Radical university-industry innovation – research design and preliminary findings from an on-going qualitative case study

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Abstract

This paper reports from an on-going pilot project investigating university-industry collaboration on the development of radical innovation. There is evidence in the literature that such collaboration increases the likelihood of radical innovation. A conceptual framework is presented and it is arguing that there is a lack of in-depth understanding of such collaborative radical innovation processes. The paper then suggests an abductive research design for an explorative in-depth case study of collaborative radical innovation involving a university and an established Danish manufacturing firm. Some preliminary findings are presented and briefly discussed, including the role of the university's formal set-up to deal with IPR/commercialisation and the researchers' personal networking with industry as well as challenges concerning the sharing of IPR/commercialisation outcomes.

Keywords: University-Industry collaboration, radical innovation

INTRODUCTION

Radical innovation holds great potential for businesses as well as for exploitation of research knowledge, and there is currently an increasing interest in improving our knowledge of firms capabilities for radical innovation (see e.g. Birkinshaw et al., 2007, Etzkowitz & Leydesdorff, 2001; Geunam et al, 2003; Mowery & Sampat, 2005).

Universities engagement in innovation is a relatively recent phenomenon (Movery & Sampat, 2005) (that is, beyond the contribution of knowledge/research results/inventions). The institutional pressure on university researchers to transfer knowledge to the private sector has divided the research community, embraced by some and dismissed by others, and the deviation has deep historical roots related to more or less ideological stands regarding the role of universities in society. People in the field of this study are mostly embracing the opportunities, so their concern revolves around the question of how to make transfer and commercialization work better and how to strike a fair balance the effort and benefit.

Furthermore, universities role in collaboration with companies *leading to radical innovation* seems to be of particular importance. Given the recent increase of the amount of such collaboration and its importance as well as the (relative) uncommonness of the phenomenon, research into the details of such collaboration is considered to be scarce.

We build the research based on experience from previous studies and deduction from literature reviews of two areas - radical innovation and U-I collaboration - included in our question of interest. We focus on established businesses, omitting entrepreneurial and spin-off companies, which is quite a different issue, and better covered by entrepreneurship research.

The research is part of an on-going pilot project called "RUBIN" ("Radical University-Based INnovation") funded by the regional governance in the Northern Region of Denmark. The purpose of our project is to better understand the process of developing radical innovation through university-industry collaboration. The explorative pilot study aspires to provide rich case descriptions, to identify key variables, linkages and patterns and the reasons why these exist.

The paper proceeds with a literature review outlining the conceptual framework of our on-going research project by reviewing two adjacent streams of literature: (1) radical innovation and (2) university-industry collaboration. Based on the literature review we position the research according to the existing literature and

specify the research gab to be addressed. Based on the research question and implications from the literature study, we suggest a single case-study methodology for researching radical university-industry innovation, and present some preliminary findings from the first round of interview concerning university-industry collaboration that lead to radical innovation.

LITERATURE REVIEW

A literature search targeted at university-industry collaboration on radical innovation led us to conclude that the specific topic is not *explicitly* presented in scholarly work. Instead we targeted our search on university-industry collaboration and radical innovation and looked in this literature for linkages between the two areas as well as for experience relevant for our research design. It is clear that some of this literature *implicitly* hold experience of the type we are investigating.

Radical innovation

This section will address some key studies in order to discuss definitions and the character of radical innovation as well as the research design applied.
In this paper we have chosen to use the term "radical innovation" although taking into account that a number of partly overlapping terms exists, such as "breakthrough innovation", "disruptive innovation", and "discontinuous innovation" to mention the most commonly used.

A brief desktop search provides an indication (only) of the use of the most commonly used terms in scholarly journals and on the web.

	ProQuest (all databases, scholarly journals, citation & abstract)				Google scholar	Google web
Search entry A (exact phrase) (This is referred to as "search entry A" in the columns to the right)		Search entry A AND "university"	Search entry A AND "collaboration"	Search entry A AND "collaboration" AND "university"	Search entry A	Search entry A
"Breakthrough innovation"	50	2	1	0	2120	54200
"Radical innovation"	328	14	6	0	18300	125000
"Disruptive innovation"	101	1	3	0	3810	135000
"Discontinuous innovation"	57	0	0	0	2330	46800

Table 1 Indication of use of terminology in scholarly journals and on the web (searches carried out April 2010).

With reservations, this search indicates that "radical innovation" is the most commonly used term and that there are few journal articles using these terms in combination with "collaboration" and "university", as we do in this paper.

A *radical innovation project* has been defined by Leifer et al (2000, p 5) in their recent comprehensive research on (formalised) radical innovation as:

> "... one with the potential to produce one or more of the following:
> An entirely new set of performance features;
> Improvements in known performance features of five times or greater; or
> A significant (30 percent or greater) reduction in cost."

Core to this definition is that radical innovation "...is driven by new value added to the marketplace rather than by technical novelty or newness to the firm." (ibid., p 6). The empirical focus is on existing large firms and they identify 3 types of radical innovations:

- Within the technology/market domain of their existing businesses units.
- In "white spaces" between a firms existing businesses (within the strategic umbrella, but in a new or expanded business unit).

- Outside the realm of the current strategy (new markets, either change of strategic context or spin-off venture).

The authors furthermore emphasize the radical (in the common meaning of the word) character by saying that: “In our view, radical innovations create such a dramatic change in products, processes, or services that they transform existing markets or industries, or create new ones.” (ibid., p 5).

