





# Collaboration in practice

A multiple case study on collaboration between  
small companies and university researchers

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### **Abstract**

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University-industry collaborations (UICs) have been hailed as key for Sweden's innovativeness and economic growth. Similarly, building research and innovation policies for the promotion of collaboration between universities and industry have become a cornerstone for many other European countries.

In academic literature there has been an emphasis on efficiency, facilitation, effects and values obtained in UICs. They have been widely studied, both in terms of the reasons why they are formed, their structure and the effects they create, but not much in terms of how they work on a daily basis. There is less attention in the literature to analyse or problematise how UIC work is carried out when a connection has already been formed or is repeatedly enacted. Additionally, there is also a lack of studies looking at small firms UICs. Through identifying a lack of perspective in the UIC literature this thesis builds on the recent developments in practice theory in addressing some of the gaps found. It thus analyses these collaborations from a perspective not present in the literature in pursuit of *how* UICs are carried out.

Through four embedded case studies between small enterprises and university researchers the thesis questions some of the assumptions made in the UIC literature and policy documents. First of all, through the practice theory lens, the thesis shows how the creation of a node/linchpin, a boundary object or a broker, between university and industry is instrumental in enabling collaboration work to take place. Secondly, being able to work together successfully does not equal outcomes sought after by policy organisations. Nevertheless, a general conclusion is that there were valuable outcomes for both the companies and the researchers, confirming previous research on UICs. But, these benefits were often difficult to put into clear numbers or metrics and appeared only after a very long time.

The thesis argues that policy (and associated organisations) should promote the connection between a research site/practices and a company site/practices rather than pushing for a joint practice. In such a way UICs can be valuable for *both* researchers and companies.

**Keywords:** Practice theory, University-Industry collaboration, SME, Commercialisation

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# Abbreviations

AIMday – Academy Industry Meeting day

ERDF – European Regional Development Fund

JTI – Swedish Institute of Agricultural and Environmental Engineering

OECD – Organisation for Economic Co-operation and Development

SME – Small and Medium sized Enterprises (Including micro enterprises)

SLU – Swedish University of Agricultural Sciences

SLU-Holding – Swedish University of Agricultural Sciences holding company

SMURF – SMå företag i Uppsala Regionen samverkar med Forskare vid universiteten. (Translated to: Small enterprises collaborating with researchers at the universities).

TvV – The Swedish Agency for Economic and Regional Growth

UUI – Uppsala University Innovation

UU – Uppsala University

UIC – University Industry Collaboration

UUAB – Uppsala University holding company Inc.

VINNOVA – Swedish Governmental Agency for Innovation

ÅMA – Ångström Material Academy

HumSam – Knowledge intensive social science service sector



# Chapter I: Introduction

University-industry collaborations (UICs) are perceived as one of the keys for Sweden's innovativeness, economic growth and long-term competitiveness on the global arena. Sweden is one of the world's most innovative countries at the top of European Innovation Scoreboard (2017) (Figure 1). The nation's performance is 20% above the EU average across the measured indicators. Sweden performs high on all measured innovation indicators but has its strength in indicators for human resources, innovation-friendly environment, and attractive research system (European Commission, 2017). Sweden also invests heavily in its research system and since the beginning of 1980 has been well above the Organisation for economic co-operation and development (OECD) average of investments into R&D with a yearly average during the last 30 years close to 1% of GDP. This means that Sweden is one of the countries in the world that invest the most in R&D in relation to the size of the economy (VINNOVA 2015).

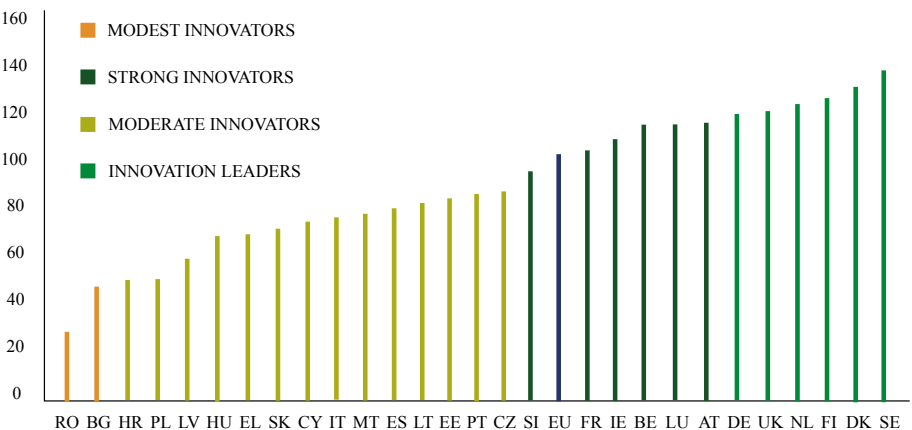


Figure 1. Performance of EU Member States' innovation systems, EU average in blue (Adopted from the European Innovation Scoreboard 2017:6)

The idea of linking academic research to a state's economic growth is not new (Gibbons et al. 2010). Since the introduction of the Bayh–Dole act in the United States in the beginning of 1980 different attempts have been made in involving universities with the economic sector in most western countries. The trend has been towards an increased pressure to make academic research valuable in very direct sense (Severinsson 2016). Ideas of

how to accomplish this have also emerged and two of the most influential have been the Innovation system approach (Lundvall 2010) and Triple helix model (Etzkowitz & Leydesdorff, 2000) which has gotten widespread recognition across most OECD countries including Sweden (Eklund 2007).

Public funding directed at different forms of commercialisation/innovation activities in Sweden is mainly distributed by three governmental agencies (the Swedish Energy Agency, Sweden's innovation agency (VINNOVA) and the Swedish Research Council). During 2016 these agencies distributed about 500 million SEK and the three agencies are planning to increase public funding to approximately 600 million SEK during 2018. Much of this funding is towards collaboration projects between university and industry (less so from The Swedish Research Council) and it is often required that the company matches received grants with their own resources, so-called "in kind resources". This is said to contribute to closer collaboration between university researchers and companies and a prerequisite for mutual knowledge exchange, interactive learning and problem-formulation processes between companies and universities. It is also said to contribute to more efficient utilization of research and competences at universities (VINNOVA, 2015).

From a policy perspective it is clear that there is high regard for UICs. Funding and support for collaboration between Sweden's universities and the rest of society is said to strengthen the nation's innovative capacity and generate economic growth (Government.se). The idea of collaboration as a way to make academic research useful to private as well as the public sector can be found in Sweden's innovation and research policies, where it is often mentioned in passing with some parts more than others talks about the role of collaborating as highly beneficial for Sweden's economy. In fact, the governmental research policy that stretches from 2017-2020 is called "Knowledge in collaboration - for society's challenges and strengthening competitiveness" and in some of the material distributed about that bill the following can be read:

[...] to find innovative solutions to a number of major and global challenges facing society today. In these areas, partnerships between different sectors of society has been established to stimulate new innovative solutions that strengthen competitiveness, contribute to sustainable development and create more jobs [...] The programmes build on co-creation among key players, including government bodies, businesses and academia. This challenge based approach building on cross-sectorial collaboration is a great way to fuel innovation (Government.se)

The quote above is telling on how policy, and in effect, the political sphere, seems to view the importance of making businesses and universities collaborate in order to boost Sweden's economy to greater heights. On a similar note, Sweden's innovation strategy from 2012 also makes a connection be-

tween economic growth and use of academic research. Utilization/commercialisation of academic knowledge is thought of as valuable for economic growth in a very direct sense:

Utilization of research-based knowledge is of value to both private and public sectors. Innovations strengthen the competitiveness of Swedish industry and can make it possible to find solutions to the global societal challenges. [...]. The efficiency of this can be further improved through increased collaboration between academia, government, industry, research grant providers and the rest of society [Author's translation from Swedish] (Research and innovation bill. 2012/13:30: 119)

Similar trends can be seen throughout the OECD area, building research and innovation policies for the promotion of collaboration between universities and industry has become a cornerstone for many European countries (Etzkowitz 1998; Geisler & H. Rubenstein 1989). The European commission initiated the program "Horizon 2020" during 2013, with over €8 billion distributed over a 6 year period (2014-2020) it is the biggest program built upon the idea of fostering innovation ever launched. Within these €8 billion are funding of public-private partnerships, meant to be a powerful tool to deliver innovation and economic growth to Europe, which will be funded at a cost of more than €2,2 billion over 6 years (European Commission, 2016). Essentially this is money earmarked to foster university – industry collaborations.

Simply put; collaboration between university and industry is seen by both national and international policy/governments as a way to improve innovativeness (see e.g. Etzkowitz & Leydesdorff, 2000; Perkmann, Neely, et al., 2011; Bercovitz & Feldman 2005; Ankrah & AL-Tabbaa, 2015).

## 1. University – industry collaborations (UICs) as a research topic

How has the academic literature addressed these collaborations? The body of literature on UICs has seen an increased number of research papers since the early 1990s corresponding with a general interest on stimulating UICs from policy and politics (Caloghirou et al., 2001). UIC is a pluralistic notion and the literature has a range of definition on what it is. It can be a joint venture, a network, a consortium, a project, an alliance, contract research or even consulting. Beside specific organisational forms the literature also distinguishes between types of links between industry and university, e.g. patents and licensing agreements, informal information exchange, public meetings and conferences, hired graduates or staff movement (Ankrah & AL-Tabbaa, 2015; Barringer, 2000; Bonaccorsi & Piccaluga, 1994; D'Este & Patel, 2007; Meyer-Krahmer & Schmoch, 1998; Perkmann & Walsh, 2008). The com-

mon denominator in these concepts is a varying degree of reciprocity between the university and the company partner. The notion of UIC can then be referred to as *“any interaction between a university and business or industry partner with the aim of knowledge or technological exchange”* (Ankrah & AL-Tabbaa, 2015;1).

Along with a political discourse that highlights the importance of universities for economic growth comes a growing political pressure on universities to demonstrate greater social accountability and overall economic relevance to society (Barnes et al., 2002; Etzkowitz, 1998; Perkmann, King, & Pavelin, 2011). The literature suggests that there are benefits for universities to engage in UICs beside policy incentives. For instance, in order to reduce their dependency from public funding, increase reputation towards certain stakeholders or as a legitimating effort (Logar et. al., 2001; Zinner et al., 2009; Santoro & Gopalakrishnan, 2001; Cohen et. al., 1998).

From the individual researcher’s perspective other reasons to engage are brought forward in the UIC literature. They engage in these activities for a number of reasons: they want to secure funding for their research, get access to funds otherwise hard to come by, get access to lab equipment, gain awareness and “real-life” insights into the practical application of their research and gain private financial benefits or complement their own research (Lee, 2000; Cyert & Goodman, 1997; Meyer-Krahmer & Schmoch, 1998; Santoro & Chakrabarti, 2001)

Industry on the other hand, is motivated to engage in UICs as they might acquire access to technologies and expertise otherwise difficult to obtain on their own, to exploit research synergies for cost savings, to improve R&D productivity, keeping up with new **technological** developments, reduce risk and stretch limited resources and share R&D costs. University and industry collaboration research can also enhance company sales, R&D productivity, and patenting activity (Cohen et al., 1998). Also, the lack of in-house R&D to carry out technological research leads companies to seek out universities as a way to elevate this (López-Martínez et al., 1994; Ankrah & AL-Tabbaa, 2015).

Because of the cultural difference between university and industry, trust between a researcher and company is said to be crucial in UICs. This trust lowers institutional barriers and makes UIC more likely to form or to have a successful end-result (Schartinger, Schibany, & Gassler, 2001; Ankrah & AL-Tabbaa, 2015; Santoro & Saparito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Mora-Valentin et al., 2004; Davenport et. al., 1999).

Analysing the UIC literature reveals that rather little attention has been paid to SMEs, which is somewhat surprising as 99% of all businesses in the EU are companies with less than 250 employees providing two-thirds of the total private sector employment in the EU today (European Commission, 2017). Some studies do exist and they indicate that there is a difference between the strategies used by large versus small firms in relation to UICs.



Larger firms want to strengthen their skills and knowledge and gain access to university facilities for advancing non-core technologies (Peças & Henriques, 2006). Smaller firms go about this in the opposite way and tend to focus on gaining skills and knowledge for strengthening their core technology. They are more focused on survival and therefore participate in more relationships building with universities in order to find immediate solutions to critical issues affecting central business areas and core technologies in comparison to larger firms (Santoro & Chakrabarti, 2002). UICs are also a successful method to create or stimulate knowledge-based SMEs (Klofsten & Jones-Evans, 1996).

It could be argued that this stream of literature is rather comprehensive in some specific areas, i.e. the cultural or institutional difference between university and industry, why UICs are formed (their motivations), what facilitates successful UICs and also the different organisational forms UICs can have. There is also a heavy emphasis towards motivations of single actors in engaging with a UIC and the need for trust in these types of collaboration, often as a way to overcome cultural differences. Furthermore many articles focus on resources and the value of UICs for companies and universities. Simply put, the interest has been on efficiency, facilitation, effects and values obtained in UICs. There seems to be much less attention in the literature to analyse or problematise how UIC-work is carried out in practice. To this author's knowledge, there are no attempts in trying to understand the process of work when a connection has already been formed or is repeatedly enacted between a university/research and industry/company.

More specifically, as will be discussed below, the UIC literature is skewed towards rational and positivistic approaches along with relying on either a structural or individualistic explanation of university-industry collaborations. This literature falls short of capturing the mundane social activities along with the practices that arguably make up a large part of these collaborations.

## 2. Putting practices in the spotlight

These gaps in our understanding of UIC originate from an ontological debate almost as old as social science itself. It concerns what role the individual should play in the definition and explanation of a social phenomenon. In one corner are the methodological holists who argue that the actions of human agents can only be explained and understood in terms of the social entities with which they are associated (Zahle 2015). There is something greater than only the combined sum of a group of individuals. So, any social phenomena should be wholly or at least partly explained in terms of these social wholes. In the other corner are the methodological individualists with the opposite opinion on what constitutes a satisfactory explanation of social phenomena:

social units can and should only be explained in terms of the actions of individuals (Heath 2015). Social wholes are made up of human beings and are caused by their actions. That means that methodological individualism amounts to the claim that explanations on the social outcomes are accumulated results of actions, choices, and mentalities of individuals (Ibid.). It harbours a variety of perspectives that can be referred to as "agent-centred" approaches to social explanations. Methodological holism is on the other hand largely the opposite of individualism. It claims that explanations that invoke social phenomena (e.g., institutions, social structures or cultures) should, or need to, be offered within the social sciences in order for them to make sense (Zahle 2015)

Within the body of knowledge on UICs both methodological individualists (e.g. Santoro & Saparito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Nilsson et al., 2009) and methodological holists (e.g. Bjerregaard, 2010; Cyert & Goodman, 1997) with varying perspectives can be found. However, there is a third camp on contemporary social science that argues for a way to resolve this debate. This is a diverse group of theorists that can be gathered under a *practice approach* umbrella (Hui et al. 2016). By focusing on human practices as the unit of analysis they claim to offer a third perspective on the social. The theoretical focus on practices is said to reconceptualises how to understand the social world (Shove et al. 2012) Instead of relying on explanations that presuppose either "individual" or an opposing "non-individual" view of the world, practice theorists' argue (with some minor disagreements) that social life is composed of a nexus of human practices and material arrangements (Schatzki, 2005). In this way they acknowledge that both camps grasp something important and need not engage in a debate of which is the preferred explanation on social phenomenon.

At one level, practices are composed of individual performances. These performances nevertheless take place, and are only intelligible, against the more or less stable background of other performances. "Practices" thus constitute the background that replaces what earlier holist theorists would have described as "culture" or "social structure (Rouse, 2007:505).

By building an analytical framework centred on practices as the unit of analysis, that is "the doings", this thesis addresses some of the gaps found in the UIC literature. Practice theory requires a detailed description of action and activities in order to sketch out practices and, consequently, the focal point will fall on "how" UICs are carried out. This will also lead to an attention and sensitivity on *organising* as opposed to *organisations*.

### 3. The multiple case study

In order to get at the practices of UICs and address the gaps found in the UIC literature, I utilise four embedded case studies with a unit of analysis centred on the practices within the collaborations.

