigo 1993).

20.3.2 Knowledge Diffusion Infrastructures

This point to the importance of regional knowledge development, accumulation, and diffusion infrastructures which operate independently of local supply chain collaborative linkages, and thus are able to explore new combinations on a more broad basis. Such examples include regional business and technology councils, regional development organizations, and different labor training and mobility schemes. However, these are also examples of mechanisms, which are dependent on the commitment of, leading firm actors, and the successful definition of common interests and objectives among a set of diverse firms; and vulnerable to fluctuations in such commitment. In addition, they may experience problems in adapting to circumstances, which evolve with structural change, even when this structural change can be attributed to the effectiveness of the infrastructure (Asheim and Herstad 2005).

Universities and university colleges may therefore play an important role, by adapting teaching and research to regional potentials and demands (Cummings 1998; Goddard and Chatterton 2003). This is often labeled as the third role or the service role of HEIs (Brulin 1998; Nilsson 2006). These roles are consistent with the triple helix model and its emphasis on a dynamic interplay between industry, research infrastructure, and government (Etzkowitz 2002). It is reflected in recent developments such as those emphasizing research activity and education programs tailored to specific regional industry needs, in turn enabled partly by "(…) a growing acceptance of the need to draw upon knowledge from whatever source may be appropriate to the purpose, rather than from a single disciplinary corpus" (Becher and Parry 2005).

An increasing amount of empirical studies have in the last decades analyzed knowledge transfer processes (Balconi and Laboranti 2006; Bekkers and Bodas-Freitas 2008; Daraio and Bonaccorsi 2007; Kaufmann and Tödtling 2001; Ponds et al.2010; Varga 2009). These studies have shown that collaboration and interaction between university and industry is highly beneficial and cost effective way to transfer knowledge and technology (Etzkowitz et al. 2000), and more so than the 'linear' and often arms-length processes sought stimulated by different technology transfer and licensing schemes. But, these studies have also shown contrasting evidence concerning the importance of the different types of knowledge outputs of university to firms; the spatial extent of knowledge spillovers and to what degree do sectors matters. Ponds et al. (2010) define three main knowledge diffusion mechanisms which are particularly geographically localized;

1. spin-offs,
2. labor mobility, and
3. informal knowledge exchanges through social networks.

Bekkers and Freitas (2008) analyze the importance of a variety of knowledge transfer in The Netherlands, and find that basic characteristics such as knowledge and technological opportunity conditions, as well as the disciplinary background of knowledge, explain the use and importance of different knowledge diffusion channels (2008: 1848).

The diffusion mechanism is reflecting the advantages that firms enjoy in accessing knowledge that spillsover from other firm and research institutes by being located at the same place or near each other. Beside informal social networks, formal networks of research collaboration are also found to be an important diffusion mechanism, which is of particular relevance for science-based industries and advanced engineering (Bekkers and Bodas-Freitas 2008; Ponds et al. 2010), as these companies invest relative heavily in R&D and collaborative close with academia. However, research collaboration (formal network) can lead to not only localized knowledge spillovers but also to knowledge transfer between researchers over long distances (Adams 2002). Yet, according to Lam (2007) such collaboration is part and parcel of a development through which university and industry may create overlapping labor markets, which remain tied to places and enable much richer exchanges of information and knowledge than the collaborative relationship in itself.

It is therefore important to acknowledge how (a) the limitations on local collaborative knowledge development created by globalization applies not least to the relationship between universities and industry; but also (b) how other potential roles for university colleges in the regional innovation system are opened up. By means of education, they enrich the local labor market and contribute to the formation of personal ties across industrial firms; independent of collaboration. By conducting activities perceived as relevant by a broader set of firms, they may also attract the attention of research personnel and contribute to the reinforcement of personal ties and idea exchanges across such firms. Universities may accumulate knowledge from a broad spectra of channels related to scale (regional, national, and international) and industrial sectors, thereby acting as a knowledge bank enabling diffusion independent of specific industrial actors. This illustrate that although the ability of the university college to accumulate and diffuse relevant knowledge into the regional innovation system may be contingent on its collaborative relationships with industrial actors; this role cannot be understood merely by considering the outcome of such collaboration for the individual firms engaging in it.