Although the definition can be criticised for partly relying on the outcome from the process, they seem to have managed this in their own research. Their research approach for the case studies included: Exploratory multiple and longitudinal case studies (6 years), cases selected on the basis of having formal radical innovation set-up, emphasis on semi-structured interviews of different level R&D managers (initially 9-14 managers pr company, 4 rounds of follow up, and phone follow up), cross-disciplinary research team, multiple case analysis were conducted (O’Connor et al, 2006).

However, the study provides very little explicit information about the role of collaboration with universities (also, a search using Google Books searching the book by Leifer et al (2000) revealed 15 incidences of the word “university”, three of these were related to collaboration). Generally the focus in the cases is rather intra-organisational and the collaboration - where mentioned - concerns other firms.

As apparent from Utterback’s (1994) definition, radical innovation can be very dramatic to the firm: “By discontinuous change or radical innovation, I mean change that sweeps away much of a firm’s existing investment in technical skills and knowledge, designs, production technique, plant, and equipment.” Whereas, Utterback’s definition emphasize the well-known disruptive effects (Christensen, 1997) inside the company, Sandberg (2008) instead looks to the proactive involvement of customer in a recent book “Managing and Marketing Radical Innovations” and propose a market oriented definition: ”[Radical innovation is:] A new product or service that requires considerable change in the customers’ behaviour and is perceived as offering substantially enhanced benefits and which is also technologically new” (ibid. p. 229). This research was also conducted as a multiple retrospective case study (in Finland) and cases were selected according to the definition above, i.e., cases should be: based on a new idea, commercially successful/provide new benefit to the market/customer, make substantial changes in customer behaviour, and incorporate new or new combinations of technology. It is mentioned that “commercial success” was difficult to operationalise due to the stage of the innovation. Instead “customer acceptance” was used. Cases were identified by an expert panel of executives and publicly available information about the cases. Five cases were selected (cf. above) to maximize variety (“holistic understanding”) with respect to target market (B2B or B2C) and type of offering (product, system, service). The data collection relied mostly on semi-structured interview (2-5 per case, and phone/email follow-up) triangulated with various other types of information. The analysis included chronological listing of events, thematic organizing of data, and pattern-matching (matching chunks of information with the a priori conceptual framework). Case comparison followed the analysis of the single cases.

The sustainability literature seems to have adopted a particular notion of innovation, namely “systems innovation” (distinct from “systems of innovation”), which is used for complex and integrated innovations with sector-level impact including both behaviour and technological as well as organizational and other changes (Tischner et al, 2006).

Notwithstanding the diversity in these definitions, they all indicate that radical innovation holds great potential for businesses as well as for economic growth, and there has been an increasing interest in improving our knowledge of firms capabilities for radical innovation (see e.g. Birkinshaw et al., 2007).

Radical innovation is generally characterised by being based on ”radically” new knowledge (Henderson & Clark, 1990), i.e. in order to come up with a radical innovation firms cannot rely on current knowledge bases or incremental expansions of their current knowledge bases. This aspect is important in distinguishing between radical and more incremental types of innovation, and it implies that managing and organising for radical innovation is, in general terms, different from managing and organising for more incremental types of innovation (Ettlie, Bridges, & O'Keefe, 1984; Henderson & Clark, 1990). Complying with this, Lassen (2007) adds implications for where the knowledge is acquired from, concluding that “incremental innovation strategies are often supported by internal knowledge acquisition strategies, while radical innovation is supported by external knowledge acquisition strategies”.

Radical innovation process and organising

Based on the study of 12 cases from 10 large US-firms (Leifer et al, 2000) found that the process of developing radical innovation is rather stochastic and revealed the following key characteristics:

”long term – often a decade or longer;

highly uncertain and unpredictable;
sporadic – stops og starts, deaths and revivals;
non-linear – requiring a recycling back through activities in response to discontinuities and setbacks and a continuing application of all the key radical innovation project management competences;
stochastic – key players come and go, priorities change, exogenous events are critical; and
context dependent – history, experience, corporate culture, personalities, and informal relations all matter, creating a mix of accelerating and retarding factors."

These characteristics pose some inherent methodological difficulties, e.g., the processes run over a long time in a "stop-and-go" mode, and that "radicality" is often an emerging feature of an innovation and may only appear later in the process (consequently only recognised in hindsight). Sometimes there is a situation of "technologies looking for markets", which can require much market exploration and testing. These characteristics of radical innovation processes require different managerial approaches from those of incremental innovation.

Maybe the most significant contribution from the work by Leifer et al (2000) is the evidence that there are ways that allow large organisations to embed radical innovation, which is a complementary understanding to the most common position that radical innovation needs to be organized in autonomous smaller organization 'at the edge' or outside of the larger organization.

Versus incremental innovation

In contrast to knowledge on radical innovation there is a vast majority of existing knowledge and models of "good practice" related to incremental forms of innovation. Well-known models of innovation emphasize planning and linearity as central elements of the successful (product) innovation process (Cooper, 1983). Considering that only ten percent of all products are radical innovations according to Griffin (1997) (even less according to other sources), the division of the literature on radical and incremental innovation, respectively, seems to be probably reflecting innovation practice. However, considering the impact-side, there is strong evidence that when radical innovation succeeds, the result is a highly increased financial return in the long run (Ettlie 2000) and in addition, the largest breakthroughs serve as the basis for future technologies, products, services and industries (Christensen, 1997; Hamel, 2000, Abetti, 2000).

A sustained interest in contrasting and balancing incremental and radical innovation can be found throughout the innovation literature (Freeman & Perez 1988, Utterback 1994, March 1995, Christensen 1997, Tushman & O'Reilly 2004, Leifer et al, 2000, von Stamm 2003, Tidd & Bessant 2009).