#### 3.1 Uppsala University

This thesis takes its starting point within the broader Swedish context and focuses on Uppsala University (UU). Founded in 1477, UU is Sweden's first university and the oldest university in all of the Nordic countries. In 2017, it was ranked among the best universities in Northern Europe and in the top 100 worldwide, being prominent in many research areas. The university is fairly large and diversified, with nine faculties distributed over three “disciplinary domains” (uu.se). In response to the policy demands put on Swedish universities, UU has since 1985 created a number of organisations to support, directly or indirectly, the commercialisation of research. Recently, a key organisational unit for this thesis was formed: Uppsala University Innovation (UII). UII has been for a number of years one of the leading commercialisation and support units in Sweden. The organisation was created in 2007 for two main reasons: firstly, as a reaction to the government's instructions to all Swedish universities to be more actively involved in dissemination and commercialisation of research. Secondly, the legal regulation made it very difficult for the university to financially support its holding company, UUAB. The plan was to create an organisation within the university that could work with a proactive approach to complement the more reactive approach (direct commercialisation) of UU's holding company, UUAB. In addition, this new organisation was picked by VINNOVA as one of the five national winners for the “key actors” and was granted a substantial eight-year funding. Now UII provides assistance for researchers wanting to commercialise new business concepts and gives advice and support to business development, financing and intellectual property rights. They also support researchers in developing ideas through collaboration with companies, the public sector and the civil society (uinnovation.se). UII has also created AIMday, which is a one-day conference where researchers and companies meet and discuss issues that interest both of them. This conference has received widespread recognition both nationally and internationally (Severinson, 2016).

#### 3.2 SMURF and the four embedded cases

SMURF project is the context for the four embedded case studies which are the unit of analysis in this thesis. The project is a direct response to the mission given to UII and thus an indicator of the public policy trickling down

from the Swedish government. It all began in 2010 when a project idea that had been evolving in the hallways at UII for a long time was slowly being assembled into an application for funding. The reason was said to be that Uppsala university innovation network had over its (then) 15-year existence never really directed any major efforts towards small and medium-sized enterprises (SMEs). This idea correlated well with the governmental policy along with available funding from the EU. The idea was to engage SMEs that previously had *no connection* with Uppsala's two universities. The general feeling was that UII needed to find ways to reach out to a group of companies "out there"; that there might be a group of small companies that they could target and would benefit from university resources. The goal of the project became *"enhancing small business development and long-term survival by improving their relationship with the universities of Uppsala"*. The project sought to create a platform that facilitated and financed collaborations with small firms and a researcher from Uppsala's two universities in small/short sub-projects. Further ahead in this thesis there is a more thorough review of how the SMURF project progressed over the years. Having the SMURF project as a starting point and context, the focus of this thesis will be on the collaborations that sprung out of the project. In other words, the SMURF project will help to make better sense of preconditions and contexts that formed the practices in the collaborations that will be studied in detail.

From a total of 27 collaboration projects formed thanks to the SMURF project, four were selected and followed over a period of five years. They were similar in that they were all given funding from the SMURF project, but they are also unique in that each one tells a different story on how collaborations between small enterprises and researchers are performed in practice. In the first case study, a researcher at UU and a company worked together in characterising an innovative new material with electron microscopy techniques. In the second case study, a researcher and a one-man company examined whether compressed and hydrated biogas from rural farms could be more energy-efficient than conventional storage of biogas through a macro system analysis. In the third case study, a life science company worked with a diabetes researcher from UU to develop a biological assay for detection of a specific protein in human plasma. The last case study was a collaboration between two small consultancy companies and researchers trying to commercialise an IT product.

## 4. Research purpose & research questions

UICs are said to be one of the ways to achieve innovation and economic growth for Sweden. They have been widely studied in terms of the reasons why they are formed, their structure and the effects they create, but not much in terms of how they work on a daily basis. Using a practice approach in the

way it is outlined in this thesis is a clear distinction from previous research on UICs and highlights, among other things, “how” they are performed. Secondly, the UIC cases in this thesis are all based on small companies (some indeed “micro” companies with one or no employees), which is a group of UICs we do not know much about. This thesis thus has one overarching purpose: to investigate *how small companies collaborate with university researchers*. With such purpose, in tandem with the empirical material, three research questions are also addressed in this thesis:

Using practice theory as an analytical tool means trying to sort out the practices within the cases in order to understand how they work; thus the first question is:

1. *What are the practices that appear in this kind of UICs?*

With this thesis theoretical lens, the unit of analysis is put on practices rather than human actors. In order to understand how UICs work from such perspective it is essential to outline how practices from a business setting connect to those in a research setting. Thus the second question is:

2. *How do practices from different organisational contexts in the UICs connect with each other?*

A practice theory approach is likely to bring out different notions along with questioning some of the assumptions in the UIC literature and, since much of the knowledge base in this literature concerns facilitation and outcomes of UICs, the third and final question is:

3. *What are the facilitating factors and outcomes connected to the analysed practices in comparison to the existing literature?*

## 5. Structure of thesis

This thesis’ second chapter is a literature review on previous studies on collaboration between university and industry. The theoretical framework is presented in Chapter 3 and after that, in Chapter 4, the methods and methodological considerations that have been used in pursuit of the researcher questions. Chapter 5 provides an outline of how the SMURF project came about and what transpired within and around the project over its three-year existence. The chapter provides the context from which the four embedded cases originated. Chapters 6-9 cover the four embedded cases. They are structured in a similar manner to allow for comparison. Each case is followed by an in-depth analysis that utilises the theoretical framework provided in the theoret-

ical chapter. In Chapter 10, the four case studies are compared against each other and the UIC literature with a focus on the practices found. Lastly, in Chapter 11 the research questions are addressed in the conclusions along with theoretical contribution, policy implications and suggestions for future research.

## Chapter II: Previous studies of university-industry collaborations

The notion of collaboration between industry and universities is seen as something important in both policy and public discourse. It is thus logical to turn towards the academic community and to look at how they have tackled university-industry collaborations. I will begin this section by defining the notion of university-industry collaboration (UIC) in relation to the literature and then provide a general overview of the body of knowledge concerning UICs. From there, I will go on and problematise this knowledge and point to the lack of an important perspective not present in this literature.

### 1. How is UIC defined in literature?

At the core of any university–industry collaboration is the difference in institutional norms governing public and private knowledge practices (Dasgupta & David 1994). It is this that makes UICs a different type of social phenomenon than other inter-organisational collaboration. This is rooted in the university system and Mertonian norms of science, (communalism, universalism, disinterestedness and organised scepticism) (Merton 1973). These norms are said to be fundamental to the way that many academics perceive and perform their work (Bruneel et. al, 2010). Indeed, scientists are willing to accept lower wages in order to work within the institutions of a university, indicating that many scientists are motivated by intrinsic goals as well as the social objectives of the universities (Stern, 2004; Cohen & Sauermaann, 2007). Establishing a reputation through publication is critical to an academic career. Given this environment, much of the science system is driven by internal dynamics that are separate from market transactions (Polanyi et al., 2000; Dasgupta and David, 1994; Stephan, 1996). It might be tempting to see the science system as operating outside the confines of market transactions, but in modern day (mode 2) universities, economic and social forces outside the science system play a powerful role in shaping scientists and science (Gibbons & Johnston, 1974)

In contrast to the science system, the process of knowledge creation in the industry/private sector is dominated by attempts to appropriate the economic value of what companies know in order to gain competitive advantage

(Teece 2003). This ‘private’ knowledge is hidden within the firm or disclosed in a limited way through patents filed primarily for the purposes of obtaining temporary monopolies (Allen 1977; Dasgupta & David, 1994). This is not to say that industry knowledge is completely closed but the primary motivation of companies’ knowledge creation practices is for private gain, and openness to external actors is used as a strategic mechanism to gain advantage over competitors (Chesbrough 2006). Given these two different systems of knowledge production, UICs are likely to be plagued with conflicts due to a weak attitudinal alignment between partners. Private companies often conflict with university researchers over attitudes towards the topics of research or the timing and form of disclosure of research results. While researchers may be keen to disclose information to gain priority, companies may wish to keep secret or appropriate the information.

Academics create ‘leaky’ knowledge so that their peers will recognise their ideas while companies want the knowledge to be ‘sticky’ so that they can control a resource that is not available to their competitors (Brown and Duguid, 2000). University researchers are also likely to choose research topics that are perceived by their peers to be interesting and valuable, while companies are likely to choose topics and problems that are perceived as being valuable for the development of new products and services for their customers (Nelson 2004). This means that the problems that each party may want to explore within a research project may be very different and the types of outputs each partner is interested in may diverge (Bruneel, et al., 2010).

Considering this important premise about the involved parties, the notion of university–industry collaboration (UIC) is defined in the literature as *any interaction between a university and business or industry partner with the aim of knowledge or technological exchange* (Ankrah & AL-Tabbaa, 2015). This definition excludes any interaction between a university or researcher and a non-profit organisation or the public sector, even though it is likely that such interactions are numerous, both formally and informally (see e.g. Etzkowitz, 1998; Ryan & O’Malley, 2016). In the theoretical section, I will come back and reevaluate this section along with the definition of UICs.

## 1.1 UIC body of literature, general conclusions

In order to clearly show both what this stream of literature contains and its gaps, I have structured this literature review into two sections. The first section will sketch out what scholars have concluded in a general sense about the topic. The second section is an outline of how this knowledge has been created and its imitations.

The body of literature on UICs has seen an increased interest during recent years corresponding with a general increase of UICs in political discourse since the early 1990s (Åström 2015; Caloghirou et al. 2001). A few examples are: Geuna and Muscio (2009), who provide a review on the gov-



ernance of knowledge transfer between university and industry; Phan, Siegel, and Wright (2005), who focus on the literature on science parks and incubators; Larsen (2011) who writes about the literature on academic enterprises and lastly Rothaermel, Agung, and Jiang (2007) who perform a taxonomy of the literature on university entrepreneurship. These four works consider aspects on university–industry interaction in a very wide sense but lack some of the defining features on UIC with an emphasis on *collaboration*. Ankrah & AL-Tabbaa (2015) and Perkmann et al. (2013) are the only two reviews that are within a scope of a more narrow definition of UIC (see above) and match the embedded case studies in this dissertation. Perkmann et al. (2013) focus on what they define as ‘academic engagement’, which includes collaborative research, contract research, consulting and informal relationships for university–industry knowledge transfer. Ankrah and AL-Tabbaa (2015) go further and focus on not only the university but also equally on the industry side in exploring the literature on UIC, making their review quite comprehensive. Unlike the previously mentioned reviews, these two employ a systematic procedure and with that they are aiming towards finding *everything* written on their topic of interest.

In general, there appears to be a plethora of quantitative studies in relation to UIC. Qualitative studies are less common but are still published, and then often with a case-study approach. It has been common, and still is, to focus on data sets on patents, licensing, academic entrepreneurship and co-authoring, partly because of that type of data being easily obtained. This has been criticised of falling short in capturing the in-depth social relationship between parties (Perkmann & Walsh 2007).

## 2. Different forms of UICs

UICs have been identified in many different organisational forms. I am to show this below in order to demonstrate how diverse the literature is on this topic and by doing so highlight its fragmented structure.

Barringer (2000) distinguish four organisational forms that the literature most often mentions: joint ventures, networks, consortia, and alliances. There is also a lot of mention of collaborative research, contract research (including technical services contracts) and consulting (see e.g. Bonaccorsi & Piccaluga, 1994; D’Este & Patel, 2007; Meyer-Krahmer & Schmoch, 1998; Perkmann & Walsh, 2008). Outside specific organisational forms the literature is extremely diversified, encapsulating a large pool of links between industry and university: patenting and licensing agreements (licensing of intellectual property rights), informal information exchange, publications and reports, public meetings and conferences, recently hired graduates, licenses, joint or co-operative research ventures, temporary personnel exchanges, mobility (staff movement between universities and firms,) and

training (co-operation in education, training of firm staff at universities, lecturing by industry staff, joint supervision of students), , employment of relevant scientists by industry, use of university or industrial facility (e.g., lab, database, etc.), equity holding in companies by universities or faculty members, exchange of research materials or joint curriculum development, joint research programmes (including joint research, with a university as a research partner, or joint research, with a university as a subcontractor). It would therefore seem that a large number of different connections can be made between university and industry partners (Ankrah & AL-Tabbaa, 2015). It should be added that authors do not agree on the definitions and distinctions of the various forms of UIC and have different typologies or taxonomies of these relationships (Bruneel, et al., 2010). Taxonomies have, however, been developed for grouping different relationships, e.g. the one below adopted from Ankrah and AL-Tabbaa (2015) and Bonaccorsi and Piccaluga (1994), seen in Table 1.

Form of relationship	Example of organisational forms
Personal Informal Relationships	<ul style="list-style-type: none"> <li>— Personal contact with university academic staff or industrial staff</li> <li>— Co-locational arrangement</li> </ul>
Personal Formal Relationships	<ul style="list-style-type: none"> <li>— Employment of relevant scientists by industry</li> <li>— Use of university or industrial facility (e.g., lab, database, etc.)</li> </ul>
Third Party	<ul style="list-style-type: none"> <li>— Liaison offices (in universities or industry)</li> <li>— General Assistance Units (including technology transfer organisations)</li> <li>— Industrial associations (functioning as brokers)</li> </ul>
Formal Targeted Agreements	<ul style="list-style-type: none"> <li>— Cooperative research projects</li> <li>— Exchange of research materials or joint curriculum development:</li> <li>— Joint research programmes</li> <li>— Project with a university as a research partner or joint research</li> </ul>

Formal Non-Targeted Agreements	<ul style="list-style-type: none"> <li>— Broad agreements for U-I collaborations</li> <li>— Industrially sponsored R&amp;D in university departments</li> </ul>
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Table 1. Forms of relationship in the UIC-literature

Ankrah and AL-Tabbaa (2015) point out in their concluding remarks that trying to create a typology that demonstrates all of the possible links that could transpire between industry and university is likely to be an extremely difficult task.

### 3. What explains the formation of UICs?

There are two subcategories in this perspective: the university as whole (an organisational/institutional perspective) and the individual researcher. They are both important to take into consideration because both have an impact on the current understanding of UICs and emphasise slightly different facets of the reasons for UICs formation.

#### 3.1 University perspective

There are two subcategories in this perspective: the university as whole (an organisational/institutional perspective) and the individual researcher. They are both important to take into consideration because both have an impact on the current understanding of UICs and emphasise slightly different facets of the reasons for UICs formation.

From the university perspective, there is a general pressure from government through policy directed at universities around the western world to increase their contribution to innovation and thereby enhance wealth creation in society (Barnes et al., 2002; Etzkowitz, 1998; Perkmann, King, & Pavelin, 2011). On a similar note, it has been claimed that it is important for policy-makers to enable a well-established interface between university and industry (Hall, Link, & Scott, 2001). This pressures universities to increasingly enter into forms of collaborations with industry through knowledge diffusion or technology transfer (Siegel et al., 2003). All this creates a situation where universities are increasingly trying to encourage UICs out of the necessity to fulfil their mission towards policy (Ankrah & AL-Tabbaa, 2015).

Sherwood & Butts (2004) argue that universities might offer industry extensive access to a wide variety of research expertise and research infrastructure (e.g. lab equipment). Industry, on the other hand, offers universities or re-

searchers extensive access to market knowledge and a wide range of expertise in product development/commercialisation (Ibid.), as well as employment opportunities for university graduates, both PhDs and others (Lee & Win, 2004)

Many scholars point out that universities are not only “pushed” by policy towards more UICs, but also that there are strong benefits for universities to engage in UICs apart from policy incentives, for instance, in order to reduce their dependency on public funding (Logar, Ponzurick, Spears, & Russo France, 2001; Zinner et al., 2009; Santoro & Gopalakrishnan, 2001). Some parts of the literature find that universities engage in UICs or try to create industry relationships as a way to increase the university’s reputation, or as a legitimating effort towards the growing pressure to demonstrate greater social accountability and overall economic relevance to society (Cohen et al., 1998) Past experience in interaction with the business sector was crucial for university departments to get involved in interactive relations with the business sector. The quality of research of a university or a department does not count as much as the quality of the past relationship as a motivator to engage in UICs (Schartinger et al., 2002).