20.4 University-Industry Dynamics in Context

20.4.1 Industrial Knowledge Development and Networking

We first consider the industrial context into which Vestfold University College (VUC) has attempted to insert itself. With this follows a focus on the knowledge bases developed by industrial firms (Asheim and Coenen 2005); how this reflects in distinctive modes of innovation as well as the geographical configuration and dynamics of external innovation networks. In order to approach this systematically, we draw on the survey information indicating, which mechanisms for competence upgrading that firms perceive are most important. This information is used to construct a set of indicators, which describe the importance of competence upgrading by means of ‘doing, using interacting’ (DUI) and ‘science, technology, innovation’ (STI), respectively. Indicator construction, reliability, and descriptive statistics are given in Table 20.1 below.

These indicators formed the basis for the grouping of firms according to their dominant knowledge development logic, using hierarchical cluster analysis. In accordance with Jensen et al. (2007), we find the two distinct STI and DUI groups, in addition to a large intermediate group of companies, which combine the two modes. Basic descriptive statistics on these clusters are given in Table 20.2 below.

Table 20.1 Modes operationalized

DUI mode composite indicator (1 = high importance - 4 = non existent)	Items entered: Stated importance (1 high—4 not used) of: Competence upgrading through daily work Competence upgrading through teamwork Competence upgrading through customer interaction Competence upgrading through supplier interaction
Reliability (Cronbachs alpha)	0.79
Range	1 (high importance)—2.8 (lowest importance)
Mean	1.62
STI mode composite indicator (1 = high importance—4 = not existent)	Items entered: Stated importance (1 high—4 not used) of: Competence upgrading through R&D Competence upgrading through HEI/university interaction Competence upgrading through research institute interaction
Reliability (cronbachs alpha)	0.68
Range	1 (high importance)—3 (lowest importance)
Mean	2.01

Source data from the survey

Table 20.2 Basic descriptive statistics

	Combined mode	STI mode	DUI mode	Total
Number				
Electronics	14	2	5	21
Engineering	3	2	2	7
Mean indicator scores				
DUI mode	1.53	2.45	1.37	2.01
STI mode	1.69	1.83	2.91	1.62
N	17	4	7	28

Source: Survey data

Thus, we find a group of seven companies stating that competence upgrading occur primarily through daily, team-oriented work processes, and interaction with customers and suppliers. R&D investments are limited, and those conducted predominantly target-specific customer needs and the refinement of existing technologies (see Table 20.3). Four of these are electronics manufacturers; producing either specialized components or delivering manufacturing, test system and logistics services to system integrators. Two are large maritime engineering and service providers; and all are affiliated with multinational corporate groups. Innovation search patterns are highly oriented toward the mobilization of ideas and

Table 20.3 R&D orientation and R&D investments

	Average R&D intensity	Orientation of R&D (average share of R&D conducted by orientation)			
	Share of turnover	Customer needs	Refinement of existing technologies	New product development	Long-term research
Combined mode	24.71	28.75	37.81	24.38	9.06
STI mode	46.75	5.00	28.75	45.00	21.25
DUI mode	6.29	53.60	35.01	24.40	0.00
Total	23.25	29.92	35.77	27.68	9.20

Source: Survey data

information already existing within own organization and parent group network; and external search and collaboration patterns reveal the overwhelming importance of client firms—located elsewhere in Norway or abroad. In addition, they maintain international search spaces with a distinct focus on their sector communities in general and supplier networks in particular.

These organizations learn on an incremental basis by continuously interpreting streams of external customer and supplier information against the background of existing, experience-based knowledge; and innovation entail a wide range of issues such as improvement of logistics and supply chains, adaption of production tools to specific process needs; design changes on behalf of customer firms to lower production costs and the development of dedicated test equipment. Continuous, complex, and context-specific problem solving thus best describe innovation activities. Inputs from more systematic knowledge development processes enter, but they do so indirectly, through customer and supplier firms located elsewhere. For instance, engineering firms in the region are heavily dependent on interaction with leading subsea system designers, who collaborate with specialized Norwegian research communities. They are also dependent on collaboration with certification agencies such as DNV, which provide quality and compliance control on behalf of authorizes and customers. Competence upgrading by means of external recruitment is considered of relatively low importance, for three main reasons: First, because such competences are not necessarily readily available in external labor markets. Engineering firms experience overall supply deficits, combined with an increasing shortage of engineers with hands-on experience from large vessel or offshore construction. Electronics firms in this group, on the other hand, show a very low rate of employee turnover, which in itself limit renewal through recruitment. Third, because most remaining activities within electronics have strong firm specific components to them; which translate into requirements of firm-specific training and reinforces the reluctance of the companies with respect to hiring new staff.