U-I collaboration

The managerial literature on radical innovation has directed little focus to the potential that university-industry relations hold vis-à-vis radical innovation. This potential has, however, been established in system-based, institutional and evolutionary approaches to innovation. Freeman (1992) has argued that:
"…when it comes to incremental improvement type of innovations, the experience of users is bound to be extremely important and will often predominate as a source of ideas for innovation. But in the early stages of radical innovations it is the contribution of scientific and technical institutions (in our time especially from R&D organizations) which tends to predominate … when there is a radical discontinuity in technology systems the role of science and technology network becomes exceptionally important." (Freeman, 1992: 182)

Partly based on this perspective, Kaufmann and Tödtling (2001) have argued that universities may spur radical innovation in firms by: (1) transferring relevant knowledge, (2) knowledge inspiration, and/or (3) by cooperating with firms in preparation for developing relevant knowledge. And, in their quantitative study, they establish statistically that firms' external relations to universities are significantly important for radical innovation, defined as "new-to-the-market (Supporting this we found from a tentative analysis of the data from a representative national Danish survey ("DISKO") that university-industry collaboration significantly affects the likelihood of launching a new-to-the-world product). Also Dodgson et al (2008, p 73) generally claim that "...[universities] have always been a key source of ideas for radical innovation". Sandberg (2008, p 4) found that one of the most critical resources for radical innovations is knowledge and that R&D-based knowledge is "new raw information" and hence is often communicated through face-to-face communication. Köhler et al (2009) suggest that "A primary strategy of avoiding "customer-led" traps of incremental innovation may rest in extending a firm's knowledge pool with search strategies directed at leading universities and specialized suppliers."

Lööf & Broström (2008) concluded from their enquiries into 2071 university-industry linkages that collaboration with universities had a positive effect on innovation (”innovation sales” and ”patenting”) for the larger manufacturing firms (but not for service firms). They did not, however, explicitly address *radical* innovation (although it might partly have been so according to some definitions). They also indicated that ”research joint ventures” between industry and universities are commonplace and the amount of such ventures have been growing in recent decades (Lööf & Broström, 2008). Also sharing of IPR and different cultures are issues often discussed vis-á-vis U-I collaboration.

We find these perspectives from and findings in the system-based approach to innovation to be relevant for the managerial literature on radical innovation. But, we also argue that *the general, quantitative findings need to be complemented by more specific case-based studies in order to better understand the process of developing radical innovation through university-industry collaboration.*

Broström (2008) takes out-set in Kaufmann and Tödtling (ibid.) and similar work and addresses what he claims is a methodological gab between this level of quantitative survey type analysis and the level of in-depth contextual case-studies of U-I collaboration. He strives for more representative result by means of large scale interviewing of R&D managers of 50 firms with formal relations with two research universities in Stockholm in order to inform their study of firm’s rationales for engaging in such interaction. They found four distinct categories of rationales for cooperation with universities on R&D: 1) cooperation outcomes for product and process development (distinguish between broader learning, supportive research, problem solving, commercialization of academic research), 2) access to academic networks (for various purposes and status) 3) human capital management (e.g., recruiting, interacting, influencing, supporting) 4) direct business opportunities (e.g, knowledge for ”re-packaging” and sales, special competences, opinions for shaping general opinions, selling to universities). The motives for firms to interact seem to be more towards “indirect benefits” for innovation than “direct” benefits (Broström, 2008).

In a literature review of U-I collaboration Harryson et al (2007) identified drivers, advantages, benefits and main-barriers for such collaborations. Given that this study is rather unique and relevant to our study, we summarise some of the main results in Table 1. The result will be considered when preparing our interview guide.

Main advantages and benefits that companies expect	**Academic scientists’ goals and expected benefits**
“Gaining access to and acquiring, or producing new knowledge in specialized fields Creating a forum for networking by obtaining access to researchers and facilities Getting answers to specific problems through access to complementary skills, or developing new ideas related to an initially stated research problem, or even outsourcing specific parts of the innovation process that require specialized R&D Enhanced R&D productivity by sharing R&D costs – sometimes also through access to government subsidies Improved appropriability conditions and accelerated commercialisation of R&D outputs.”	Improving their ability to conduct research and exploit the results Assuring protection, marketing and diffusion of the university’s IP and accelerating the rate of development of new products Gaining knowledge about practical problems for better alignment with industry needs and goodwill creation Generating royalties and fees – usually through IPR-licensing.
Barriers to U-I collaboration	
Universities and companies are located towards different ends of the continuum from basic research to product/process development Exploitation of pre-mature technologies Scarce resources on both sides Cultural differences and lack of secrecy Incompatible rewards systems Inflexible academic research time tables Obtaining control over university inventions through IP rights	

Table 1 Drivers, advantages, benefits and main barriers summarised here based on a study by Harryson et al (2007).

The study (ibid.) does not explicitly distinguishing between incremental and radical innovation, although there are indications that cases of radical innovations are part of the underlying empirical evidence in the literature being reviewed. The authors conclude that (Harryson, 2007): “Although there is a wealth of literature on such [U-I] collaborations, no link is made to innovation theory….. [seen] from a company’s

point-of-view. Accordingly, there is no literature on how to manage this link, including the critical aspects of steering and internalising university-supported/conducted R&D for enhanced technology innovation impact."

As a contribution Harryson et al (2007) provide a theoretical frame work for transferring academic knowledge and technology to companies through a process of simultaneously involving three interrelated network levels with different foci. First an U-I network with weak ties focused on exploration through collaboration with universities and academic research institutes. Secondly, an intra-corporate process network focused on transfer and transformation of invention into innovation, linking technology and product development processes towards market needs, and transferring R&D results to production, and finally a project network focused on interlinking the two first networks.