### **3.1.2 Individual researcher’s perspective**

Nilsson et al. (2009) use seven longitudinal case studies in three Swedish research centres performing studies on stem cells. They have two research questions: Firstly, why do researchers engage in commercialisation at all? And secondly, if researchers do transfer research, how do they choose to perform such a transfer? They find that the organisational, regulatory and work environments within the organisation encourage engagement in technology transfer and commercialisation. They also find that researchers engage in these activities because they want to secure funding for their research, put their research into practical use and/or gain private financial benefits. Researchers tend to use technology transfer offices only if they believe they are competent or if they do not have enough social capital themselves; otherwise they interact directly with firms. Perkmann et al. (2011) find, using a survey of 4337 university researchers in the UK, that most academics engage with industry to further their research rather than to commercialise their knowledge. Researchers generally benefit from collaboration with industry by getting access to funds otherwise hard to obtain, by gaining awareness and ‘real-life’ insights on the practical application of their research, by securing funds for their students and access to lab equipment, by supplementing their own research and gaining new insights (Lee, 2000; Cyert & Goodman, 1997; Meyer-Krahmer & Schmoch, 1998; Santoro and Chakrabarti, 2001)

### 3.2 Company/industry perspective

Most articles about UICs express a positive view and beneficial side for firms involved in UICs. Cohen et al. (1998) claim that university-industry cooperation can enhance company sales, R&D productivity, and patenting activity. Industry is motivated to engage in UICs as they might acquire access to technologies and research facilities with expertise otherwise difficult for them to obtain on their own. But firms also collaborate with universities to exploit research synergies that could lead to cost savings or improvements in R&D productivity, keeping up with major technological developments, and sharing R&D cost. Caloghirou et al. (2001) find that firms thought that the most important benefit from such collaboration was the positive impact on their knowledge base. Bonarccorsi and Piccaluga (1994) find that this helps to relieve the impact of current shorter product life cycles and thereby enhance competitive advantage. There is also the possibility to get access to new technologies which may reduce time from design to production and as such gain competitive advantage in the market (Santoro & Gopalakrishnan, 2001). Santoro and Betts (2002) find that the societal transition towards a knowledge-based economy is motivating firms to engage in UICs or seek relationships with universities, and Pavitt et al. (1989) concludes that firms use universities to enhance their ability to solve complex problems. The lack of R&D and in-house capacity to carry out technological research and thus the need to seek out universities as a way to mediate this is also indicated as a strong motivator in the UIC literature (López-Martínez et al., 1994; Ankrah & AL-Tabbaa, 2015). Schartering et al. (2002) find in their survey that regardless of whether a firm has in-house R&D, collaboration with universities is still highly valued as it might reduce risk and stretch limited resources. They also find that the main channel of knowledge transfer from universities to the business sector occurs through the mobility of human capital. The major barriers of interaction were said to lie in the differences between university and industry ‘cultures’ as well as lack of information/knowledge on the part of the firms.

George et al. (2002) find that access to research networks that include both firms and universities, and thus the potential for deeper collaboration, are also a strong motivation for industry. Mora-Valentin et al. (2004) looked at a series of contextual and organisational factors on the success of 800 cooperative agreements between Spanish firms and research organisations, run between 1995 and 2000. They show that the important factors for firms were commitment, previous links with research organisations, and clear definition of objectives. For research organisations, on the other hand, previous links, communication, commitment, trust and the partners’ reputation were more relevant. One topic that is brought forth a lot in the literature is the concept of trust and its importance to support UICs (see e.g. Santoro & Saporito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Mora-Valentin et

al., 2004; Davenport et. al., 1999). If the partners have had a history of some type of collaboration, they are more likely to have a positive outcome from a UIC. The reason is that there might have been a gradual build-up of trust through constant interactions and evolution of expectations and demands between the partners. This pre-existing trust is said to be crucial as past interactions lower personal and institutional barriers and make UICs more likely to form (Schartinger, Schibany, & Gassler, 2001; Ankrah & AL-Tabbaa, 2015)

Perkmann and Walsh (2007) bring forth an important point in relation to the motivational factors in UICs. A central argument for them is that various studies have indicated that a firm's reasons for engaging in UICs or similar undertakings are informed by generic benefits such as accessing students, gaining 'windows' on emerging technologies and enhancing their knowledge base, rather than by the desire to develop specific innovations. As a result, firms often choose not to assess the value of these relationships via hard performance measures. They argue that because of this the desire of firms to generate tangible outcomes from university–industry links only tells part of the story. This means that performance measures such as patents, licensing or spin-offs promoted by the emerging technology transfer professions do not necessarily reflect the whole range of anticipated benefits for firms.

### **3.2.1 Small companies involved in UICs**

The empirical material that this thesis bases its argument on concerns small or very small companies, indeed even “micro” companies with just one employee. One of the contributions of the thesis will then concern that special group of companies. One thing to note in the literature referenced above is the lack of reflection on the size of the company and UIC. It would seem like the literature makes little distinction in this regard, although some studies that consider more or less explicitly small firms' interaction with universities do exist, as referenced below.

Klofsten and Jones-Evans (1996) point out that a number of studies have found that UICs are a very good way of creating and stimulating knowledge-based SMEs. Others look at the differences between large and small firms. Mohnen and Hoareau (2003), using data from an innovation survey for France, Germany, Ireland and Spain, point out that small firms benefit to a larger extent from university-based research spill-overs than large firms, who rely more on their own R&D. Small high-tech firms that engage in university-based research are likely to exhibit a higher rate of return from R&D and have an advantage in exploiting university research as compared to their larger counterparts. The advantage of small firms in exploiting academic research is evident particularly when innovative activities of small firms and university research are geographically concentrated. In Italy, small firms are found to utilise university research for innovation outputs, measured as patents and innovation counts, better than large firms (Fukugawa, 2005).

Laursen and Salter (2004), writing about why firms use resources from universities in their innovative activities, find that it is the larger firms as well as start-ups that have the highest likelihood of benefiting from university links. They point out that smaller firms with no direct link to a university have less absorptive capacity.

On a similar note, Santoro and Chakrabarti (2002) identified that there is a clear difference between the strategies used by large versus small firms (in their sample <500 employees) in R&D projects. Larger firms want to strengthen their skills and knowledge and gain access to university facilities for advancing non-core technologies. Smaller firms tend to focus on strengthening skills and knowledge and gaining access to university facilities for strengthening their core technology. Smaller firms are focused on survival and therefore participate in more relationship-building (than larger firms) with universities that provide immediate solutions to critical issues affecting central business areas and core technologies (Baraldi et al. 2016). Peças and Henriques (2006) find that these smaller companies often have specific needs when they engage with universities central to their core competences and businesses performance. They identify successful cases of UICs with SMEs in innovation processes and note that these are always short-term agreements involving little risk and with small financial resources, with an outcome that can be immediately exploited by the SME. They also point to that if a university is to foster the involvement of SMEs in a collaboration, there needs to be an interpersonal and informal rather than formal approach.

## 4. Facilitating factors for UICs

Much focus has been given to this topic and it paints a picture of what has been the interest of researchers on UICs. The literature is, however, quite inconclusive and a large variety of different facilitators can be found, on occasion even in conflict with each other. I have structured this section as bullet points to highlight each notion as separate from the other.

Combining the findings from the various articles one can conclude that if these factors are handled in a perceived “correct manner” they are facilitating and if not they become a hindrance for a successful collaboration. The factors more commonly found in the literature were (largely adapted from the article by Ankrah & AL-Tabbaa 2015):

- Availability of adequate resources (funding, human and facilities). This is fairly self-explanatory – without any resources it would be difficult to do any work.
- Incentive structures for university researchers. This has to do with how university management creates organisational structures, and could be a source of motivation for collaborations with companies.

- Inflexible university policies including intellectual property rights (IPR), patents, and licenses and contractual mechanisms. This is also rather self-explanatory: when there is no flexibility in what researchers can do, it can create conflicts between a university and a company.
- Treatment of confidential and proprietary information. This issue is similar as the point above but varies greatly depending on what business sector is investigated (Bruneel et al., 2010). There is possibly also a difference depending on the size of the company, but this is inconclusive in the literature.
- Leadership/top management's commitment and support.
- Collaboration champions are said to be of importance in general, but even more when there are potential issues that might be a hindrance (e.g. IPR, university policies). The champions can then mitigate such problems. Bstieler et al. (2015) found that activities of champions amplified the positive effects of shared governance and reduced the potential hindrance of university IP policies for trust formation between UIC partners.
- Communication. In any social relation, communication is a key aspect. Lack of it could cause problems in UICs.
- Mutual trust and commitment (and personal relationships) are said to be of great importance in all UICs.
- Organisation culture (cultural differences between academia and industry). This has been claimed to be one of the major obstacles for UICs. However, it can also have positive effects if both parties are accustomed to or understand the "other side" (Bruneel et al., 2010).
- Capacity constraints of SMEs and firm size (size of organisation). This group of companies is said to have limited resources in general and thus have more constraints to collaboration than larger companies (ibid.)
- Skills and role of both university and industry boundary spanners. These are persons that are able to move across the different communities in companies and universities, taking knowledge with them (Gertner et al., 2011).
- Nature of the technology/knowledge to be transferred (tacit or explicit; generic or specialised; academic rigor or industrial relevance), i.e. issues relating to the technology in focus, if such a thing is present. It might be a hindrance but just as much a facilitator.
- Policy/legislation/regulation to guide/support/encourage UIC.
- Enhancement in reputation/prestige. This can be important for both university and company partners (Siegel, Waldman, & Link 2003; Hong & Su, 2013; Mian, 1997).



- Use of intermediary (third party) as a way to bridge cultural differences.

The variety of factors confirmed the view of Barnes et al. (2002) that the success of a collaborative project is governed by a complex interaction of factors as well as the cumulative result of negative and positive impacts from those factors. One important issue in relation to the small companies in question in this study is that much of the identified mechanisms that should increase the likelihood of achieving the expected outcomes from UICs are based (mostly) on studies of larger companies. Those studies do not take into account the lack of labour, managerial capabilities and financial resources in SMEs (Parida et al. 2012).

## 5. In conclusion

This stream of literature is rather comprehensive in some areas, i.e. the cultural or institutional difference between university and industry, the reasons why UICs are formed, what facilitates a successful collaboration, and the different structure and forms of UICs. The UIC literature has a tendency to focus on categorising and/or finding typologies of UICs and in so doing also tries to identify the facilitating factors in the formation of these collaborations. There is also a heavy emphasis in the literature on the motivations of single actors in engaging with a UIC and the need for trust between universities and companies. Furthermore, many articles focus on resources and the value of UICs for companies and universities. What is also evident is that all of this understanding that has been built up sees a clear divide between universities and companies. In fact, one might claim this entire research area is built around this idea of a divide between universities and companies – that there are different cultures, resources and viewpoints that need to be handled. This brings a range of implications to our understanding of UICs, as the focus will tend to be towards two different entities trying to bridge their differences. It is not to say that such conclusions are wrong; such differences do certainly exist. However, there seems to be few attempts in the literature to analyse, problematise, and focus explicitly on how UIC work is done in practice.

Simply put, the interest has been on efficiency/facilitation/effects/values obtained rather than on the process whereby a connection is formed or is repetitively enacted between university and industry. The question is then why such gaps exist in the UIC literature and what can be done about them. In order to argue for a different way to address the lack of detailed descriptions and understanding of the process behind UICs, one needs to penetrate the ontological and epistemological perspectives behind most of the UIC literature. The next section will deal with this issue.

## 6. Knowledge on UIC is based on two opposing perspectives

A general observation from the literature is that many articles that look at UICs tend to have a heavy emphasis on the empirical sections and link their arguments to a more empirical discussion than a theoretical one. If we thus set our gaze a bit further away from the specific details of a UIC study and instead look at these studies from a more ontological level, it is possible to categorise the literature into two opposing ‘camps’.

In philosophy and the social sciences there have been, and still are, a number of debates about the proper way to analyse social phenomena. One of the most hotly debated issues concerns what role the individual should play in the definition and explanation of a social phenomenon. There have been (roughly speaking) two camps. These two camps are called *methodological individualism* and *methodological holism* (Dray W., 1967). Methodological holists argue that the actions of human agents can only be explained and understood in terms of the social entities with which they are associated. So, any social phenomena should be wholly or at least partly explained in terms of these social wholes (Zahle, 2015). The other camp, individualism, has the opposite opinion on what constitutes a satisfactory explanation of social phenomena: social units can and should only be explained in terms of the actions of individual humans. Social wholes are made up of human beings and are caused by their action (Heath, 2015).

Methodological individualism therefore amounts to the claim that social phenomena must be explained by showing how they result from individual actions, which in turn is explained through the intentional states that motivate individual actors. This view includes a variety of perspectives on social explanations that can be referred to as ‘agent-centred’ social explanations e.g. in analytical sociology (Hedström & Swedberg 1996). The general idea is that explanations on the social outcomes are accumulated results of the actions, choices, and mentalities of individuals (Heath, 2015). As a general inference this approach then gives way mostly to quantitative methods.

Methodological holism is largely, but not fully, the opposite of individualism. In this approach, social phenomena cannot be explained by *only* individual actions (Zahle, 2015). The argument is based on the view that explanations of social phenomena need to be complemented by social and institutional structures of some sort. Institutions and culture are socially collectively formed and holistic structures that transcend the individual and have a clear place within the social sciences in order for an explanation of social phenomena to make sense. Explanations of this sort can be referred to as holist, collectivist, social (-level), or macro (-level) explanations. Some proponents would even claim that some purely holistic explanations, (social phenomena explained only in terms of holism) can stand on their own and do not need the additional individual approach (Ibid.)

Taken purely on their own, these two have an inherent conflict as one approach is focused on explanations from an individualistic perspective and the other is focused on societal/institutional explanations. However, such demarcations rarely hold up, with very few scholars ascribing to being purely holistic. A common debate, in general terms, has instead been more about how indispensable holistic explanations are in explaining social phenomena (ibid.). Both parties agree that individualist explanations should be advanced and efforts have then been directed towards the question of whether holist explanations are indispensable or not. Whatever way methodological holists swing towards in this issue, they are still opposed by methodological individualists who insist that individualist explanations alone are sufficient, and thus, that holist explanations should be dispensed with (Heath, 2015).

Over a long period of time this has caused varying heated debates between or within different sub-fields of social science where the main questions have concerned what explanations are most suitable to explain the social. In some areas this is still an ongoing and visible debate. For example, most paradigms that originate from the discipline of economics presuppose a self-interested figure of the *homo economicus* (Persky, 1995). On the opposite side in this debate are paradigms that originate from the discipline of sociology that argue for social agents as the norm-following and role-playing actor of the *homo sociologicus*. In the former case, the social world seems first and foremost to be populated by independent individuals who confront one another with their decisions. In the latter case, the social world is first and foremost a system of normative rules and expectations, to which agents/actors as rule-following figures conform (Reckwitz 2002).

This philosophical discussion can also be reframed towards the interrelated discussion about *structure* and *agency*. However, the agency or structure discussion is focused on what *influences* human actors to act in the way they do. The question that this concerns is one of ontology: is it social structures that determine the actions of humans or is it purely human agency? As such, the same two camps explained above each subscribed to a different viewpoint: those who believe that methodological individualism is the correct way of explaining social phenomena claim that agency is the main influencer of human behaviour. Those of the opposing camp, methodological holists, would instead claim that we must always incorporate structure in explaining what influences actors. In order to highlight how knowledge has been created on UICs, the next section outlines some examples of studies of UIC from both perspectives.

## 6.1 Examples of conclusions within the perspective of methodological individualism

Most of the articles found in the UIC literature are *methodological individualistic* in nature. In line with this approach, most of these articles use quantitative methods. These papers all share some basic methodical building blocks and assumption centred on the individual in their explanation of UICs. Below are examples of which conclusions have been reached within this perspective on UICs:

- UICs are something positive and valuable, although depending on the type of research conducted in a given UIC (complementary or not, applied research or basic, natural/technical vs. humanities) they can be more or less beneficial to the parties involved (e.g. Perkmann et al., 2011; Cohen et al., 1998; Zinner et al., 2009).
- Trust is important (e.g. Santoro & Saparito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Mora-Valentin et al., 2004; Davenport et al., 1999)
- There is a barrier between university and industry and communication is essential in managing this barrier (e.g. Bruneel et al., 2010; Santoro & Saparito, 2003). Individuals can be important in the managing of UICs and overcome boundaries (e.g. Barnes et al., 2002; Bstieler et al. 2015), as well as past interactions (Schartinger et al., 2001).
- University researchers interact with industry using a wide variety of channels such as consultancy and contract research, joint research, or training. Academic research is also transferred through a variety of channels (e.g. Nilsson et al., 2009 D'Este & Patel, 2007; Fukugawa, 2005).
- Intellectual property is important to manage (e.g. Nilsson et al., 2009).

The list of findings above does not only rely on methods of a quantitative nature, because some studies have also used more qualitative methods like case studies (e.g. Barnes et al., 2002, Nilsson et al., 2009). They do however have positivistic assumption on society and can therefore be grouped under methodological individualism.

There was one theory found that corresponds with the individualistic approach: transaction costs economics (TCE). TCE builds on the basic idea that transaction (or economic exchange) is the basic unit of analysis for organisations' economic relationships and that these relationships are made in order to reduce production costs and increase efficiency (Coase, 1960). TCE derives from transaction cost theory, which refers to the cost of providing for some good or service through the market instead of having it provided from within the firm. Although some disagreement has been voiced on how this

theory is situated within an agency vs. structure discussion (Pratten, 1997), it is broadly considered to be supportive of the general mainstream approach of methodological individualism in economics. TCE assumes that two basic attributes of human nature are bounded rationality and opportunism, which in turn is in line with the classical economic perspectives that view all individuals as self-interested and therefore opportunistic. TCE has been used to explain why a business might want to engage in a collaboration with a university and comes to the conclusions that it is a way of acquiring goods and lowering its costs for technological development (Grant & Baden-Fuller, 1995; Ankrah & AL-Tabbaa, 2015).