The mirror image of this is found in another small group of companies which state that core competencies are developed primarily by means of systematic internal R&D, linked to external science system actors; and that learning through daily, team-oriented work processes contribute very little if anything to building these competencies. The four firms constituting this group is found within advanced subsea engineering (recent spin-offs from another engineering incumbent), in the interface between electronics and life sciences, and in the development and production of optics and display technologies. Although, both customers and suppliers are present as information sources and collaboration partners; no single company state that customers are of high importance and external search and collaboration is distinctively oriented toward the science system. Reflecting this orientation is a very high R&D intensity, and a large proportion of this R&D target long-term basic research and the development of new technologies. The external orientation toward science is reflected in an internal competence base, which is stated as easily maintained by external recruitment of personnel with education at PhD and master levels.

However, these DUI and STI mode companies are opposite extremes surrounding a population of companies which state that core competence evolve by means of daily, team-oriented work linked to external customer, and supplier interaction; combined with systematic R&D linked to science system interfacing. These firms thus integrate science-based and experience-based knowledge internal to their organizations, and constitute the core of the regional knowledge base. They are either system integrators who deliver complete product systems to demanding final end uses at e.g., hospitals, airports, or vessels; or component manufacturers which operate in markets, such as aerospace, medical, and subsea. They share the DUI focus on customer search and collaboration externally, and actively search their internal stocks of accumulated daily work and R&D-based experiences. The existence of an R&D-based knowledge stock is indicated by a much higher R&D intensity than what is found among DUI firms (on average 25 % among electronics firms); and by a much more even distribution of this R&D in the range from long-term basic research to specific customer needs. Yet, they are distinctively less oriented toward science system than customer search, and both long-term research and more short-term product development is to a very large degree shaped by existing or expected customer needs.

We now turn to consider how knowledge base characteristics and network configurations contribute to defining regional system characteristics. A main common denominator is the importance of innovation search and collaboration networks which to a large extent target actors and communities outside the region. Another is the importance of experience-based, tacit knowledge; either by itself within the DUI group or as a basis for harnessing the value of science-based knowledge. Related to this is the long-term sensitivity of these activities to the trend of outsourcing production (electronics) and assembly (engineering), processes lubricated by firsthand experience with production among remaining staff in Norway while contributing to hollowing this necessary absorptive capacity out. Last, the attention of firms is distinctively oriented toward the challenges and requirements of their established technological development paths; which either diverge strongly (electronics) or place firms in positions where they are competitors (engineering). Taken together, this portrays a picture of fragmentation between entities, which each on their own are strained by intense competitive pressures, and hollowing-out from globalization. Firms are either technologically too far from each other perceive that there are gains from direct collaboration; or they are two close to each other and point to the risk of diffusing proprietary knowledge to competitors; and they have little leeway to engage in activities on the side of what is at present their operational core. And they are either too oriented toward the DUI mode of specialized knowledge development to perceive that there are any real gains from collaboration with the local university college; or they source their main science-based knowledge inputs elsewhere.

Yet, a striking feature is that the region remains an important venue for those processes which resist formalization, planning, and codification. Just above half of the survey sample state that information flows within the regional 'milieu' is somewhat or very important for own competence upgrading purposes. Interviews confirm that this reflect the reliance of these firms on the local—informal—information ecology, and its overlapping ties of personal networks and arenas for face-to-face contact. The picture comes even more distinct when we consider innovation search; almost all companies outside the STI group state that regional information flows are somewhat or highly important either for competence upgrading or for search. Contribution to this information ecology is formal networks such as Electronic Coast and Avanse, and the activities at VUC and the affiliated NCE. Contrasting this is firm in the STI group, in which no single state that regional information flows support their search activity and only one single firm perceive it as important for own competence development purposes.

The importance of extra-regional linkages clearly emerges at the level of targeted innovation activities, For instance, whereas nine intermediate mode firms state that localized information flows are important for overall competence upgrading, only 2 such firms state that the same transmit information which is used directly as inputs to innovation. At the same time, most firms in this group state that international information flows specific to their sectors as moderately or very important. Only the DUI group remains heavily oriented toward localized information flows; while combining this with orientation toward global sector-specific communities similar to that of the intermediate group.