Summing up on the literature review, we have been able to identify a number of studies related to U-I collaboration and radical innovation. The identified studies of U-I collaboration are mainly based on theoretical and/or quantitative research strategies and the few that are based on case studies do not explicitly address radical innovation. The studies of radical innovation are not focusing on U-I collaboration. We have not been able to identify qualitative research based on in-depth case-studies on U-I collaboration that *explicitly* address the idiosyncrasies of radical innovation, although a few have de facto focus on radical innovation (according to some of the definitions discussed). *Arguing that a qualitative research strategy is complementary important in order to capture in-depth knowledge of how U-I collaboration is related to radical innovation, we find the lack of such studies in the literature to be a research gap*.

RESEARCH DESIGN FOR STUDYING RADICAL UNIVERSITY-INDUSTRY INNOVATION

Positioning the research

The literature study has revealed ideas from adjacent studies from which we will deduce input to our research design.

In figure 1 we illustrate the research gab identified and consequently the positioning of the research.

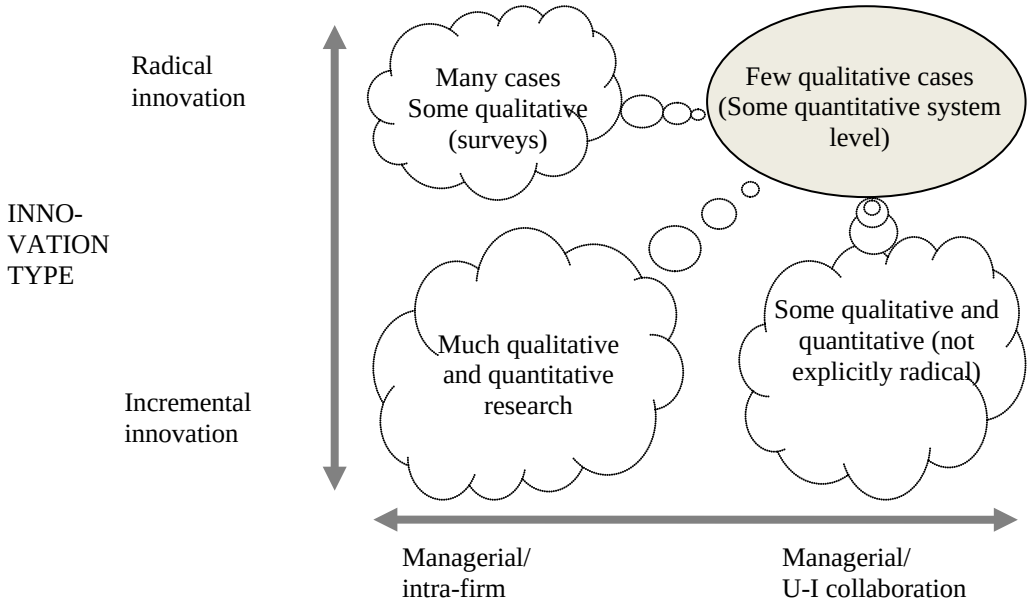

Figure 1 Illustration of the research gab/positioning (bold text) and potentially informing adjacent areas of study (the "clouds").

The purpose of our project is to contribute to better understand the process of developing radical innovation through university-industry collaboration. The explorative pilot study aspires to provide rich case descriptions, to identify key variables, linkages and patterns and the reasons why these exist.

The research design is conceived as abductive in the sense that the streams of literature enlighten the interview guide (deductively), but leave open question, and the data is explored with the theory in mind, but with an open eye for interesting/surprising/unexplained themes and statements (inductively).

First, we account for the design of the qualitative method for researching radical university-industry innovation. Secondly, we present and discus some preliminary findings from the first round of interviews.

Design of the case-study

Given the characteristics and uncertainty embedded in both radical innovation processes and U-I collaboration, the combination of the two endeavours, as well as the exploratory purpose of our study ("what", "how", "why") of this rare phenomenon, there is little doubt that *case-study is the best choice of research method*.

Just to mention a few of the case-study merits that fit our research purpose: Case studies have the potential of capturing and presenting the dynamics of the phenomenon in its context (Eisenhardt, 2007), they allow for rich empirical descriptions based on a variety of data sources in situations where boundaries between phenomenon and context are not clear (Yin, 1994), and are acknowledged as the basis for theory building and vigorous communication (Eisenhardt, 2007). Our literature study of radical innovation also instigates this choice.

Ideally a number of cases should be selected in a way that ensure representativeness, but acknowledging the explorative stage of this type of research, representativeness is not seen a pressing issue. A different sampling strategy for this stage would be to aim for variety by deliberately selecting diverse cases (Flyvbjerg, 2006). However relevant, neither of these two strategies are within the scope of our current project, but will only be considered for continued research.

Arguably it might have been the next most valuable approach to choose several (less in-depth) cases (e.g. 4-5) in order to explore the research problem. However, given the current resource constraints in the project and our preferences and intent to continue the project lead us to *the choice of explorative in-depth case study*. Taking this as our point of departure, we develop a qualitative case-based research design in preparation for in-depth studies of radical university-industry innovation.

Identifying potential cases and selecting two

Given the aim of improving in-depth, case-based knowledge on U-I collaboration related to radical innovation, the case should be selected so that it illuminates how such collaboration is related to radical innovation. This necessitates a sampling process that can identify and include U-I collaborations that are related to radical innovations. Since the project is funded by the regional governance this constraints the participation so that at least one of the U-I partners should be located in the region.