In this individualistic perspective, UICs are explored through an underlying assumption of the rational *homo economicus*. It puts the individuals involved in the collaboration in focus, looking at how trust, communication and agreements can overcome the differences and barriers between universities and companies. In the individualistic perspective, UICs are also seen as something rational and positive that can provide both companies and researchers with resources.

## 6.2 Examples of conclusions within the perspective of methodological holism

In this perspective the unit of analysis shifts towards also incorporating structure (in the general sense). This also has implications for what these scholars conclude and corresponds to what type of theoretical lens they utilise. It is in articles assuming the holistic perspective that a more explicit theoretical focus can be found, which also incorporates structure (to varying degrees). Not many scholars have had this perspective working with UICs, but those who have it bring out other social notions than the individualistic perspective

One of those perspectives is institutional theory (DiMaggio & Powell 1983). Institutional theory has a few different variations but these share some basic characteristics. In these theories, organisations are subject to institutional pressures and influenced by normative pressure both internal (from within the organisation) and external (e.g. the state). These pressures cause the organisation to be in a constant state of tension through different ongoing legitimisation processes guided by legitimating elements, which has the effect of drawing attention away from performance tasks. Adoption of these legitimated elements, leading to isomorphism with the institutional environment, increases the probability of survival (Deephouse, 1996). Bjerregaard (2010) is one example of a UIC study which draws on the development of institutional logics (Friedland and Alford, 1991) to study the converging institutional logics of R&D work in an R&D collaboration between SMEs and a university. He finds that the lack of conflict was due to

the blurring of institutional logics governing R&D. This contradicts literature that portrays the view of a ‘cultural clash’ that impedes collaboration between universities and firms. Instead, this study demonstrated how the institutional logics in these two sectors served to facilitate a knowledge exchange. The study thereby challenges some of the stereotypical and stylised characteristics often attributed to SMEs and public university departments, assuming that deeply seated cultural differences will constitute a barrier to the transfer of technological knowledge if not properly addressed.

Another theoretical perspective applied in holistic studies of UICs is learning theory, which has been used in the context of UIC to focus on the role of knowledge in creating and maintaining competitive advantages (Larsson et al., 1998). As knowledge is seen as tacit, socially constructed and difficult to price and acquire from the market, an organisation that seeks to learn a particular skill stands a better chance of accomplishing its objective by forming a relationship with an organisation that has more knowledge in that area. Inter-organisational learning is said to be a key motive for the formation of strategic alliance (Ibid). For example, Cyert and Goodman (1997) oppose the “effectiveness model” of technology transfer they say exists in the normative literature on UICs. Instead, they point out that UI relationships are an opportunity for organisational learning in a broader sense than and without explicit purposes to increase effectiveness. Learning can impact the organisation’s strategic thinking, culture, problem-solving skills, and knowledge base. These changes may improve the organisation’s long-run viability more than any specific tool, method, or product. Learning can happen on the individual level as well. It can also be stored in some form of organisational memory, such as course descriptions that can be made accessible to others in the organisation. Thus, a focus on technology transfer limits our understanding of the real benefits of UICs. (Ibid.)

Lastly, some also point to a more general notion of structure in analysing UICs rather than grabbing hold of any specific theory. For example, Meyer-Krahmer and Schmoch (1998) find that there is a need to change the national innovation system, which includes a set of macro-structures, meso-structures (industrial/technological level) as well as on the micro processes, and to convert it into a concept supporting a “two-way bridge”. Some industries have a long-standing culture of co-operation and economic success, which can be interpreted in terms of a path-dependant evolution of a stable sector of the national system of innovation, but with the tendency of a “lock in effect”. These authors thereby acknowledge that there is some sort of over-arching structure that affects UICs.

### 6.3 Practice theory, a third option

The above discussion of how knowledge on UICs has been created from two opposing methodological perspectives (although with an heavy emphasis on

individualism) has two main implications: 1) it stresses that a particular perspective which is present in social science is missing in the UIC literature, and 2) it points out the consequence of this absence.

In contemporary social science there is a perspective that takes on the agency and structure debate differently in an attempt to find a balance between the two positions, the practice perspective. This perspective is often argued as positioned between individualism and holism as a third complementary perspective, that both perspectives offers something important and thus need not engage in a debate of which is the ideal way of explaining social phenomenon. This perspective sees structure and agency as complementary forces: structure influences human behaviour, and humans are capable of changing the social structures they inhabit. Bourdieu's (1977) theory of practice and Giddens's (1984) theory of structuration can be said to be two of the most influential approaches in this line of thought and a flourishing, fragmented and ever-evolving stream of social and philosophical research has followed from their work. Eventually, Theodore Schatzki outlined in *Social Practices. A Wittgensteinian Approach to Human Activity and the Social* (1996) a social philosophy explicitly focused on the practice concept. This way of explaining social phenomena is different from the methodological views and theories found in reviewing the UIC-literature, as eloquently expressed by Rouse (2007:505):

Practice theories typically resolve these disputes [between individualistic and holistic viewpoints] by acknowledging that both sides grasp something important. At one level, practices are composed of individual performances. These performances nevertheless take place, and are only intelligible, against the more or less stable background of other performances. 'Practices' thus constitute the background that replaces what earlier wholist theorists would have described as 'culture' or 'social structure'. The relevant social structures and cultural backgrounds are understood dynamically, however, through their continuing reproduction in practice and their transmission to and uptake by new practitioners. While there is nothing more to the practice than its ongoing performative reproduction, these performances cannot be properly characterized or understood apart from their belonging to or participation within a practice sustained over time by the interaction of multiple practitioners and/or performances.

By adding a practice perspective it would be possible to offer an explanation on UICs distinctly different from those referenced above. So much of knowledge on UICs is skewed towards methodological individualism, thus giving way to an understanding of these social phenomena through a rational and positivistic lens focussed on the efficiency/facilitation/effects/values, but missing the process of UICs. Practice theory is a tool that can tackle this shortcoming by penetrating into the detailed process whereby a connection is formed or is repetitively enacted between university and industry.

A practice approach reorients the unit of analysis towards the practices, not individuals and not the structure; it is a different way of explaining the social. In this way of analysing the social world, we can look at the things that happen in ‘everyday life’, the mundane activities that constitute the social itself. Rather than talking about abstract cultural values or about individuals driven by certain motives, we discard these two and focus on the practices in an attempt to explain the social.

The philosophical and social scientific significance of human activity; the nature of subjectivity, embodiment, rationality, meaning, and normativity; the character of language, science, and power; and the organization, reproduction, and transformation of social life. In making these contributions, practice approaches thereby oppose numerous current and recent paths of thinking, including intellectualism, representationalism, individualisms (e.g., rational choice theory, methodological individualism, network analysis), structuralism, structure-functionalism, systems theory, semiotics, and many strains of humanism and post structuralism (Schatzki et al., 2001:10)

With a theoretical framework on practice I will be able to address some of the limitations found within the UIC literature, because practice theory requires a detailed description of action and activities in order to sketch out practices and thus the focal point will fall on *how* UICs are carried out. Furthermore, as the unit of analysis is on practices and how they are carried out, there will also be a focus on *organising* as opposed to *organisations* in this thesis. This can then shift the focus away from stressing the separation between university and industry to focusing instead on how apparently separate entities are connected via practices.

To be more specific, I aim to use the ‘new wave’ of *practice theory* to complement UIC literature and by so doing also problematise the current understanding of UICs. Practice theories conceive practices as routine bodily activities made possible by the active contribution of an array of material resources. Practices with no things and no bodies involved are thus simply inconceivable. Adopting a practice approach also transforms our view of knowledge, meaning, and discourse. From a practice perspective, knowledge is conceived largely as a form of mastery that is expressed in the capacity to carry out a social and material activity. Knowledge is always a way of knowing shared with others, a set of practical methods acquired through learning, inscribed in objects, embodied and only partially articulated in discourse. Becoming part of an existing practice thus involves learning how to act, how to speak (and what to say), but also how to feel, what to expect, and what things mean (Nicolini, 2012).

In the next chapter, I will more thoroughly explain a *theory of practice* and its benefits, and sketch out the analytical tools that will be used in examining SMURF and the embedded cases of UICs within this thesis.



# Chapter III: Practices and practice theory to understand university-industry collaborations

This chapter concerns the theoretical and conceptual base for arguments and analysis made within the thesis. I will build a theoretical framework that focuses on practice theory. I do this because I seek to get at the nitty-gritty aspects of the empirical material, to explore the social ‘micro’ processes of University-Industry Collaborations (UICs) in a way that arguably has not been done before.

There are two reasons for exploring a theory of practice. The first one was pointed out in the end of the last chapter and concerns the debates on agency and structure and how knowledge on UICs has been built up from two separate perspectives on the social (skewed towards individualism). Secondly, and connected to this, are the benefits of using practice theory on UIC when compared to what has previously been done on the subject. I will shortly explain in more detail what practice theory contributes to such debates and with that also outline the theoretical tools and conclusions that allow for a practice theory analysis of UIC.

It should be made clear that practice theory has no single theoretical coherence; instead there a number of prominent scholars that have adapted a “practice approach” (Rouse, 2007; Reckwitz, 2002). This is important to mention because the reader should understand that forming a theoretical framework with the ideas from “practice theorists” will then implicitly always involve a value-laden subjective choice in what counts as theory and which thoughts are the most appropriate to utilise. However, all the different thoughts on practice theories I will mention share some basic characteristics that allow for them to be grouped together under a “practice umbrella” (Nicolini, 2012). Moving into this section I do, however, make a choice to use one of many available approaches, and the reasons for this will also be explained. What should also be mentioned at this point is what this ‘new wave’ of practice theory brings to the table as opposed to most other theories in social science, and that is to view practices as the fundamental unit of analysis and, by doing so, avoid falling into a debate on agency or structure.

The most distinct feature of the second coming of practice theory, most clearly articulated by Theodore Schatzki (1996, 2002), is its injunction to view practices as the fundamental unit of analysis. Preferred to individual action – which has dominated economics, psychology and most of micro-sociology in

neo-liberal times – practices are proposed as the central scientific object of study and as a means to avoid a collapse into methodological or ontological individualism (Warde 2005:18).

Change is commonly based on a prior understanding of agency and structure. The prevailing idea in contemporary policymaking and certain areas of social science, as well as in everyday discourse, is that new social arrangements result from millions of individual decisions about how to best act. This way of looking at change is just common sense for many people. Action is explained by the pursuit of individual interests. Behaviour is driven by beliefs and values, and lifestyles and tastes are expressions of personal choice.

Instead, using the ideas from practice theory, change becomes not an outcome of external force like technological innovation or social structure that “comes down” and influences daily life, but instead it is the social structures and human activity together that recursively shape the social world (Shove et al., 2012).

The basic domain of study of the social sciences, according to the theory of structuration, is neither the experience of the individual actor, nor the existence of any form of social totality, but social practices ordered across space and time (Giddens 1984:2)

A basic foundation is that practices are always changing; they are in constant flux and the study of them gives a way of understanding social change as it unfolds. A theoretical model of a practice gives the opportunity to study the recursive relation between practice-as-performance and practice-as-entity. Meaning that by focusing on the practices when they are performed one can follow how practice-as-entity evolves and changes over time (Shove et al., 2012). As put forth by Nicolini (2012), it just makes sense to study social life in postmodern contemporary society in this way as opposed to more functionalistic traditions:

The attraction for the practice idiom stems in particular from its capacity to resonate with the contemporary experience that our world is increasingly in flux and interconnected, a world where social entities appear as the result of ongoing work and complex machinations, and in which boundaries around social entities are increasingly difficult to draw. When we enter an office, superstore, or a hospital it is increasingly difficult to think of it as outcomes of the application of a detailed blueprint and plan, or a single system with definite boundaries as in the traditional structure-mechanistic and functional-systemic views of an organisation. Things seems to fall into place much better if we think of the fluid scene that unfolds in front of us [...] that connotes organisations as bundles of practices, and management as a particular form of activity aimed at ensuring that these social and material activities work more or less in the same direction (Nicolini 2012:2).

Before moving deeper into a theoretical framework on practice, the first thing that needs to be dealt with is: What are we talking about when we theorise about it? But the question is perhaps rather: What do we mean when we talk about a practice as a theoretical construct? Most people would probably agree that almost every activity they engage in on a day-to-day basis is a practice, e.g. cooking, playing football, driving a car or some of the things they do in their workplace. Certainly those are practices, perhaps just because of the very notion that we think about them as such. But even though life can be said to largely be about doings or thinking about doings, it is unlikely that one reflects upon whether what they are engaging in is a practice or not. There is simply no need to; we work, we do stuff and life continues.

However, what if we are seeking to understand what a practice consists of? Let's take an example, driving a car. Anyone who has a driver's license and often uses a car rarely reflects on the actual doings of how he or she is driving. The practice of driving has turned into a routine that does not require one to think about which pedals to push and where each gear is on the gear stick. But if one is interested in what people do when they are driving a car and how such a practice has emerged and changed over time, it might help to distinguish what driving consist of. In its typical form, the practice of driving is a complex system of the human body and the car together with the infrastructure of roads and signs. It requires a bodily competence to press pedals, shift gears and turn the steering wheel as well as an understanding of what happens when such activities are performed. There are also rules and norms for how to act in relation to other drivers, pedestrians, etc. that one needs to understand in order to practice driving in relation to others. Driving is thus a set of identifiable connected elements that we can talk about and draw upon as resources in performing the practice. We can relate to driving as a practice because it is *"a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge"* (Reckwitz, 2002:249). It is just as important to realize that without the successful connection of these elements there is no practice; I can have the "material" (e.g. the car, my body) and "meaning" (e.g. I know why I want to use the car), but if I am lacking "competence" to use the car, there is no practice. Without all the combined elements connected through performance, there is no driving.

## 1. The elements of a practice

With this introduction of what a practice is, we can move forward and explore the idea of *practice theory* and the more complex aspects of practices. First of all, we need to establish what practices consist of. In the example

above, there seems to be some things/notions that are needed for the practice of driving to be performed. However, the definition of what a practice is might differ depending on whom you turn to. For Schatzki (1996:89), a practice is a temporally and spatially dispersed nexus of doings and saying that consists of three notions:

To say that doings and sayings forming a practice constitutes a nexus it to say that they are linked in certain ways. Three major avenues of linkage are involved: (1) through understanding, for example, of what to say and do; (2) through explicit rules, principles precepts and instructions; and (3) through what I will call 'teleoeffective' structures embracing ends, projects, tasks, purposes, beliefs, emotions and moods

When Schatzki (1996) outlines what a practice is by claiming that it is a nexus of *sayings and doings* he gives no priority to any of them. That implies that there is a very intimate connection between language and practice. According to most theorists, language can never fully capture the understanding of a practice but is nevertheless inseparable from the practice. Practice is thus always linguistically under-determined, yet language actively enters practice and is part of it (Nicolini, 2012). For Reckwitz (2002:249) practises are "*a routinized type of behaviour*" that exist as "blocks" or "patterns" which can be filled in with often individual or unique actions. It is through the immediate doings of a practice that the block or pattern is filled out and reproduced. "*It is only through the successive moments of performance that the interdependences between elements which constitute the practice as entity are sustained over time*" (Shove et al., 2012:7).

Through merging the definition of practices given by Reckwitz (2002) with Schatzki's (1996, 2001) outline of what a practice is, Shove et al. (2012) come to the conclusion, just like Schatzki, that every practice has three elements:

- Materials – such as things, technologies, tools and even infrastructure or the body itself.
- Competences – Skill, know-how or techniques. Similar to what Schatzki calls "understanding", but here this element envelops more and encapsulates multiple forms of understanding and practical knowledgeability.
- Meaning – Symbolic meaning, ideas and aspiration.

Their arguments on practices are close to Schatzki's but with some important differences. For one thing, they have a more pragmatic view on practices incorporating much more of a framework. Shove et al (2012) also provide means to apply their framework, something Schatzki only vaguely hints at as his approach is towards the philosophical account of practice theory and does not easily seem to be transferred into empirical analysis.

It is essential that each of the elements is described as they form the core of how one can understand and analyse the social world through practice theory and will be applied in this thesis to analyse UICs.