The university college is clearly present as information source and collaboration partners to the intermediate mode group. Half of this group state that the regional science system is used somewhat or extensively as source of information input to innovation; and all of these collaborate actively with it. This is combined with a strong orientation toward external science system search: More than half states that external science system search provides important inputs to innovation; all but two of which collaborate actively with the regional science system. This means that they serve as 'gatekeepers' (Ebersberger and Herstad 2011; Graf 2010). However, it is largely the mature firms with strong internal capabilities and broad external networks within and outside the region who state collaborative relationships with the regional science system. Our interviews reveal that STI group companies stating collaboration with the regional science system either orient themselves toward specialist consultancy or certification agencies, or, in one case, in essence have outsourced most of their technological development to the UC.

20.4.2 The Repositioning of Vestfold University College

The analysis above point to the predominance of firm or sector specific knowledge development processes by which inputs from outside the region are merged with inputs from actors and environments within it; and by which experience-based knowledge is merged with scientific knowledge. The region in question had developed and institutionalized several diffusion mechanisms outside the realm of the regional university, prior to its more active entry into regional development. The Avanse network operates as a collaborative arrangement between electronic- and microelectronic firms, and enables exchanges of high-skill production personnel. However, its role is diminishing with overall downsizing of production and thus with decreasing reliance on those specialized production skills which it diffuses. No similar mechanism exists within the engineering cluster. In 1998, VUC led the formalization of the Electronic Coast (http://www.electronic-coast.no) project, supported by the public Regional Innovation Program. This had started as an informal network of local business managers working at electronic- and microelectronic companies. The redefined role of the EC-network was to stimulate innovation and entrepreneurship within the industrial cluster of electronic- and microelectronic companies (Finsrud 2007). The re-vitalization process of the EC-network was anchored and organized as a broad participative process involving participants from the University College, Vestfold County Council, Horten Municipality, and electronic- and microelectronic companies.

Yet, by the late 1990s several companies expressed dissatisfaction with the lack of more substantial commitment from VUC. In particular, teaching and research was criticized for been outdated and the educational profile for not being adapted to the specialized needs of the regional industry. At the turn of the century the message from these companies was pretty clear. If VUC had any ambition of engaging with regional industry, VUC needed to make significant changes in their educational programs and research activity. These in turn entailed the breakdown of well-established disciplinary and departmental barriers. Externally, the electronics industry was at this point beginning to feel the combined effects of increased international competition at the component supply and production sides. Leading system developers pointed out that their need for long-term, high-risk investments in complex internal R&D to fight off this competitive pressure was financially difficult to combine with the need for firm-specific investments in the competences of new researchers. Something had to be taken out of this equation, and the latter was the most obvious candidate.

VUC responded from the beginning of 2000, following the election of new principal and new faculty deans. The new principal, an engineer from department of engineering and science, brought with him credibility among the firms as he has worked as project manager for the newly founded EC-network. The new dean from faculty of Science and Engineering similarly gained respect for his proactive attitude toward the needs and demands from the industry as he focused heavily on establishing a constructive dialogue with leading companies.

Based on the experience from the EC-network, the Faculty of Social Sciences developed a tailor made management education program, aiming at improving both management practices and co-operation within the industrial environment. The program was designed for the specific purpose of allowing participants to share their work experience (Gausdal 2007), and thus drew its content from these experiences. In 2003, VUC decided to establish a new master program in microsystem technology, which entailed large financial and professional challenges. As a medium-sized university college, VUC had almost no experience of managing such advanced and expensive master program. In order to get a master program officially certified and considered relevant by industry, VUC needed to obtain the necessary specialized competences; and invest in expensive supportive infrastructure such as clean room laboratory and production equipment. VUC therefore made an agreement with large, leading electronics companies. These were willing to share their technical expertise as tenant professors, and to donate necessary research equipment to the university college (Nilsson 2006). VUC also recruited several key personnel from local companies (professors, phd candidates, and technical assistants). These initiatives and processes combined enabled VUC to establish the foundation necessary for more self-sufficient activity within the MEMS field.