In search of potential radical cases we identified and set up meeting with key "intermediaries", that is, people with long experience and broad insight who are involved in or are likely to know of the type of radical projects at the regional scene that we were looking for. One-three hour meetings with a rather open agenda were held with the following 6 "intermediaries":

- Two former department managers of central administrative innovation department
- Director and technical director of the science park (NOVI) located by the university
- Head of central administrative innovation department, responsible for the university activities regarding entrepreneurship, networking, funding-support and IPR/commercialisation, and the person responsible for IPR/commercialisation activities.

From these meetings 17 potential cases were identified and adding to this from our own experience, contacts and colleagues etc, we were able to build a rough tentative list of 30 potential radical innovations of which many could be easily screened due to our selection criteria. Some cases were historical, others on-going. From the list we identified a few favourites and two were selected with the intension that we would approach both, but sequentially to allow withdrawal from the second case if our research resources were not sufficient for both case. The HEALTH case (described later) was selected as the first case.

A large and a smaller Danish manufacturing company were used for piloting the industry interview guide.

The interview with intermediaries proved later to become relevant contributions to the analysis of themes emerging from the case study and other test interviews.

Case entry point

In the RI literature section we raised a methodological dilemma regarding the best time/stage of entering the process and begin the data collection. Early entry allows for good real-time data (but require resources to conduct longitudinal studies). It may cause problems to identify and get access to cases due to secrecy or just hard to find information. Also, given the nature of radical innovation there will be uncertainty whether a (potential) innovation is actually going to become "radical" (according to the definition used). Late entry (retrospective study) makes it easier to identify radical innovation cases. Since radical innovations are often long time underway, the data, however, may have memory flaws and reflect interpretations that has changed during the course of time. Sandberg (2008, p 85) screened out innovations (in her initial sample), which were launched more than approximately 10 year ago due to risk of oblivion. A particular aspect of the changing interpretation mentioned above is described by Pettigrew (1990) under the compelling headline "Truth is the daughter of time". He argues that "change and continuity are a matter of time", meaning that the timeframe considered in the analysis will impact how you perceive the change. If studying a change process and make observations now and in one year big changes may appear to have been happening. If studying a big change and carefully untangling previous events leading to the change, the change may start to appear as a continuous process of small step changes. It may well be similar for "radical innovation".

We tried to strike a balance and found a case that we could enter at a stage where the chance of a radical innovation would be good and where we are still not too long time from the start of the process.

To get better data it could be desirable to enter projects while in progress. According to Leifer et al (2000) a project is considered radical if it meets just one of the three criteria (see section "Radical Innovation"). If we use the criteria "An entirely new set of performance features" we may be able to identify radical projects very early in the process and as a result retrieve data in real-time by conducting a longitudinal study. There will of cause be no guaranty that the project will be radical according to the two other criteria or that it will reach the market at all. In identifying "new-to-the-world performance" acts of secrecy may counteractive, whereas our location at the university may position us better to identify projects from the inside.

If such potential radical projects fail to produce valuable outcome, it may indeed still be valuable to research.

Selecting interviewees

In getting access to the case and key corporate people, we attempt to take advantage of our position as researchers to access the company via the research colleagues (and perhaps administrative staff) involved in the radical innovation process. This is a strategy successfully followed by Broström (2008).

The interviewees will include key actors of the UI collaboration. To some extent we will be "building the bridge as we walk on it", using "snow-ball" tactics to identify relevant interviewees from those already interviewed. Our experience indicates that this is an efficient "heuristic" search strategy.

Developing an interview guide for semi-structured interview

The themes of inquiry via semi-structured interviews were derived from theory. "Explorative case will not have well developed propositions but some looser defined purpose(s) of the exploration and some criteria for judging whether the exploration has been successful" (Yin, 1989, p 37).
The interview guide includes the following question areas:

- Tell about the project
- Overall assessment of the collaboration
- History/background regarding the idea;
- UI collaboration: previous experience, strategy, the university set-up
- Initiating: initiative, purpose, chose of partners, funding and resource commitment, initial organizing, expectations to results and agreements of sharing
- The process: plan vs. Realising: purpose, phases, partners, funding, organizing
- Mutual understanding, barriers, uncertainties, advantages - of collaboration
- Critical events timeline
- To-the-market/future/expectations: results, commercialization, continuation
- Closing: available documentation, next step

There is a slight difference between the university and industry version. The I-interview guide was tested by interview with the CTO of larger Danish manufacturing company that has produced radical innovations and has participated in various types of U-I collaboration. It was also tested in a smaller company which had experience with both successful and failed university collaboration (and less of radical innovation experience). The U-interview guide was tested by interview with a senior U-researcher.

Data collection

The plan includes two rounds of interview with key actors at the university and in the case company. The interviews are recorded and transcribed. We are currently in the first round of interviews.

Additional data is being collected, such as documentation, presentations, archival records, direct observation, participation observation, physical artifacts (Yin, 1989).

The following interviews have currently been conducted (in order of time):

- Three interview with six "intermediaries" (see above section "Identifying potential cases and selecting two"
- One CTO from a large Danish manufacturer
- One CEO of a small/medium sized Danish Manufacturer
- One senior university researcher
- Three researchers key to the HEALTH case

Data analysis

The preliminary analysis has taken its outset in themes identified from the interviews as recurrent and important to the interviewees. The recorded interviews have then been revisited to further detail and understand the particular themes.

Further intentions include coding of the interviews to detail current themes and indentify further relevant themes of interest to the research purpose. By means of these analyses we will pursue patterns, important factors for collaboration etc. Case descriptions with time-lines and critical events will be further elaborated. We will compare and contrast findings with theory and look for explanations for unexplained issues encountered.