## 1.1 Materials

Incorporating material objects as a practice element essentially means that practices are inherently heterogeneous and socio-material in nature. Looking at the world through practices means that it is impossible to disregard the importance of artefacts and performativity of human and non-human actors. The nature and identity of objects cannot be apprehended independently of the practices in which they are involved in the same way as we cannot make sense of our practices without taking in the material (Nicolini 2012).

It has been claimed that materiality in social science has been kept in the background of other notations of the social. “Language matter. Discourse matter. Culture matter. But there is an important sense in which the only thing that does not matter anymore is matter” (Barad 2003:1). A characteristic of the post-modern society is that everyday life is increasingly bound up with the materials around us. Materiality and its link with the social is a central notion within much of the practice approach. Materials and things in everyday life play an intricate role and are in large part the stuff that makes up society: they are not a reflection of society. Agencies and competencies are distributed between things and people and social relationships are connected through the stuff in everyday life (Shove et al. 2012). This is because humans cannot be reflective 100% all the time in what we do. We need to offload the cognitive skills to our environment, to our bodies. We externalise to our bodies as well as artefacts to help us. Like using a computer, this amplifies our cognitive structures.

Man is bound to the material in such a way that the material can take the same position as the human and humans can form emotional ties to objects in such a way that the objects have their own influence on organisations and how we organise (Cetina, 1997; Cetina, 2009). Andrew Pickering (1995) argues that practices are made up of both human and non-human actors. In Pickering’s own words (Pickering & Guzik 2008:1):

... offered an ontological vision of the world and our place in it, a vision in which both the human and the nonhuman are recognised as open-endedly becoming – taking on emergent forms in an intrinsically temporal dance of agency.

However, non-human and human elements are different as the former lack intentional agency, something that the latter has. Artefacts like the computer become inscribed with our agency, but do not have the same type of agency. Agency is then situated between the material and human intentionality; it is

the result of a dialectic process between the two. Through enactment of real-time practices, human and material emerge together (Nicolini 2012). With that said, as the material impacts the world through the agency inscribed, it sometimes does so with unintended consequence. Artefacts do not always act the way we intended them to; they exert their own agency on the world and that might be separate from the direction of the desires of humans.

Star and Ruhleder (1996) made the case for material infrastructure being a web of objects that emerges when people perform practices. Think, for example, of such a small thing as being able to communicate through email or phone calls. This infrastructure is not in itself a motivation for collaboration, but collaboration would be much more difficult without it. Material infrastructures purely on their own might seem insignificant, but together with the rest of the ecology of objects that support work, their importance becomes clear (Nicolini et al. 2012).

All types of objects can potentially become infrastructure. As such, they are ‘black boxed’ or invisible at one moment, but can become the very topic of an activity at a different time. For example, the computer system used to support the circulation of email in our case, until a decade ago was the focus of the attention of scores of researchers, practitioners, and organisations (Nicolini et al. 2012:31).

This means that the social is always and everywhere material. Not only the direct things in everyday (like using my keyboard to write this text), but also the material around me that enables me to perform this work is paramount (Orlikowski 2007). The material infrastructure around us might seem stable but Star and Ruhleder (1996) argue that this is only because the infrastructure is embedded and sunk into other structures. Nicolini et al. (2012) suggest the connection to this being like a “Russian doll”, a number of layers that unfold when you start opening it. Above I used my computer as an example of a material infrastructure, but that assumes that there is a functional electrical grid. Such stable infrastructure is not something one directly connects to the activity of writing on a computer.

## 1.2 Competence

The second element of a practice has to do with how one becomes a competent practitioner. If one is to perform something it often requires competence to do so, and in a routinised type of behaviour or practice (Reckwitz, 2002), it is fundamental. Similarly, as Schatzki’s talks of rules in his way of understanding a practice, competence is about know-how, background knowledge and knowing. Competence is also about a shared understanding of what is a good or appropriate way to act (Shove et al. 2012). Competence does not exclusively reside within the carrier of a practice. The spaces that practices

require and occupy is often intertwined and tangled up together in a complicated web. Objects and material infrastructures determine boundaries of a practice as some aspects of our competence are delegated to technology while other stay with us. For example, in writing this text the computer does the work of forming the letters, but I decide what letters to form and what words the computer should write.

Knowledge and competence are closely connected; knowledge on how one is to perform, act and/or use a skill is how one becomes a competent practitioner. Within a practice theory perspective, knowledge is not seen as being present in the heads of people. Nor is it within the organisation management, but rather it is situated within the practice itself.

The basic idea is that knowledge is not something present in the heads of people; nor is it a strategic productive factor located in the organization's management. Rather, it is a 'knowledge-in-practice' constructed by practising in a context of interaction. [...] The practice constitutes the 'topos' that ties the 'knowing' to the 'doing'. Participation in a practice is on the one hand a way to acquire knowledge in action and, on the other, a way to change/perpetuate such knowledge and to produce and reproduce society (Corradi et al., 2010:271).

Because practices are understood as being shared between individuals performing them, they transform the conception of knowledge. It is a prioritisation of practices over mind and as such, knowledge is no longer automatically a self-transparent possession of the mind or even the property of individuals, but instead a feature of groups, together with their material setup. Knowledge is mediated both by interactions between people and by arrangements in the social world (Barnes, 2001). It is this way knowledge is within the doings, in the actions that are performed.

Knowledge transfer becomes in this way rather different from the conventional view of merely sending and receiving information. Knowledge has to be "abstracted" (packed) and taken from one place and then "reversed" (unpacked) when it arrives in some other destination. This has to do with practices being integrative performances in which elements are conjoined. The limit of an effective circulation of elements and knowledge is the capacity to "reverse". Codified knowledge and/or know-how cannot be utilised with the same intent, or not at all, if the practitioners are not already prepared and have the ability to "reverse" it. (Shove et al., 2012)

### 1.3 Meaning

A practice is not only about the activity itself, the bodily performance, it is also a set of mental activities.

This necessarily imply certain routinized ways of understanding the world, of desiring something, of knowing how to do something. For practice theory, this is not a contradiction: A practice such as, say, playing football consists of a routinized set of bodily performances. Yet, within the practice these bodily performances are necessarily connected with certain know-how, particular ways of interpretation (of the other players' behaviour, for example), certain aims (most of all, of course, to win the game) and emotional levels (a particular tension) which the agents, as carriers of the practice, make use of, and which are routinized as well. Without these mental and bodily activities, we could not imagine a practice of 'playing football' (Reckwitz, 2002: 251-252).

By merging Reckwitz's description of mental activities, emotion and motivational knowledge and Schatzki's teleoaffective structures we can arrive at the third element of a practice, *meaning*. It represents "*the social and symbolic significance of participation at any given moment*" (Shove et al., 2012:23). Meaning has three dimensions: 1) emotional engagement – we have to be concerned about something, we have to be interested or perhaps even irritated in what we do; 2) moral conduct – how to behave i.e. how we usually do, what ought to be done and what is right to do in a certain situation. These two could be said to be the driver, that is, why we want to engage in a practice; and 3) the rules of a practice, i.e. what is an acceptable way to act in a given practice, the situated normativity. Situated normativity, not the social norm, is the normativity that is created in every practice, because in every practice there is an interpretation of the social in its own way. Performing a research practice also includes adapting to a set standard of rules of how to behave within that practice, i.e. falsifying results or plagiarising is not an acceptable behaviour.

Schatzki (1996) instead calls this part of a practice "teleoaffective" structures. A teleoaffective structure is the linking of ends, means, and moods applicable to particular practices (or a set of practices) which makes sense to do beyond what is specified by a particular understanding, rule or competence (as described above).

## 1.4 Elements linked

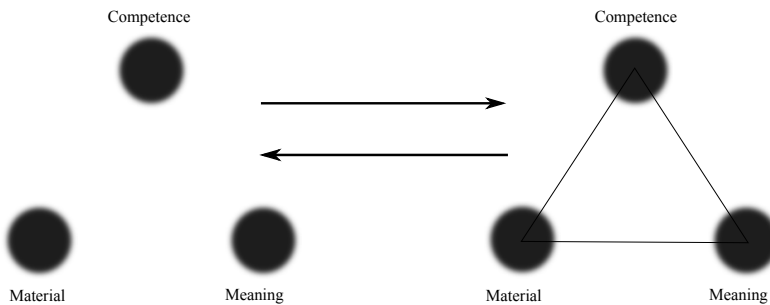
It is these three elements that, when linked, form a practice. Arrangements that work, do so because these elements are linked<sup>1</sup> together, and transformed, through the active process of doing (Shove et al., 2012). Elements are said to exist as entities "out there" that can be spoken about and used as resources when a practice is performed. These elements thus have the potential to become linked at any given time and the links are broken and made depending upon the availability of the elements in a constant ongoing pro-

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<sup>1</sup> "Linked", "interlinked" or "connected" are use here are merely descriptive terms. They are a way of talking about how practice elements must come together in order to form a practice. The links are only a fictive notion.



cess. On the left part of Figure 1, the elements are not connected and as such there is only the potential to perform a practice; it is when the three are inter-linked that we might talk of a practice.



*Figure 2.* Elements disconnected and then linked. The picture should be seen as constant ongoing process rather than a fixed state (adopted from Shove et al., 2012:25).

This triad that forms a practice puts an equal emphasis on each of the three elements. This means that in the description of a practice, or the change or formation of a one, none of them is more important than the other. If I were to explain how innovations come about (arguably a social process) and any associated practices, the technological/material aspect would not be given precedence over the other two elements.

Practices are common observable entities. If one is able to find connected practice elements that have all the necessary components, then there is a practice that we can talk about and reflect on. This is not to say that within this version of a theory of practice *everything* humans do can be analytically understood as practices. Agents carry practice as practitioners and while they carry out those practices they can also engage in activities that are not ‘*a routinized type of behaviour*’ or lack some of the defining properties of the just mentioned practice elements. The decision that Shove et al.’s (2012) version with their three elements is the most practical framework to use in exploring the research questions in this thesis also brings with it some demarcations, that is, not every social mundane activity is a practice. In the framework presented in this text, practices are seen as semi-stable organisational corpuses of activities, e.g. Nordic walking (Shove, 2005) or scientific experiment (Pickering, 1995) or science as a whole field (Pickering, 1992). Other practice theorists would say that sitting down correctly at a table, making a phone call or trading on the stock market are also practices (Nicolini, 2012). I instead claim that such notations are examples of *activities* that are part of or cut across a number of practices. Activities are of a more simple nature and can be part of a number of practices. For example, a research practice within a laboratory could contain the activities of sitting on a chair, using a pipet in a correct manner, putting on a lab coat, arranging flask and

so on. Together, all these activities come together and form a particular practice. In some way this is also a question of what aim a study might have. In some circumstances, it might make sense to have a more narrow definition while in others less so (Hui et al., 2016).

Elements are not only interdependent, they also mutually shape and transform one another (I will explain this more further down). When an element of a practice changes it can also bring about alterations in how to use one's body or a material component, perhaps even in the way we understand that element. Within such a discussion it is imperative to point out that although a linking of elements is said to be '*a routinised type of behaviour*' (Reckwitz, 2002) that exists as "blocks" or "patterns" they can be filled in with often *individual or unique* actions. So even though there is a part of routinised behaviour to all practices, this repetition has been shown to be a unique set of activities that can never be enacted in exactly the same way, making even the "routine" a site of ongoing reproduction and change (Hui et al., 2016).

Practices are an ongoing process of integrating elements, but some elements may no longer take part in this circulation and integration; they may have been replaced or taken out of the equation. There are plenty of examples of materials that used to be part of a practice but have ceased being relevant. Instead, they have been replaced or altogether taken out of circulation. The landline, or home phone, has almost become obsolete during the last decade. Instead, we have mobile phones that we use both inside and outside of the house. Over time, we have reconfigured the material element and replaced it with another similar one that has become the norm of how we phone each other. It has also changed our relationship to the phone and how we contact friends or family. Looking at another practice, the historical version of driving had a different material configuration than today and there used to be a number of materials that were needed to use the car: goggles, coats, gloves, etc. Similarly, elements of competence can also be taken out of the circulation of elements; they can lay dormant or preserved in the minds of people or in written form as manuals or instructions. If some competence is no longer needed it might reappear, but it may also become lost and with that an element that is needed to perform a certain practice. Elements of meaning may also come and go as rules and norms might change and practices that are associated with a particular way of thinking about the world or a particular way of acting fade away over time. This could lead to the practice completely ceasing, as there isn't any meaning in performing it anymore (Shove et al., 2012).

## 2. The individual in practice theory

When practice elements are linked, practices are continuous accomplishments performed in a routinised manner by practitioners/carriers of a given practice. As already mentioned, practice theory conceives of the role of the individual differently than many other theories based in other perspectives. This does not, however, mean that those who carry practices are unimportant, that human agency doesn't have its place. A common assumption present in the UIC literature is that individuals are self-determined and coherently bounded in their actions and thinking, i.e. methodological individualism is prevalent. Practice theory rejects such a perspective. Decisions are instead based on habits and "habitualised" routinised action and this is because of the effect of the practices we engage in. As individuals we have values but those values are largely governed by our practices. In this way of explaining the social, we are not really individuals in the sense that we are completely self-determining. Practice theory offers a milder form of agency (in unique the way which every single individual chooses to perform a practice and which practices she chooses) and a way of thinking about how structure is formed through these practices we perform; we act in a "habitualised" manner and with that re-establish structure just as much as our agency changes it.

In all the examples given to highlight certain aspects of practice theory, a pervasive simplification has been made. There is an implicit standardisation of a practice, that driving or playing football are done in the same way for everyone. This is, of course, never the case. There are always a number of ways to perform a given practice; my way of playing football is different from my fellow teammate and so on. Similarly, practices are always shared and the individual is the carrier of the practice(s). By definition, this means that when one engages in a practice, for instance playing football, the purpose – the skill of playing the game – is not contained within the bodies of the players. Rather, these are features of the football game of which the player is merely a carrier. Still, this is not to say that individual agency does not have its place in practices; each player on the football field masters the practices of playing football differently: one is a good header, others run fast or shoot hard. Each player brings with them their individual traits to a game and collectively they engage and in effect create that game of football together.

As agents are carriers of practices they are neither autonomous nor blindly conform to social norms. They understand the world and themselves, and use know-how and motivational knowledge in accordance with a particular practice. Therefore 'the individual' must take a special place within practice theory:

There is a very precise place for the ‘individual’ – as distinguished from the agent – in practice theory: As there are diverse social practices, and as every agent carries out a multitude of different social practices, the individual is the unique crossing point of practices, of bodily-mental routines (Reckwitz 2002:256).

It is important to highlight this quote on the role of the individual because moving on I will focus on specific individuals and their practices. This has to do with the empirical cases in the thesis as well as an interest in understanding how practices connect, which often seems to happen with or through individual human agents.

### 3. Connections between practices

This is an essential part in the theoretical framework. In order to understand collaboration between practices we must also understand what might connect them. In some instances, several practices may come to share elements and when elements change in one practice this can lead to changes in another practice. In general many practices are intertwined, touching one another like great big nets of actions and activities, with practice elements connecting and disconnecting, linking and breaking. There are a few ways in which this can come about. Let us first of all look at how individual practice elements can be shared or become connected. Driving is once again a good example because cars were initially associated with speed and unpredictability, and marketed as thrilling and adventurous, which caused them to become intertwined with the already present culture of masculinity (within the element of meaning). Similarly, the technical competences that many men already had from engaging in previous practices meant that a connection was made between driving, masculinity and repairing. This generated a situation in which masculinity became associated with both repairing and driving, providing an element of meaning to both practices (*ibid.*), as can be seen in Figure 2.

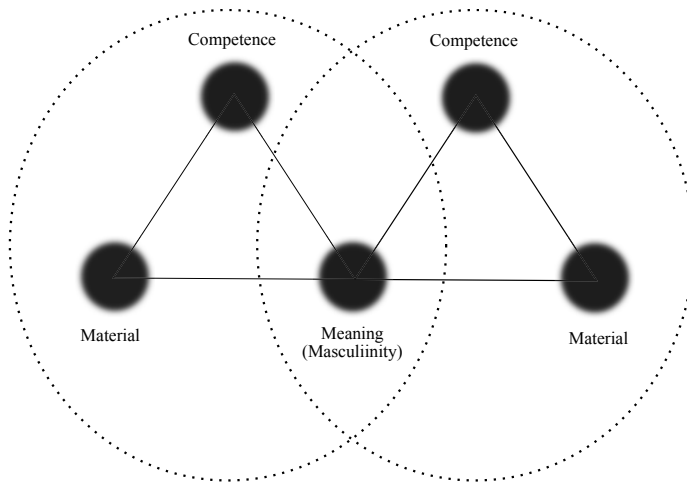


Figure 3. The element of meaning is shared between driving and repairing (adapted from Shove et al., 2012:37)

In this example, the element of meaning is in the centre, connecting the two practices, but one can think of other situations where competence or material elements are in a comparable situation. We can do repair work on a car just as much as we can be driving it. Our body, in as much as it can be the material element, is used in a vast number of interrelated practices.