But these processes were not without friction, neither within the university college nor in the relationship toward industry. At the university college side, this involved internal tensions because it entailed the channeling of attention and financial resources toward one specific area, at the expense of other well-established areas. In practice, this meant a substantial reorganization of the engineering department, and downsizing of former academic strongholds. At the industry side, the content of the program was considered critical because it would directly contribute to defining the future "platform" technology for the cluster as a whole. MEMS technology was chosen partly as a result of pressure from leading firms; and legitimized with reference to this being a general purpose technology applicable—and increasingly relevant—across most segments of advanced electronics. It is also a technological field with potential for drawing heavily on other high velocity fields, such as biotech. Others still claim that a stronger emphasis on the "packaging" of advanced electronic components would have better reflected the breadth of activity in the region; contributed more to maintain production capacity and thus competences in the region and added more immediate value to the cluster as a whole. Some firms also saw the build-up of competences at the UC by means of recruitment from industry as a direct threat to their own internal competence base.

Yet, with new staff-members the Faculty of Science and Engineering became more attractive as a partner in several large-scale joint research programs, such as NEWPACK[1] and MULTIMEMS,[2] run by staff member from the University

[1] NEW knowledge and technology for PACKaging of Microsystems (NEWPACK) was a collaborative research program founded by the Norwegian Research Councilin 2003–2006.

[2] MultiMEMS N: Manufacturing Cluster Providing Multi-functional MEMS Services to the Industry is a collaborative research program founded by the Norwegian Research Councilfrom 2003 to 2004.

College in partnership with local industry such as SensoNor and the national research institute SINTEF. Partly based on external founding related to such collaboration with industry, and partly because of the knowledge transfer into the UC which came with them, the Faculty of Science and Engineering manage to finance and build a new institute with a bachelor and master degree program in MEMS technology by 2005. This institute today has 30 employees, hosts 25 phds and is in the process of applying for certification of its own PhD program. The subsequent establishment of a National Center of Expertise in Nano- and Micro-systems engineering marked a shift toward a more active role for the UC as platform technology developer—based on the competence based it had built through its intimate relationship with regional industry.

Summarized, the situation for the University College at the end of the decade was quite different from the situation when entering in the millennium. However, this potential does not at present materialize as growth. The role of VUC as contract research partner for the electronics industry is limited; partly because firms operating outside the MEMS perceive its activities as irrelevant, and partly because firms in this area consider such contract research technologically difficult and strategically problematic. It involves large resources spent on communicating tacit, contextual knowledge to the contract partner, and thus entails exposing proprietary technological knowledge to VUC researchers and—more problematically—students. Its role as a collaboration partner is limited by the deepening embeddedness of firms in their respective global innovation networks, and impacts through the local electronics industry labor market are constrained heavily by the lack of growth among existing firms and the lack of new firm formation.

20.4.3 Discussion

Specialized competences initially contained within a limited number of advanced industrial firms has now in essence been “externalized”, subjected to further scientific scrutiny and development, and made available as a platform technology for firms in the region. Against this background it is not surprising to find a strong emphasis in regional development plans on nurturing new firm formation within electronics, based on these competences. In 2008, the NCE partnership developed a new business model for Microtech Innovation, established in 2003 by local government and three leading industrial firms to serve as a commercialization vehicle, but idle while awaiting the build-up of research activity at VUC. This defined MTI not only as the main commercialization engine for NCE and VUC technology, but also as a national innovation and commercialization player in the micro- and nanotechnology area. The MTI board and shareholders approved the new business plan and—model in 2010, and the company established new head-quarters in Horten Industrial Park. As of 2010, MTI has project management responsibility for the Norwegian Center of Expertise, and now also incorporates the networking organization Electronic Coast. Yet, after Sensonor established

MEMSCAP in 2000, there have been few signs of new firm formation within electronics based on competences on electronics. Part of this is directly attributed to the complexity of technologies involved; and the negative demonstration effects of earlier entrepreneurship. Although, long recognized both by industry and researchers at VUC, fundamental funding and human capital constraints on new firm formation based on the technologies in question have not been eliminated.

But the real potential for the university college may lie not so much in directly supporting the current—specialized—activities of existing firms, as in the exploration of how these electronics competences can feed into and be fed by activities outside its current domain. It lies in its ability to transcend the cognitive distances which exist across different technologies and sectors; and which is reinforced by the segmentation of labor market mobility and the lack of cross-sector, industry-driven technology exploration. Although the evidence is yet anecdotal, examples of such cross-sector knowledge diffusion point to an important enabling role for VUC and link well up with other research findings pointing to the importance of cross-sector linkages at both firm (Katila 2002, Katila and Ahuja 2002) and regional economy (Cooke 2008) levels. Signals from inside VUC do suggest an increasing recognition of the potential in this role; however, this may be counteracted by internal forces seeking to establish more mainstream technology commercialization schemes.