PRELIMINARY FINDINGS

This section presents some preliminary findings identified from the on-going study. First we present and discuss themes that stood out from the full range of interviews conducted so far. The first theme is the role of the university's formal set-up to deal with IPR and commercialization, including the role of the researcher's personal networking with industry. The second theme is the process of negotiating a balanced solution to the sharing of IPR/commercial interests. Finally we introduce the first main case of radical innovation in our study and comment on some selected issues highlighted by respondents or issues related to our conceptual framework.

Organising commercialisation

The expediency of the university's set-up for commercialisation is a theme emerging in several interviews. This should be seen in the light of a still increasing political attention to commercialisation of publicly funded research, and in particular a Danish law of inventions in public organisations that came into action at the turn of the millennium. Having roots in the American Bayh-Dole Act of 1980, the law (no. 347) aims to ensure that research results generated using public funding will benefit the Danish society through commercial exploitation. Many other industrialised countries have followed this path, all sharing the premise that universities will produce deliverables for commercialisation (e.g., patents), despite modest evidence that this is actually the effect of Bayh-Dole inspired set-up for commercialisation (Mowery & Sampat, 2005, p 225).

Essentially, law 347 gives the universities the right (not obligation) to take over the IPR of inventions made by employees and it requires the employees to report inventions made and the university to actively seek exploitation, restrained by time limits. The inventor is also assured a reasonable proportion of any surplus that may comes out of selling or licensing the IPR to – typically - private companies. The details of the law are left to the university to fill in and so is the organising. Policies and procedures largely follow practices derived from US Universities.

There is evidence in our data that the university in this case has not yet fully adapted to the change.

A senior researcher says:
"I believe I have a strong opinion about the university and innovation….. I have seen the way the university have handled it [IPR and commercialisation], I think it is unprofessional…

… research and education belongs to the university, but the other things [IPR and commercialisation] does not belong here. But this is not to say that our result should not be put to work, I just cannot see that the university can do it in a way that adds value."

(Senior researcher; our translation from Danish)

The researcher is indirectly questioning the viability of the basic intensions of the law mentioned above (the universities' enhanced role in commercialisation), and secondly the ability and possibilities for implementing the intention of the law. Issues related to the above strong statement include the concern whether the university has sufficient ability to effectively protecting IPR. It is argued that this is such a specialised competence that it requires specialised and expensive professionals, who are difficult to attract to the university in order to build in-house competence. There is evidence in the literature that collaboration between organisations involving IPR and commercialization is indeed a delicate and complex task (Mehlman et al, 2010). It may take more than 10 years (since the law was enacted) to build the necessary in-house competences, especially if it is not possible to attract and recruit sufficient expertise within a reasonable budget. Our data holds examples that the patenting and contracting have been partly outsourced to specialists. Another claim is that there is a lack of ability to differentiate the effort put into inventions of various importances regarding IPR. This implies that the central offices sometimes become a bottle neck in the process. A third issue concerns the move from "gentlemen agreements" to (extensive) contractual relationships regarding the sharing of potential IPR. This seems to have evoked a seedy sense of bureaucracy and forced an agenda of mistrust, especially in cases involving partner that used to rely on trust and consensus agreements. On top of this, it is considered by researchers/practitioners to be time and effort consuming and may lead to postponement or even in some cases interruption of the collaboration.

According to a respondent, the resistance to contracting was enhanced by an example where the university did not stand on their contractual rights when a large global company was violating the contract. The university instead decided not to legally pursue the case, which of cause harmed the trustworthiness of the university's contractual procedure in the face of the researchers. As a researcher expressed it: "Contracts are aimed to help when things go wrong, and if you don't want to use them when it actually goes wrong, what is it worth then? That one is swept well under the carpet!"

Similarly, our data reveals critical attitudes amongst researcher as to the central staff's ability to assess reported inventions and to find matching partners to engage in commercialization. The law and procedures also seems to create a time problem. The period for assessment of inventions is restrained by the law and there are several examples that this has creased bottleneck problems and unreasonable time pressure, when the university does not want to take over the IPR after the assessment and the inventor is offered to keep and exploit the invention left with little time to do so.

As illustrated above the data indicate a tension between researchers and central administrative innovation staff (and management) regarding IPR and commercialisation. Whereas the researchers are more concerned about substance of content and results achieved, they express the interpretation that the central staff is more concerned about (visual/countable) results that can be communicated and be useful in the relationship with various stakeholders (management, government, funding bodies etc).

From an overall change perspective it seems that the researchers need to adapt to the changing rules of the game and the institution needs to find a prober policy, set-up and build its competence.

Formal university set-up vs. the researchers' personal industry network

Another emerging theme is the role of researcher's personal network in building new research projects. Personal networks is claimed to be the primary midwife of new UI collaboration by one researcher respondent and this was supported by others and by a corporate respondent, who stressed the importance of personal relationship with competent researchers who can deliver the desired results.

In building and maintaining networks, a researcher emphasizes the importance of being able to deliver "solutions that work" to met specific company needs, e.g., via consultancy work, student projects, speeches, and input to networks. This is claimed to build credibility, which in turn will be the foundation of larger UI collaborations. Although commonplace, this give-and-take regime and the personal relationships that grows along with this, seems to be an efficient mechanism working over the long term to the benefit of both research groups and firms. . Burnside & Witkin (2008) suggest a "model" of building a team, agreeing on a pre-determined process, and being committed to finding creative ways to reach agreement. They argue that "This model bears fruit when institutions value the collaborative relationship more than they do any single

collaboration opportunity, utilize their networks to advantage, and value research support as highly as license revenue." In addition they claim that "Broad multi-tier relationships are invariably more successful..."