Secondly, individual practices can also become so closely connected through mutual influences, linkage or distribution (of elements) that any distinction between them ceases to be and we begin to understand ‘them’ as ‘one’. It is common for someone who is trying to instruct another person in performing a complex practice to break it down into several different components, treating each of them as an individual practice. Driving can be said to be a number of different bodily motions that together comprises the ‘practice of driving’ which can, for a short time, be broken down into smaller components, each performed on its own and then put together and executed as one. In precisely the same way, anyone who attempts to perform a research practice to conduct an experiment within a laboratory<sup>2</sup> will find that this practice has many pieces that can be broken down and understood as individual practices. For instance, in a “wet laboratory”<sup>3</sup> pipetting, diluting solutions, handling of machinery, writing and so on are essential for a research practice. It follows then that driving and laboratory practices, like many other practices, are in fact “black-boxed” to the extent that driving and performing an experiment involve many different practices but can be *seen* as one single practice (Shove et al., 2012).

<sup>2</sup> This is very much a simplification of what transpires within a laboratory, but it is useful as an illustration in this instance.

<sup>3</sup> Laboratories where chemicals, drugs or biological matter are handled in liquid solutions or volatile phases.

Thirdly, not all inter-practice connections result in the emergence of a new hybrid practice that can be seen as black-boxed. The everyday life world is made up an astonishing array of connected practices that are still seen as separate from one another. A person's lifestyle can involve a number of practices, everything from social interactions to laboratory work, programming, mechanical labour or cooking. They can, and are, connected but are still very much separate. Practices can, however, influence one another, shape and be connected. It must be said that relations between practices require ongoing reproduction; like practices themselves they have to be enacted continuously to persist in time (Ibid.).

### 3.1 Boundary objects

There are also other ways in which practices can connect. One of those is the boundary object(s) that can exist between practices. This is a notation that was first brought out as a theoretical concept by Star and Griesemer (1989). Boundary objects have been used to explain connections between different social worlds and can be anything from repositories to standardised forms, sketches, drawings, workflow matrices, physical objects, IT objects or even metaphors (see e.g. Nicolini et al., 2012, Fujimura, 1992; Carlile, 2002; Akkerman & Bakker, 2011). Objects become boundary objects when they act as translation at disciplinary or professional boundaries between communities of work (Nicolini et al., 2012).

[Boundary objects] inhabit several intersecting social worlds [...] Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use [...] They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation (Star & Griesemer, 1989:393).

Boundary objects are flexible, and useful, because they can mean different things depending on community, profession, organisational unit, department, etc. but they also have a structure that can be understood and recognised by all these groups and thus serve as translation. Some artefacts have a way of mediating coordination between social groups or individual actors, allowing diverse practices to cooperate efficiently in distributed work, even in the absence of consensus (Star, 2010). Through the activities of individuals, boundary objects are ascribed some particular functions: they provide a shared language, provide concrete means to learn about the differences and meaning across the boundary or they may also provide a form or reification (individuals making something concrete or real) that allows for the different practices to construct a shared meaning (Nicolini et al., 2012).

Boundary objects have been described as a way of coordinating a communicative connection between diverse practices or perspectives which can be established by boundary objects that are shared by multiple parties (Christiansen & Rump, 2008). Paterson (2007) describes how an information structure can allow exchange of relevant patient information across different communities of practice in health care. Thus, this notion provides a way to conceptualise how objects can mediate the connections between different practices.

Nicolini et al. (2012) suggest an analytical framework of three levels of objects for organisational collaborations. At the first level are the tertiary objects/artefacts, which mostly concerns the material infrastructure e.g., buildings, room, documents or information and communication systems. Then, there are the secondary level objects/artefacts supporting collaborations. They can be either material or symbolic and although essential do not trigger work or provide motivation that sustains collaboration. The secondary level objects often explain the “how”. For them, most boundary object falls in this second category. The last category, the primary objects, explain what motivates and fuels collaboration. The primary objects explain both the “how” and the “why” for collaboration.

### 3.2 Brokers

The connection between practices does not only take place through reification; there are also many instances in which a connection is enacted through individuals, so-called brokers. This comes back to the discussion above on the role of the individual and how actors shape and perform practices. Brokers are either individuals moving back and forth between different social worlds as knowledge users and knowledge producers or they act as individuals participating in many groups and enabling the transfer of information between them (Haas, 2015). Brown and Duguid (1998) emphasised the importance of brokers for innovation and knowledge transfer as they move across multiple groups.

Individuals belonging to overlapping groups who allow knowledge sharing between communities [...] actors who use their in-between vantage position to support innovation through connecting, recombining and transferring to new contexts otherwise disconnected pools of ideas (Burgess & Currie, 2013:1).

Brokers can also be seen as not only moving knowledge, but also producing new types of knowledge, something termed by Meyer (2010) as “brokered knowledge”. Individuals who act as brokers translate knowledge and can transmit experience and knowledge about other organisational practices or introduce elements of one practice into another (Cohen & Levinthal, 1990).

Any individual has the potential to be a broker, but some tend to play the role more than others, either within a given profession and/or through individual traits. It is often a complex role involving translation, coordination and alignment of different perspectives. It requires a certain degree of legitimacy to be able to address conflicts of interest and mobilise actors. It also requires the ability to link practice elements and facilitate transaction between them. Brokering individuals provide a participative connection through their multi-membership and possibilities for negotiation inherent in their participation (Wenger, 1999). The broker role has also been described as being an entire organisation and not associated with only one individual. A technology transfer office would be an example of such a brokering-organisation (Hargadon, 1998; Chataway et al., 2007).

In this academic conversation it is common to also discuss the concept of “boundary spanner” in relation to individuals who are able to move between different social worlds (Haas 2015). Sometimes broker and boundary spanner are used interchangeably making it hard to distinguish between them (see e.g. Cohen & Levinthal 1990; Nochur & Allen 1992; Ramirez & Dickenson 2011). The point of bringing in “broker” as a theoretical concept is to add a sophisticated way of discussing the individual as the connection point between practices (or contexts). It is not to engage in the argumentation on the merits of distinguishing between boundary spanner and broker. I will thus not use boundary spanner.

## 4. Collaborating and competing practices

Many practices are routinely carried out in the same place and many spatial arrangements create and support such patterns of association. Some practices are dependent on the successful result of another in this way (Shove et al., 2012). For example, if we are to operate a high-powered electron microscopy, performing a type of laboratory practice, there needs to be material infrastructure that provides enough electricity to operate the microscopy. The machine operator needs the electrician to perform his or her practice so the electron microscopy can function properly. It is easy to think of an almost infinite number of practices that require electricity, and thus the associated practice with its connection to material infrastructure has the power to allow for a multitude of practices to be carried out (Ibid.). Similarly, in some literature on innovation systems and science parks the idea of proximity has received some interest. The idea is built around the notion that geographical closeness will lead to the successful interaction of otherwise unrelated practices. The spatial dimension of how practices can come together is not the only way in which connections between different practices can come about. The temporal relationship can be just as important for the successful performance of many practices. It simply means that as one practice unfolds an-



other can continue, that the activities performed are dependent on the temporal unfolding of another practice (often that means coordination and in a specific sequence) (Ibid.).

It is within this discussion that one might start to talk about how practices compete and/or collaborate. Certain practices (e.g. conducting complex laboratory experiments, surgical operation or steelmaking) suppose and require the reproduction of others. For example, shipping captains depend on harbours and docks and a global network of people capable of faithfully reproducing a docking practise when called upon to do so. In some cases a sequence of practices are important, and when one practice produces elements (meaning, competence or materials) on which another depends, pre- and co-requisite practices “collaborate” in the reproduction of more extensive complexes in which they all have a part to play (Ibid.).

Practices can also be seen as competing with each other for carriers/practitioners or practice elements. E-sport vs. physical sport provides such an example (at least within the public debate on the topic) in how they compete over carriers for their respective practices. Historically, sports like football or hockey have rallied a large young supporter group. But after the emergence of the Internet and competitive gaming, many younger people are being recruited to e-sport rather than to more traditional sports. These are practices that only superficially share any elements (like the element of meaning “competition/competing”) and thus can be thought of as rivals for carriers. But practices can just as much come together through what they have in common without competition. The Sony Walkman was a material innovation that was able to link the previously unrelated practices of running and listening to music (du Gay et al., 2013). Similarly, laptops and smart phones have demonstrated an even larger potential for coordination and bridge practices between socialising (Skype, email, Facebook), household management (online banking) and learning and working (Shove et al., 2012).

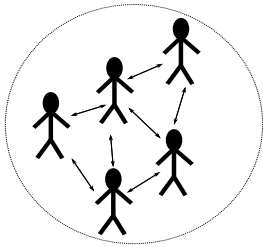
A practice does also not, automatically, require some form of direct interaction between people at the same time and place. Some practices are, at first glance, solo efforts that only involve one person while some other practices are a collaborative effort that is dependent on a group of people performing something together at the same time. However, practices can be spread out over vast distances but still be shared among a number of participants, as is neatly explained by the quote below:

Shared practices are collectively executed, like riding in formation, a legion: they include fighting together, hunting together, sailing together, singing together, even, in the present-day world, doing science together. No wholly individualistic account will succeed in accounting for these examples. Individual habits will diverge over time, however rigorously they are initially inculcated, and cannot in any case account for the constant coordination of actions that is evident in examples of the routine practice of an interacting collective. [...] Thus although acupuncture is individually administered it is adminis-

tered as acupuncture by a member who, in realizing that shared practice, has to be sensitive to what other practitioners are doing. The acupuncturist must interact with fellow practitioners, and be both cognizant of and disposed to move in the direction of their practice in order to be a practitioner herself. It is only through the interaction of a membership characterized by mutual intelligibility and mutual susceptibility that something identifiable as shared practice can be sustained, and its correct enactment distinguished from what is defective or incompetent. Acupuncturists we might say merely operate in a more spread-out mode than cavalry (Barnes in Schatzki et al., 2001:25).

What the above quote does not touch upon is that these shared practices are achievements readily performed, and every member in turn routinely expects it of members acting together, but they have to be generated on every occasion, by carriers focused on retaining coordination and alignment with each other. Although the examples are a type of routine at the collective level, they are not routines for the individual performing the specific practice (Ibid.). For me, performing a research practice, like writing an article together with other people, is nothing like a routine. At the collective level, a research practice routinely creates articles to be published, and the elements for such endeavours remain similar. Parallel arguments could be made about playing a game of football or many other social activities.

This thesis aims to understand a particular type of collaboration, and, in order to do accomplish this we have to clarify one thing about the use of practice theory. If one sets out to study collaboration as the focal point for a scientific inquiry one can think about two different approaches. In one approach, the focus may be on the study of one practice that a number of carriers/practitioners are performing in unison together at the same time and the same place, e.g. football, or a practice which they are performing in unison but spatially and temporally further part, e.g. the acupuncture example above. This would mean the study of instances where the characteristics of a practice cannot be reduced to a number of individually separated practices and would have more to do with the collaboration of carriers/practitioners rather than collaboration between practices. As such, one would have difficulty in talking about collaboration in a practice theory perspective because we are looking at people (Figure 3) rather than practices.



*Figure 4.* Practitioners/carriers of a practice collaborating together within *one* practice. The circle illustrates that actors are taking part in the same practice.

The other scenario, moving towards a practice theory perspective, would instead be to focus on instances where different practices collaborate. This requires some explanation. One must first be able to analytically differentiate that there are indeed different practices and establish that these are composed of different practice elements, that is, that they are not ‘one practice’. Secondly, one must be able to see some type of connection between these practices, that is, that they are connected through some sort of boundary object or broker (people or artefact), that practice elements are being shared between the practices or that there is a spatial or temporal connection. If this is possible to do, then one can start to talk about how *different* practices collaborate, as illustrated in figure 4. Such processes might lead to the emerging formation of new practices (i.e. they will become linked in such a way that it will be analytically hard to distinguish between them) or production of new practice elements (new types of competence, meaning or material) that are put into circulation. This could, for instance, be the case when sequences are important and where one practice produces elements which another practice is dependent on (Shove et al., 2012).

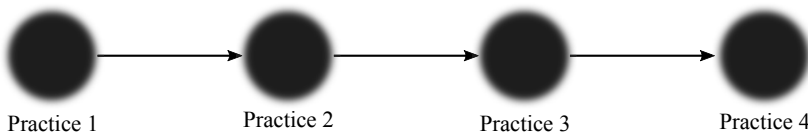


Figure 5. Practices collaborating in a sequence into the production of new practices

## 5. The site of practices and the institutions that sustain them

The previous chapter presented an outline of what differentiates UICs from other inter-organisational collaborations according to the body of knowledge on UICs. The argument can be briefly summarised in that there is a difference in knowledge creation within a company and a university. University researchers are guided by the Mertonian norms of academia: communalism, universalism, disinterestedness and organised scepticism (Merton, 1973). In contrast, knowledge creation in the industry/private sector is dominated by attempts to appropriate the economic value of what companies know in order to gain competitive advantage (Teece 1986). Such types of theorising about demarcations between business and science also lead, naturally, to the discussion of a boundary (see e.g. Siegel et al., 2003; Fontana et al., 2006;).

The relation between boundaries and practice theory appears problematic. On the one hand, the notion of boundaries seems fitting when looking at the world through a practice lens, as a question like “where does one practice end and where does the next begin?” is almost unavoidable. It seems to sur-

face in relation to empirical research and the move away from only theoretical thought. However, practices are always shared, intertwined and touching one another like great big nets of actions and activities, with practice elements connecting and disconnecting (Shove et al., 2012). It would in such a scenario be illogical to think of a clear-cut boundary between different practices. Some practice theorists are even more outspoken against the boundary idea (e.g. Nicolini, 2012) in saying that practices have no boundaries and conceiving them as such is only a way to reaffirm the structure/agency debate that practice theory is said to resolve. The main problem lies in what connotation a boundary explanation brings with it, an ontological disposition along the lines of individualism in particular but also a holistic view (see Akkerman & Bakkers, 2011; Santos & Eisenhardt, 2005; Hernes, 2004 for a detailed account on the notion of boundaries). This could then lead to an explanation of the social not coherent with a practice approach and undermine the very purpose of this study.

However, all of the studies referenced in the previous chapter on UICs demonstrate, to varying degrees, a difference between a university and a business. A different explanation, one based on practice and that does not recognise a boundary concept, is that this difference concerns *sites*. It is the notion that social life is inherently tied to a context in which it transpires and that explaining these certain contexts is central to understanding the social (Schatzki, 2009).

An academic department is a bundle of practices and material arrangements. The practices it embraces include grading practices, research practices, advising practices, governance practices, administrative practices, meeting practices, community-building practices, and consultation practices. The material arrangements it encompasses include the layouts and material connections among individual offices, meeting rooms, hallways, front offices, lounges, and people's homes (e.g. where evening events occur). Many of these arrangements are contiguous or continuous, some are connected by communication lines, and most are connected to further material arrangements that are not part of the department bundle. Similarly, many of the departments' practices are part of the practice-arrangement bundles that are other academic departments, while also overlapping or conflicting with those constitutive of such formations as the dean's office and central administration (Schatzki, 2009:41).

Simply put, human coexistence always transpires as part of a context of a particular sort. This context is then also interconnected with other practices and links in with other sites.

Reinterpreting the difference between knowledge creation in a business and a university would then be to explain it as being part of (or originating from) different sites. The sites, as different contexts, shape the practices that are present at a given place and vice versa, in a constant enacting process. This view still allows for an understanding of social practices as big nets of

actions and activities but would allow for an explanation of the reason for why practices differ depending on which set of practices one looks at.

There are more reasons for this difference between the practices that populate a university and a business, and this concerns which types of institutions sustain them. A not so uncommon view of human society is how it is made up of various kinds of institutions. One of the most familiar such institution is the economic market (Keat, 2000) defined as a structure that allows buyers and sellers to exchange any type of goods, services and information. This generates an output of goods through economic exchanges. Another type of institution not associated with economic exchanges is that of academia, of which universities are the main bearer. This institution generates a very different type of output based on the Mertonian norm of science (Merton, 1973).