20.5 Conclusion

This chapter discusses how the contemporary industrial landscape entail that regional innovation systems are deconstructed as sets of value chain collaborative linkages. Firms are embedding themselves in global innovation networks as they are forced to seek out knowledge inputs from diverse sources and places. Our argumentation stresses, in accordance with other research, the predominance of industrial knowledge development processes in which the science system only contribute one—and often minor—piece of the larger puzzle (Isaksen and Karlsen 2009; Karlsen et al. forthcoming; Laursen and Salter 2004). Yet, it simultaneously point to the enduring, even increasing, importance of the local information diffusion ecology; and the potential for innovation to emerge at the intersection between regional knowledge assets, which are already there. In order for the information ecology to survive, and the exploration of cross-sector linkages to occur, a third-party knowledge accumulation and diffusion infrastructure is needed.

Based on this recognition, the chapter has argued that regional universities and university colleges may play a much more vital future role in regional development than traditionally imagined. This is elaborated in three steps. First, the chapter shows how the transformation of Vestfold University College necessitated the build-up of new competences by means of dense industry linkages. From this follows, the importance of recognizing how initial knowledge transfers from industry and into local universities may be necessary. Following from this, it suggests, second, that regional science system actors should avoid thinking of their main role as one of delivering technology to a set of given firms or sectors. While a limited number of large universities which are internationally leading within their technological fields may boost regional development by means of such linear commercialization and spillover processes; the Vestfold case show clearly how industrial firms link up with science system actors elsewhere for the purpose of sourcing advanced, modular science system outputs while remaining dependent on those specialized knowledge assets which enable their commercialization. Hence, it is the accumulation, further refinement and diffusion of these specialized assets which should be the main concern of those universities and university colleges which cannot compete at disciplinary scientific frontiers.

This role is exercised through numerous interlinked mechanisms. The development of specialized education programs is critical, because it enables the build-up of new internal university competences and other “third mission” activities to be linked directly to the primary defined roles of universities and university colleges. This raises the legitimacy of the effort internally in the organization, and strengthens the embeddedness of the new competences within it. Furthermore, it links directly up to the main mechanisms for regional knowledge accumulation and diffusion under conditions of value chain fragmentation and globalization; namely the regional labor market, mobility within it and the resulting formation of personal ties across independent companies. Such ties can be expected to be of increasing importance when the locus of innovation shift away from cumulative activities along established paths and into recombinant innovation across sectors and clusters. Once an education program “core” has been established, the VUC case illustrate how this may simultaneously provide the basis for more advanced research activities and increase the overall attention received by the university college from actors spanning the range from local industry to research communities abroad. With this may follow the development and institutionalization of labor markets which in essence overlap between the spheres of industry and university (Lam 2007). Combined, this vastly increases the ability of the organization to attract students and researchers from abroad, thus further strengthening its ability to support regional labor market dynamics and to serve as a locus for information sharing, idea exchanges, and personal network formation.

The mobilization and commitment of industrial actors required perceptions of future relevance; and choices concerning strategic orientation and content necessitated that divergent views on this from industry could be overcome. The process of transformation at the university college side similarly involved establishing legitimacy within a broad range of professional communities; and institutionalizing the third-mission role of contribution to regional development in a context where individual researcher disciplinary excellence and inter-department competition for scarce resources remain key components of the academic model of work organization and motivation (Becher and Parry 2005; Gibbons 1994). Furthermore; it involved—and still involve—accepting that the visible returns from these activities in the form of firm growth and profit will come outside the realm of the VUC organization in itself; as social returns at the level of the regional economy rather than private returns from licensing income and patent sales. This is part and parcel of successfully exercising a knowledge diffusion role which rest on interactive learning in relationship with industry, and points to how this role differs from one of research commercialization. We therefore warn against the potentially detrimental effects which could stem from a stronger focus from the VUC side on securing its own returns by means of technology transfer schemes. The next steps, which are critical to realizing the potential role of VUC as a driver of regional development; entail a stronger focus on the exploration new linkages between competences already existing—within industrial firms and within the VUC organization in itself. However, this will also serve as a demanding test on the ability of VUC and its surrounding infrastructure to mobilize—internally in own organization and externally among industrial firms—for such radical recombinant activities, and resolve the issues of intellectual property rights and individual private returns which inevitably will arise.

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