As mentioned above, some researchers experience that the forced use of contracts (by the university, encouraged by the law) clashes with such network-based relationships amongst trusted partners.

Before year 2000 the researcher owned the right to the IP created and this IPR was sometimes part of the give-and-take regime. Therefore centralised (university) ownership and utilisation of IPR created in (decentralised) research units has an interrupting effect on the give-and-take regime in researcher's personal networking with industry.

The problem of sharing effort and benefits

Selling the "imaginary cake"

The value of an invention and associated IPR is uncertain and depends on many and various types of estimates. To use a simple analogy: Based on the recipe we may be able to imagine the taste of a cake, but much can go wrong in the baking process and further on before we know if the customer will buy it and come back for more.

Several respondents on both UI-sides had the impression that when the university first began to take over IPR, the expectations to the sales and prices of patents and licenses were unrealistically high.

An industrialist respondent saw this as a general problem of lack of insight and realism at (Danish) universities and provided an example of a UI collaborative project that was interrupted due to IPR disagreement. Mehlman et al (2010) also suggest that "spending time negotiating commercial terms for an unproven technology can waste scarce resources".

A key problem is to estimate the value of IPR. Realizing the value depends on the ability to overcome many types of uncertainties (market, technical, financial etc), the value may be realized long time after the IPR has been sold.and only 2-5% (depending on industry) of patents has positive net present value (senior R&D manager).

Some further issues mentioned by researchers: The long patenting time poses challenges to dynamic industries. When patents are exchanged/cross licensed or even "cross-violated", companies are acquired, it is hard to keep track of the agreements made and to follow up. Often the patenting process is prolonged and the patent is never issued. There is also in our study some examples that researchers considered it a problem that companies postpone the utilization of the patent.

A researcher raised another problem inherent to early sales of IPR: The buyer wants to see the full recipe (IPR documentation etc) in order to evaluate the value of the cake (the invention). The insight will sometimes enable the buyer to "work-around" or "twist" the patent and achieve the same end (although NDAs are usually signed). As a counteract to this, Mehlman et al (2010, p 57) suggest a process of gradual revealing of information, based on studies of collaborating companies though.

Baking the cake before sharing it?

Instead of attempting early "over the desk" sales of IPR other ways of commercializing was suggested by researchers and also seemingly followed by a change of IPR policy at the university level.

The suggestions typically implied selling IPR early on to an industry partner and let the partner be responsible for the patenting and commercialization. The deal could involve some smaller down payment and licensing agreements and the patent could serve as foundation for a co-sponsored collaborative project including public research funding. Such collaboration is also considered be part of the larger realm of collaboration, of giving and taking over several years. The down payment is considered to play a role as a visible incentive for the research group

Some will argue that there is a need for 1) generally toning down the economical importance of IPR to universities and 2) being alert as to identify the rare but potential radical inventions and be willing to spend many resources in such cases.

Cf. 1) A research respondent holding several patents argues that the monetary value of IPR/commercialisation is insignificant as compared to (other) fundraising for research. According to Karlson (2004) this is in line with figures for universities and colleges in the US, where IPR sales constituted 2-3 per cent of the total R&D budget. Moreover, the income came from relative few licenses, so "Most university licensing offices barely break-even" (ibid. p. 8, Campbell, 2004). Although licensing is a doubtful business for universities, it does create firms and jobs in the US (ibid. p. 11). Campbell

Cf. 2) The same respondent provided an older example of a radical innovation (still extensively in use) based on a student invention. At that time only little attention was given to IPR so great opportunities were missed due to lack of proper protection on both the university and industry side, and the innovation was widely copied. The respondent derived from this that IPR is important when you have something really radical ("one out of hundred") and in such cases you need the best people to help. It is not so much the money issue, but it is a pity if others take the whole benefit (as in the case just mentioned above). But the potential is often difficult to foresee and estimate up-front.

When holding the researcher's critique of the university set-up and policy against the current policy as expressed by the head of administrative innovation staff, some learning seems to have taken place. Some of the critique is based on "historical" examples, which the current policy has accommodated. The policy seems to have changed from emphasis on early selling and licensing of IPR towards emphasis on using IPR as "a valid ticket" to engage in joint and co-sponsored research. A central staff manager says that: "… we strongly emphasize that it [IPR] is being used to strengthen our research groups ..." and mentions examples such as using IPR to get funding for a PhD, establish a governmental funded project, funding to proof-of-concept and continue: "… so the direct pay back to the research groups is preferred to getting a royalty or selling a patent in 10 years or so, we will of cause do that too, but we put more emphasis on our main mission: research … in order to get motivation and engagement, but also because it is our main mission…".

The problems of sharing IPR were mentioned in a recent evaluation report from the Danish Ministry of Science, evaluating the type of funding scheme used in this case. The report concluded that one of two overall challenges were "examples that IPR has been difficult to handle" (Danish Agency for Science, Technology and Innovation, 2010).

The HEALTH CASE

The HEALTH case concerns the joint development of a new diagnostic method which holds the opportunity for cheap and therefore early diagnosis (and treatment) of a medical condition that accounts for a large share of deaths in Denmark. The innovation process is at a stage of wide-scale field testing and refinement, which – if successful – is planned to lead to a rather quick development of a marketable product. The innovation is radical according to the definition used in this paper. It holds new to the market features (the principle way the diagnosis is made was filed for patent) and dramatic improvements of the ease, time, and investment associated with the diagnosis. From the latter follows a dramatic reduction of the costs of each diagnosis to the size of about 1% of current costs. This may mean that a new market be created, which will be a pre-diagnosis to the - still necessary and - more accurate diagnosis currently done at hospitals using expensive equipment.