Practices strive towards an inherent standard of excellence. Every practice involves a set of standards that serves to identify what counts as a good or bad (e.g. genuine or spurious, perfect or worthless) way to perform it. When a practitioner enters a practice he or she must initially be prepared to subject attitudes and choices to the practice. However, this does not imply that there is a 'set' standard or that there is no change of this excellence. Practices evolve as they are performed and as such what counts as 'good' changes (Ibid.). One must remember that this does not refer to the individual carrying out the practice; it is the practice *itself* that strives towards excellency, meaning that there is always some way of doing something to its utmost perfection, a normative 'best way'. The more an individual performs something, the closer she will come over time to master a practice. Or, to put it differently, practice makes perfect. This standard of excellence is driven by one factor, 'internal goods', but is also dependent on another factor, 'external goods'.

1. Internal goods, as defined by Macintyre (1981), are realised by engaging in a practice. Their character can only be identified within the specific nature of that practice and its standard of excellence achieved only through the enactment of the practice, e.g. the elegance of a scientific theory, the beauty of a perfect football goal and so on. Internal goods are achievable only through the experience of the involvement (Keat, 2000).
2. External goods are a different notion than internal goods but essential in sustaining a practice. This notion refers to those things that are *not* dependent on the particular nature of a given practice and are not achievable in the experience of a practice. Prime examples are *money*, *power*, *prestige* or *status*. Practices are in one way or the other dependent on institutions to survive and institutions necessarily involve such external goods. Physics and medicine, for example, require institutions such as laboratories and

hospitals, and these depend in several ways on money, power, status and so on (Ibid.).

In the case of UICs, it is not only the sites that are different; the institution and institutional resources also differ. What this comes down to is what type of institutional resources practices depend on. Within a company this is turned more towards 'the market', regardless what type of internal goods the individual participants aim at. For example, a practice that strives towards development of a particular product is achieving a standard of excellency within that development. There are internal goods produced in such a way for the carriers of this practice. It is not for certain that the practices involved have an aim or are motivated by what the economic market desires. However, as the practice is sustained by the institutions of an economic market it will wither away unless it adheres to what the market wants, or is able to produce goods that can be capitalised by practices that are more driven towards producing such goods (Ibid.).

Within a university the goods produced are matched with the institutions that sustain academic practices, which are not predominantly oriented towards economic exchange. Modern science has arguably been effective in producing the goods of scientific knowledge. In this institution, external goods are more directed towards *power*, *prestige* or *status* rather than *money*. It is clearly so that much research is dependent on money. I am not disputing this, but an economic market does not directly govern (in an idealised world) the way in which this money is acquired. It has been argued (Ibid.) that the principal motivating factor of the production of science for researchers is *recognition* in contrast to the material security or wealth that can be acquired in an economic market. This is an important differentiation because it means that practices within institutions like universities are continuously recreated with other types of external goods than those associated with the institution of an economic market. This logically leads to the conclusion that the practices involved in the day-to-day activities in a company and a university are likely to be different because the institutional resources are different and thus the sites are different.

Furthermore, it should also be made clear that for this reason some practices that tend to look similar in both sites are in fact inherently different. A fitting example is the difference between 'research', which tends to be associated with the academic setting, and 'development', which tend to be associated with companies. Both of these practices involve very similar practice elements, but at the same time they depend on different institutional resources, i.e. money vs. recognition. In academia, the quest for knowledge is prioritised and less geared towards thinking about what might generate the largest possible economic gain. The science system is driven by internal dynamics that are separate from market transactions (Polanyi, 1962; Dasgupta & David, 1994; Stephan, 1996). Or differently put, the institution of the

market is much more prevalent in one practice, ‘development’, than in the other practice, ‘research’. Because all three practice elements can be similar between ‘research’ and ‘development’ (they use the same material equipment and the same competences and they strive towards recognition as meaning), it is likely that they in some instances are able to connect or even be termed as the same type of practice. There will be a possibility of connection or transfer of materials, competences and meanings between sites that are similar. However, this picture is further complicated because it is not for certain that all practices within each site can so easily be categorised. In some instances, corporate research might have all the same practice elements as research within a university with an output of publications and production of science. Similarly, some departments might be involved with applied research that would count as the useful development of new products on a market.

## 6. Identifying practices

After discussing how sites are different, we are still left with a problem. How does one separate practices from one another within the same site? An issue here is that this subject has received limited discussion and empirical investigation (Hui et al., 2016), and there is thus limited help in solving this from practice theorists. In some manner, this depends on the type of categorisation that serves as the shared points of reference. Peppers and cucumbers can be considered variations within the category of ‘vegetables’ but not in relation to ‘edible or non-edible items’. This shows that there are many ways in which one might go about differentiating practices, just as there are many ways in which peppers and cucumbers are similar or not similar (Ibid.).

A first way to approach this is through the elements I have outlined. If there is enough variation in each of the three elements (meaning, competence and materials), then we might talk of different practices. The resources they draw upon in their enactment are too far apart to be grouped under one practice and we must thus separate these doings into two. This does, however, not entirely suffice, regardless of how pragmatic it may seem. Such demarcation is perhaps too vague when sifting through empirical material. It does, however, provide a start.

One could also add the temporal distinction. Practices are inseparable from temporality, not only because they unfold over time, but because they play with time and tempo (Bourdieu, 1990). Practices are depending on their specific place and time as they are performed. Time ties into context; if enough time has passed between performances of a practice it might make sense to talk of two different practices rather than variation of one that has persisted over time. Natural science and philosophy were once regarded as the same practice, but during a process from the 16<sup>th</sup> century into the 19<sup>th</sup>

they separated into two very different ways of thinking about the world. They did start out as the same type of practice, but over time changed so much that it now makes more sense to talk of two (or however many) different practices rather than variations of one research practice (Ibid.).

Secondly, spatial variations are also a reason for analytically distinguishing between practices. Instead of taking about time as the factor that differentiates practices, geographical distance might also contribute to a differentiation to such a degree that two practices can be talked about as different practices altogether (e.g., American football vs. rugby or Australian football). As practices are tied to context, a large enough distance in material arrangements, culture and people could perhaps lead to separation of one practice into two.

The cases in this thesis will show just how similar but also how different the practices involved in each of these sites, university and industry, can be. I will also come back to a similar discussion within the method chapter of the thesis. At this point it is enough to stress that regardless of how similar some practices may seem, they will always be influenced by the context they are situated in at any given moment.

Lastly, I briefly want to clarify one issue that was brought up in the literature review of Chapter 2: how the notion of UICs is to be defined. The notion of university–industry collaboration (UIC), is referred to as “*any interaction between a university and business or industry partner with the aim of knowledge or technological exchange*” (Ankrah & AL-Tabbaa, 2015). This thesis adopts this definition of UIC with a few important considerations. The phenomena under scrutiny in this thesis regards the *practices* involved in UICs; the aim is not to focus on individual researchers or company representatives, or the organisations involved within these collaborations. Furthermore, it is important to take into account when reading the story that the university is seen as a heterogeneous institution that encompasses a multitude of semi-separate practices rather than a coherent homogenous entity that contains ‘one research practice’. Still, it would not be useful to redefine the definition and change ‘university’ to ‘researcher’ (or similar), because it would be confusing to totally abandon a generally accepted terminology. It could also be argued that the ‘university’ as an institution has very distinct properties shaped by the norms and rules of the practices it contains (Dasgupta & David, 1994). Those properties are what create similarities between research departments and disciplines, but more importantly are what separates ‘universities’ from the rest of society and in particular from the practices within a business. Within a company or ‘industry-sector’, the vast number of practices that operate in such contexts can be said to all have a similarity in that they have to relate to a ‘market’, that the output of the practices has to produce some type of good that others wish to pay money for. That is not to say that all practices within a business have to produce a direct output into some type of commercial good or service (Keat, 2000). So just like within a



university, ‘industry’ is seen here in the same way, where each business is different from the next but still affected by an overarching similarity that separates ‘industry’ from ‘university/academia’ and from other sectors of society: the market as an overarching value creating structure (ibid.). This means that UICs as they are defined here, and what this thesis aims to study, are the practices that are being performed between researchers and businesses (small companies in this thesis). This means that UIC *equals the interactions/connections between the practices enacted by universities (researchers) & industry (single business)*.

Now that I have outlined why practice theory offers a distinctly different way of analysing the social and analytical tools to utilise such a perspective, the next chapter deals with method and methodological considerations.

# Chapter IV: Methods & methodological considerations

This chapter concerns what I did and why I did it. I start with a short description of the conflicting and often messy process of qualitative research that I have undertaken over these five years. I then move on to outline what type of empirical material this thesis is built on and how I collected it. I also argue for the why I picked four specific cases and the reasons for choosing a case study approach. I explain how I have analysed the empirical data and built the cases. Lastly, I briefly clarify the terminology on using “samverkan” and “samarbete” which are two Swedish terms usually employed to describe the activities within UICs in Sweden.

## 1. The research process

I am a biologist. For a very long time that was a large part of my identity, I guess that in some instances it still is. Studying is part of a socialisation process, learning new knowledge and methods. Studying shapes a person’s way of thinking. You build your identity in dialog with the people around you in relation to what you learn and how you acquire knowledge of how the world works. I spent my first academic years learning the skills of becoming a natural scientist mashed together with a teacher education. The indoctrination on the ontology of a natural science perspective was always present. To put it bluntly, I was taught that there is a right and a wrong to every question and that there is only one worldview of science that is accurate and any deviation from that norm is not to be accepted (perhaps be termed “pseudoscience”). It could be argued that a natural science student is expected to adhere to a paradigm around “objective knowledge” to inform about the state of the world and the being of things. In this approach, scientific knowledge is said to be objective and exist independent of the knower. The world is made up of facts and the goal of knowledge is to provide a literal account of that world in plain accurate language (Locke & Golden-Biddle, 1997; Knorr-Cetina, 1981)

In the beginning of 2012, I was accepted into the PhD-programme at Industrial Engineering and Management at Uppsala University. Taking that position meant moving from a laboratory into a workplace where the rhetoric

of the written word was highly valued. The world became confusing, very confusing. What struck me as especially difficult to grasp coming from a natural science perspective is that nothing seemed to be stable within the social sphere, it was clear that the social world seemed to be in constant change, it was '*a world on the move*' (Hernes, 2014:1). The environment I was now part of and the PhD-education I had embarked on seemed to look at the world differently. The influences I now had around me in my supervisors and other colleagues made it clear to me that the socialisation process in this setting would be very different from what I had previously been part of. I have now over these five years been socialised into a different way of viewing knowledge and the world around me than I had when I started this journey. As every Star Trek fan knows "resistance is futile", I have welcomed and enjoyed this process. The result is that I now think about the world through what closely resembles a social constructivist view. For a social constructivist knowledge is not separate from the knower, because the content of knowledge is influenced by social practices and interactions and what ideas count as knowledge is a meaning-making activity *enacted* in particular communities (Locke & Golden-Biddle, 1997; Knorr-Cetina, 2009). However, as a biologist by training, I do think that there is something real outside social convention: nature is real and independent of our knowledge about it will transpire on its own. Instead it is how our knowledge of nature has an element of constructivism in them e.g. that Mount Everest is the world's tallest mountain is a fact, but we do not simply know this, knowledge about the world has to exist in some kind of context; it has to have a framework. The world's tallest mountain has to be measured so we know it is the tallest mountain, and how that measurement is done can be disputed (from mean sea level to the snowy peak or should we include mountains under the sea, etc.)

Throughout the research process of this thesis, I have had an abductive approach to theory and the empirical material. I have furthermore taken inspiration from Alvesson and Kärreman (2007). They go about describing a process of moving back and forth between theory and empirical material. In their way of looking at theoretical development it is neither discovery by looking through and analysing empirical material nor is it the confirmation of accumulated hypothesis. They oppose a view common in some streams of social science that argue for how theory is supposed to fit data and a misfit leads to rejection or modification of theory, or when theory is assumed to emerge from data. For them, empirical data is fused with theory and data alone is not capable of guiding their way towards generating theory. They talk about "constructing mysteries" aiming for a more creative way of theorising. It is the notions that puzzle the researcher in the research processes of analysing data in dialogue with reviewing theory that should be the focus for developing theory; it is about being sensitive to influences from theory and empirical material as well as the relation between the two. Limiting the in-

fluence of subjectivity is then only counterproductive. This way of looking at empirical material and its relation to theory made a lot of sense to me when I started to sort out what was happening around me in the beginning of my PhD-process. I have thus adopted a similar methodological idea, moving back and forth from theory and empirical material trying to argue for and construct “a mystery” that is interesting and in need of answering. In moving into the choice on methods and a case study approach the article by Dubois and Gadde (2002) has been just as important in forming my ideas on how to relate to my research. They suggest having an abductive approach to case research, moving back and forth between the empirical material under examination, the theoretical framework and a case analysis.

Interestingly the reason for picking a practice approach and then later a full focus on practice theory as the main theoretical leans is what Alvesson and Kärreman (2007) would describe as a “serendipity” moment. I joined a PhD course on practice theory in Stockholm University. This course introduced and examined the new wave of practice theorists. The whole notion on practice theory made sense to me, the aspiration from leading theorist working on this new wave of practice theory is to try and “solve” (or at least argue for a different understanding of) the issue of structure versus agency in society, i.e. how much of society is governed by individual agency and how much does societal structures influence our life? One of the core ideas with practice theory is that this is a recursive process: we, the people, have social practices and these practices rely on individual agency and both reinforce, change and influence social structures. Because of this, practice theory is also a processual type of theory: a practice is always changing and this even more provides an understanding of how society change. For me this was an intellectually appealing way of looking at the society. Secondly, practice theory seemed to focus much more on the “how” than any theories I had come across at that time. It felt like a natural approach to apply on the empirical material that was emerging from my attempts on trying to make sense around the observations and interviews. Slightly shifting the focal point towards what the actors were doing, what practices they engaged in within the collaborations, gave a sense of cohesion in a sense making process. This is what the literature on UIC seemed to be lacking and an interesting way of going about research. However, working with practice theory proved to be quite troublesome and I have worked hard with first of all grasping the subtleties of the approach and then spent 2-3 years trying out different methods and variations in applying it to my empirics. It has been one step forward and two steps backwards, but also an intellectually intriguing and fruitful process. In conclusion, adopting a practice theory approach guided me towards 1) an ontological and epistemological position and 2) a lens/tool to use in order to help me answering the overarching research purpose and related questions.

At the same time, when I was employed as a PhD-student, I also accepted sharing my time at the division with becoming a one out of two SMURF<sup>4</sup> “On-going evaluator”. Over a number of years, there has been growing concern within the European Commission that there has not been enough learning from all the projects that are granted funding from any of the European Commission’s funds. The European Commission has therefore decided that any project that is granted funding over EUR 1 million is compelled to hire an evaluator of proper academic background. An evaluator of the type defined by the European Commission should be external to the extent that he or she does not have any interest in the project’s end-results, but at the same time act as a sounding board to the project manager and project team.

On-going evaluation is a process taking the form of a series of evaluation exercises. Its main purpose is to follow on a continuous basis the implementation and delivery of an operational programme and changes in its external environment, in order to better understand and analyse outputs and results achieved and progress towards longer-term impacts, as well as to recommend, if necessary, remedial actions.” (European Commission, 2015).

This “evaluator of proper academic background” became me through a shared employment as a PhD-student. That job required me to take part in all of the activities involved in SMURF and write semi-annual reports addressed to the project and Swedish Agency for Economic and Regional Growth (TvV). This allowed me to make participating observations and get a feel for what transpired within the project and the issues that faced the interaction leaders<sup>5</sup>. I also gained direct access to all documents that had any connection with the project and the funded UICs. Over the years that I followed, the SMURF-project I gravitated more and more towards the UICs that SMURF initiated, giving room to build the four cases, I studied there UICs at first as a way to try and capture what the SMURF-project had produced with the funding the interaction leaders had given out, but in the end as these UICs became the main focal point for the thesis.

## 1.1 Collection of empirical material

Doing what I did and why I did it in performing the case studies that this thesis is based on is obviously not separated from the process above. The person I became is in tandem with collecting empirical material. Making sense of my confusion meant trying to grasp what the people around me

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<sup>4</sup> What SMURF is and how it relates to this thesis will be made clear in subsequent chapters.

<sup>5</sup> The employees of UII have been relabeled from project managers to something called “interaction leaders”. It was in this text the individual project team members will be labelled “interaction leaders” instead of project managers even though this term was invented after the SMURF project ended.

were doing, I did this with broad strokes. I went to all SMURF-project meetings and interviewed all interaction leaders and other stakeholders involved in the project. As more and more UIC-projects were funded, I focused on interviewing both the researchers and the companies in all the UICs as well. As an overall method and main source, the empirical material was gathered through in-depth semi-structured informal interviews. This way of performing interviews allows for flexibility in the interview situation and focuses on how the interviewee understands the framing and questions still allowing for a structured aim (Bryman & Bell, 2011). I had a flexible interview guide that summarised the specific themes I wanted to explore in my interactions with the respondents. This was complemented with a number of participant observations to supplement what the respondents expressed. Over the years I have had over 100 interviews and 30 participant observations. Even if not all of these constitute the empirical data directly used in the thesis, they were still part of the process of finding an aim for the thesis, building important background knowledge about UICs at Uppsala University, as well as selecting the four cases. For SMURF I participated in all the project and steering meetings, totalling 21 observations and made semi-structured interviews with all the interaction leaders and the project manager of the project. Several interviews were made with each of these respondents (in total 23 interviews).