Figure 1 describes some critical events in the course of the innovation process. We will comment on some selected themes.

Time Year:Month	**Event**
Y0:M0	Invention has been developed during a master thesis
Y0:M2-4	Inventor participate in the university incubator program
Y0:M4	Inventors decide to report the invention to the university as a co-invention with students & professors in order to engage the university in the further progression of the case. Patenting process started by university.

Y0:M4 till Y3	The university employs one of the original inventors as research assistant followed by a PhD position
Y0:M4 till Y3	Negotiation with company X - a manufacturer of equipment - to engage in the further development and commercialisation. The financial situation and the amount of venture capital at company X was not so promising. Continued testing and development.
Y2:M6	"Lunch meeting" (with a different purpose) between a professor (co-inventor) and company Y lead to the idea of combining the diagnosis method with the technology of the company and join forces. The negotiation with company X was then terminated.
Y3-	An application for public co-funding (50%) is prepared and granted for 3 years of support. The university provides about 17% and the company about 33 %. Inventor is employed in a post doc position at the university.
Y4:M6	The venture division of the company is closed due to a financial set-back and the project is moved to a dedicated new spin-off company Z. The main part of shares is owned by company Y and some by the university (in return for transfer of IPR to the company and contribution of resources). Company Z shares are then offered and sold to project managers and members.
Y4	Company Z autonomously initiates a parallel development of a component of the medical device in order to accelerate the speed of development. The incident leads to a conflict situation that needs attention to be resolved.
Y5:M0	Negotiations on venture capital for the development of a marketable product. On-going wide scale field tests.

Figure 1 Critical events during the course of the on-going innovation process.

If a resulting product is successfully marketed according to the current plan, the duration of the innovation process is rather short as compared to other radical innovations and the process is relative smooth without major set-backs and shifts of stakeholders (e.g., Leifer et al 2000).

Not unusual, when "zooming in on" the actual process of generating the invention, the inventor tends to describe the details of the idea generation as an incremental development, a process of building combinations of existing knowledge. In this case the basic principle of the invention could be traced back in writings 30 years and even more than 100 years ago. But it was the combination with knowledge about new methods and technology that created the dramatic difference.

By law students own the IPR to their inventions, so it required some exploration and careful considerations – nurtured by the student incubator - as to decide how to progress with the invention. By reporting the invention as a co-invention with faculty the IPR ownership shifts to the university, but it was possible to assess help and resources to progress.

Two problematic issues have emerged from the data. The first one is a certain discontent with the deal negotiated by the university regarding shares of ownership in the spin-off company.

The second issue was a situation where company Z autonomously initiates a parallel development of a component of the medical device in order to accelerate the speed of development. In a meeting the U-researchers had presented their basic development work. The company people got the impression that there was little prospect of tangible results and afterwards they started a parallel (competitive) development of the device, which created some disputes. The device developed by the company proved to be inferior. The corporate people were stepping onto the territory of the U-research group, that was already far in the process towards a more theoretically founded development. This incidence seems to reflect a clash of different interests/values/goals hold by industry (tangible results, timeliness) and university partner (understanding, ensure high quality) respectively. The borders between development and research are not fully clear, and some senior U-researcher expressed their concern for younger researcher who sometimes had moved a bit too far to the development side at the expense of research progress. This may be due to the pressure from the company side, but also the common obligation of project deliveries and the necessity of continuation of funding. However, this is a grain size example in a sand box of discussions and critical concern about the commercialization of research and higher education at universities including issues such as "Industry-

funded research, technology licensing, industry endowed chairs, and professors starting their own firms, earning consulting fees and marketing their lectures on the Internet" (Karlsson, 2004, p. 75). Same author (ibid.) refers to the president of Harvard University expressing that "the increasing commercialization of universities threatens to change the character of the university in ways that limits its freedom, its culture of openness and its tradition of sharing results. By compromising these core academic values, the university as an institution might lose its high standing in society and create barriers to further research and progress." (ibid., p. 75).

We have not come across this concern in our study, maybe because it is a past discussion at this university, or - more likely – our respondents embracing the positive effects of such issues, which is a characteristic attitude found amongst technical oriented researchers that constitute the majority of our respondent. One of our respondents suggests that commercialization should not be part of the university activity, but the arguments do not concern integrity, but rather quality and capability, professional compatibility with research and teaching, and concern that the university cannot efficiently handle the task.

CONCLUSION

We found that although university-industry collaboration on radical innovation holds great potential for businesses as well as for exploitation of research knowledge, there is little in-depth knowledge of how this process unfolds in practice.

Our literature search revealed some quantitative studies, but no in-depth qualitative studies specifically addressing radical innovation developed through university-industry collaboration. From this we concluded that *qualitative research strategy is complementary important in order to capture in-depth knowledge of how U-I collaboration is related to radical innovation, we found the lack of such studies in the literature to be a research gap* in need of being filled. It also follows that there is a similar lack of direct methodological experience from such studies. We inquired into adjacent streams of literature – radical innovation and U-I collaboration - in order to present the conceptual framework and derive potential methodological implications for the research design. This led to the design of a *single explorative in-depth case study*. Expert intermediaries helped identifying potential cases and tentative plans for case entry, selection of interviewees, semi-structured interview and additional data collection, analysis and outcome were discussed and presented.

Based on the first round of interview some preliminary findings were presented.

The literature review had indicated that IPR and commercialisation was part of the wide range of issues in UI collaborative innovation, but we were somewhat surprised by the amount of attention it was given.

The case study raises the question whether the intentions of the Law of Public Inventions are expedient and fulfilled and whether the way it has been implemented is sufficiently effective in handling IPR and commercialisation, especially in the case of radical innovation.

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