Outside the boundaries of SMURF, before I had selected the four embedded cases, I also had interviews with almost all of the actors that were involved in the funded UICs. These initial attempts in focusing on all the UICs were carried out with phone-interviews, partly because of the difficulty of getting access to people. Later, I transitioned into a much more face-to-face approach when the group of respondents became smaller.

As practice theory became more pronounced as a theoretical lens, it shifted the unit of analysis. I tried to move away from looking at individuals and organisations/institutions towards looking at the practices involved in the four collaborations and the SMURF-project. The unit of analysis thus became “the practices of collaborating”. When one study practices, it is about what is said and what is done. Practices are not buried deep inside the heads of individuals: they are publicly observable. Through interviews and observations one can get access to what people do and what they think about these doings. As pointed out in the previous chapter practices are not exclusively about doings as such; they are also about feelings and meanings towards such doings. Language is in this way thought of not as an individual feature but as suggested by practice theory, to understand practices one also have to talk to people and their experiences in the practice. With this in mind, I carried out 28 interviews with almost all researchers and 51 interviews with all participating companies. Specifically within the four case studies I made repeated interviews with the actors involved (12 with the researcher involved and 18 with company representatives) totalling 30 face-to face interviews

across all four cases over 4 years. In all but one case (the original contact person quit the company transferring all responsibility to a colleague) it was the same person that was interviewed on each interaction. In each of the embedded cases I have also complemented the interviews with observations on the practices the respondents said they engaged in, in total 2 observations per case. I have also kept email conversation ongoing with all the actors, checking in and asking how work was progressing. This was done in order to keep myself informed on changes (or no changes for that matter) that could then be used in interview guides. Lastly, as practices also involve material stuff and artefacts, I have had full access to all produced documents and email-conversations between people involved in the projects and the continuous collaboration (one of the companies only gave limited insight into the emails as they feared IPR-issues). This provided insight on details that were not mentioned or in the focus of interviews and observations and provided a structure when writing up a story about the cases (a table of all interviewed respondents can be seen in Appendix 1). This process of gathering of data and the shifting research focus can be illustrate with Figure 5 below, going from focusing on making sense and finding a theoretical framework and ontological standpoint, towards a structured research endeavour with a clearer research focus that ended up using practice theory in four embedded case studies. The longitudinal approach allowed for not only building interesting cases but also acted as a type of validation which is put forth by Yin (1981) as an important step in any case study research. This allowed a continuous dialogue with my respondents on how I had interpreted their answers and how I viewed their practices.

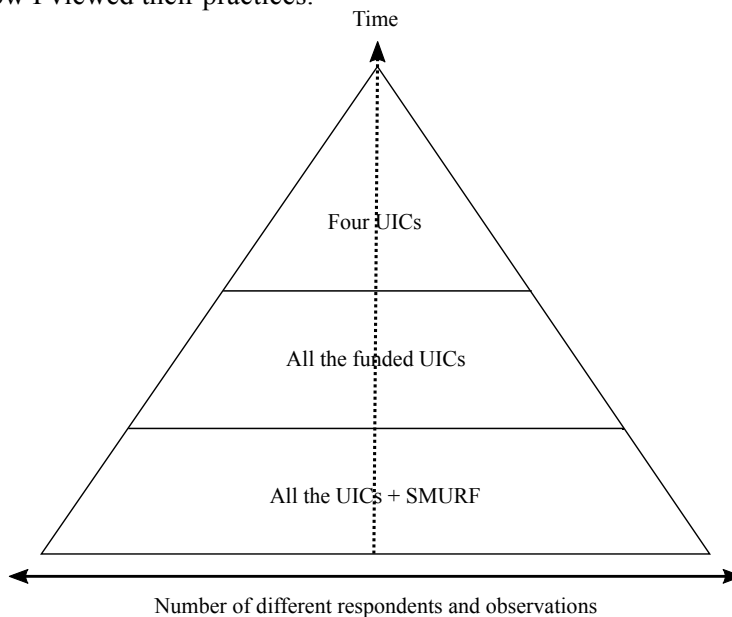


Figure 6. Illustration of the research process

## 2. Taking a (multiple) case study approach

A qualitative case study methodology provides tools for researchers to study complex phenomena within their own contexts. Choosing a case study approach was motivated by a number of factors as specified by Yin (2003): the focus of the study is to answer “how” and “why” questions; you cannot manipulate the behaviour of those involved in the study and finally you want to cover contextual conditions because you believe they are relevant to the phenomenon under study. All these criteria match or are applied in this study.

The thesis relies on an embedded case study methodology because the four UICs and their practices, which are the unit of analysis, derive from a specific organisational context, the SMURF-project. As such the thesis also utilizes multiple case studies in order to achieve as much rigour as possible in driving conclusions of the phenomena under scrutiny, an approach generally considered giving robust and reliable evidence (Baxter & Jack, 2008). Another reason for selecting this method has to do with the possibility that emerged from the context (SMURF), which allowed for a selection of a number of embedded cases. But, a key reason for using multiple cases was even more the possibility to reach well-founded inferences from the four cases combined. As put forth by Eisenhardt (1991); *“Different cases often emphasize complementary aspects of a phenomenon. By piecing together the individual patterns, the researcher can draw a more complete theoretical picture”* (p. 620). My initial thought from the outset was also that the more cases I would be able to describe the better. Now, I am less sure that such an approach is always a correct reasoning having been subject to some criticism (Ibid.), but, as the reader will probably find, each of the cases do strengthen the general conclusions on UICs, precisely because they are so different and yet similar. *“The concern is not whether two cases are better than one or four better than three. Rather, the appropriate number of cases depends upon how much is known and how much new information is likely to be learned from incremental cases”* (p. 622).

The cases described here have a small advantage in having some boundaries that allowed for a demarcation on what the cases were about, at least from a methodological point of view. By that I mean that SMURF was a project, and also the UICs that I began to follow were also initially projects, expected to end at a specific date, which however later moved on to less structured collaborations or into new projects. The project plans and related documents along with interviews for each UIC made it possible, having a pragmatic position towards them, to build the case studies by essentially allowing the actors themselves to define initial boundaries. However, it is important to also point out that defining the cases also meant that context had to be taken into consideration, thus broadening the scope of the cases. It is said that defining a case study from what it is and what it is not can be a



difficult task (Baxter & Jack, 2008), but using what was already given (a start of the UIC-project specified in the project plan and the respondents testimonials on when they started working together.) from the start paved way for finding a focus that could avoid answering excessively broad research questions or having too many topics within the study.

### 3. Selection of embedded cases

From the SMURF-project database (see appendix 2 for a summary) I initially started to follow all the projects, interviewing the actors involved, aiming to cover as much as possible. The group consisted of 27 UIC-projects. This was then boiled down to four cases for the reasons stated below. The four embedded cases along with the general SMURF-project are what constitute the empirical basis for the analytical parts within the thesis.

From the very start, after I became more interested in UICs, I decided to try and follow all the collaborations on how they developed over time and thus I sought to interview the same actors repeatedly over four to five years. However, this proved to be much more of a challenge than I initially thought. People are busy and often hard to get a hold of; they rarely priorities talking to a PhD-student. Perhaps even more so, in the very small firms I was trying to follow, time is often said to be something lacking. Researchers were just as busy and it was not possible to get hold of all of them. When I was unable to get a hold of a company or a researcher over the period of time I had allocated for interviews, they were not included in the following round of interviews next year. Parts of the data collection can thus be termed a type of *convenience sampling* (Bryman & Bell, 2011). It should also be said that as my theoretical focus became more structured and aimed, I also started to match my ideas with what could be most interesting to understand with a practice approach, moving therefore to a *theoretical sampling* method (Ibid.) according to the following logic:

- In UIC 1, it seemed like the material component they worked with played an intricate part, more so than in many other collaborations.
- In UIC 2, the actors talked about and worked each one on so very different topics from each other.
- UIC 3 had one person who was very prominent and coordinated much of what was done
- In UIC 4, the actors told me they had a long history and detailed knowledge of what their partner did. This was a dimension the other collaborations lacked, and possibly implied different ways in how their practices were formed.

The four collaborations were different and yet similar in so much as they can be used to illustrate and said to be representative of the rest of the UICs the SMURF-project funded. It was also important that the cases could be used to related to theories on the general discussion on UICs in academic literature, not only be considered as an end-result of SMURF. The four UICs have also been selected because they demonstrate different aspects of the same phenomena of interests. The cases are simultaneously also a story of the SMURF-project's main goal to create these types of collaboration and thus they are also a description of what effects the project created. However, it's not the whole story of all effects the project generated because not all the 27 SMURF funded UIC are described and analysed in this thesis. This dimension of the broader effects of SMURF is somewhat played down in the rest of the thesis as it is not within the scope of the research questions. The criteria and logics for the choice of collaborations to focus on are listed below:

- All four cover different business sectors and research disciplines respectively.
- The companies in the UICs were in different stages of business development. Metahyd (UIC 2) was in early research and development with no product on the market. Svenska Aerogel (UIC 1) was in a similar position with a promising line of products, but nothing on a market when initiating their collaboration with Klaus Leifer. GISgruppen (UIC 4) had been a very small but successful consultancy company for a number of years before joining the collaboration project. Mercodia (UIC 3), having been around since 1991, was an established and successful company in the global life science market.
- UIC 4 had one of the highest innovation vouchers, while UIC 2 had one of the lowest.
- UIC 2 was with the smallest company included in SMURF while UIC 4 was with the biggest, with 0 and 60 employees respectively.
- The partners in UIC 4 had a history together, something the others did not.
- UIC 1 and UIC 3 were both with research-intensive companies with clear ties to academia, while the companies in UIC 2 and UIC 4 were further from academic research.
- Four UICs came from different communities, i.e. no collaborative relationships had any ties to the others.

Next to theoretical and convenience sampling, the selection of the UICs was also based on the possibility, or outspoken aim, for commercialisation of their respective projects output. This was judged partly by going through all the project applications/project plans (for all 27 projects) sent into SMURF and evaluating their aim/goal. These goals were then cross-referenced with

the respondents in these projects to see if they agreed on the conclusions made. Identifying the closeness of each UIC to commercialization was important as it connects to public policy pressures towards commercialisation. Based on it, I made the illustration below shows a scale of the “degree of perceived commercialisation potential”, where each studied UIC is placed (Figure 6).

UIC 1: This collaboration could be said to be about basic research. The aim was to gain increased knowledge on a novel material and develop new electron microscopy methods

UIC 2: This was the first step in a commercialisation process. The company representative and the researcher basically tried to analyse the prerequisite to introduce a possible innovation. Respondents expressed that this was far from the market.

UIC 3: This was the initial stage to develop a new product together, rather close to commercialisation. However, the project participants sought even more to develop a close relationship with one another.

UIC 4: This was from the start an attempt to commercialise a product developed at a university by the researchers.

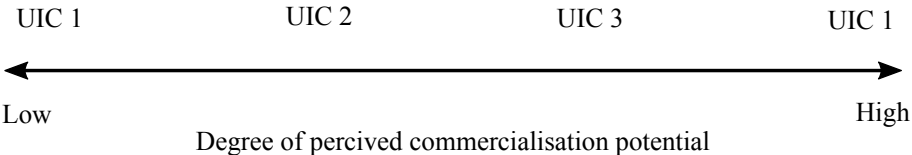


Figure 7. illustration of perceived commercialisation potential

At the onset of the thesis project, SMURF was the main focal point and I concentrated my efforts on what the interaction leaders did in relation to the project and in their networks. It was outspoken from the SMURF-project team that the target group were the companies rather than the researchers; it was the needs of the companies that came first. With that came a stronger emphasis on the companies rather than the researchers who were involved in working with the small companies, both outspoken and implicitly. Because of this I also, initially, focused my data gathering on the companies more so than the researchers. This I have tried to remedy over the years since my focus shifted towards the individual UICs.

In Appendix 2 the reader can see a summary of all UIC projects funded and rejected, including a short project description, budget and how much funding was provided from SMURF. To note, the appendix summaries *all* projects. The actual number of *collaborations* was at the end of SMURF 27 but the number of funded *projects* is larger because some collaboration got funding for more than one project. For a more detailed outline of how the selection process of actual UIC projects came about I refer to the chapter about the SMURF-project. The four cases that are the embedded case studies

for this thesis have been highlighted in bold text in Appendix 2. These four cases are expanded and elaborated on in more detail further ahead in the thesis.

## 4. Analysis of empirical material

The unit of analysis is the collaborative relationships through a practice perspective; this means that within the embedded cases, the analysis is foremost on the practices that were directly involved in the collaborations. By this unit of analysis, I specifically mean the collaborative arrangements between individual researchers and the representatives/employees of the small company, i.e. not the university as a whole entity.

It was also as important to give room, and voice, to the carriers of the practices that were analysed as well as the context around them and what facilitated and obstructed collaborative work. In analysing the empirical material within the interviews I focused on sifting out how actors described their practices and what they were doing in connection with the collaborations. I analysed the cases in search for what facilitators my respondents talked about, looking for common themes between the cases. From the data from the participating observations, I extracted how the actors were performing the practices. As a general focus I have aimed at building a narrative with the empirical material collected, aspiring for what Yin (2013) calls *explanation building*. In this approach the goal is to analyse the empirical material by building an explanation about the case, often providing a narrative. As such I have also been inspired by, but not fully exploited, the work by Czarniawska on narrating the organisation (e.g. Czarniawska, 1997; Czarniawska, 1998) in my attempts to create captivating cases.

It also has to be pointed out that the empirical descriptions are itself a first analysis (Håkansson & Waluszewski 2002) so in each case description, before going into a practice analysis, I make selective use of gathered material in putting forth specific activities that I deem part of the collaborative work.

### 4.1 Analysing the practices within the cases

In the cases presented in the chapters ahead I am focusing on the development of collaboration, how connections of practices and/or practice elements involved in their work came about and changed over time. I have built the cases and the analysis around how the actors talked about the work and what I could see in my participating observations. I acknowledge that in any social setting (or site/context) there are a vast number of practices and practice elements that continuously connect and disconnect, forming complexes and/or constellations (Schatzki, 2011). This means that there are many prac-

tices in any given site but as my research purposes and questions are centred on “the practices of collaborating” I have some demarcation to hold on to.

Furthermore, I have pointed out in the theory chapter what I have decided should be regarded as a practice and what should be seen as activities across different practices. Not every social mundane activity is considered to be a practice. In the framework presented in this thesis practices are seen as semi-stable organisational corpuses of activities, such as. Nordic walking (Shove, 2005) a scientific experiment (Pickering, 1995) or even science as a whole field (Pickering, 1992). Other practice theorists would perhaps argue that many other mundane tasks are practices (Schatzki, 1996; Nicolini, 2012). Instead I analyse such notions as *activities* that cut across any number of practices. Activities are seen as more simple in nature and are part of a number of practices: e.g. a research practice within a laboratory could contain the activities of sitting on a chair, using a pipet in a correct manner, putting on a lab coat the right way, arranging flasks in the appropriate order and so on. Together all these activities come together, and form a particular practice grouped around practice elements (meaning, material, competence). In my analysis I took a step back and raised the level of abstraction picking activities that I judged to be important in the cases for the practices of collaborative work. This was a delicate balancing act, visible throughout the empirical parts of the thesis: it was important not to lose context, while making claims about how the practices of interest in the cases are assembled and performed.

In some way, this is also a question on what aim a study might have: in some circumstances it might make sense to have a narrower definition while in other less so (Hui et al., 2016). My aim is to study large social phenomena with a practice approach, which is quite rare, since most practice theory analyses focus on small-scale or local phenomenon, e.g. cooking, leisure pursuits or professional practices (ibid.). Large social phenomena are instead on a higher aggregated level, involving many human and material carriers and practices. Therefore, I believe, it is essential to allow practices to be aggregate above every simple mundane task without losing their defining features.

Differentiating between practices was particularly difficult in this thesis. I went about this by trying to map the activities through the narratives the actors described and my observations in a recursive manner. Different practices surfaced that could be separated from each other as they had unrelated sayings and doings and were for the most performed by different individuals in different geographical location during different times, and relied on either different materials, meanings or competences. An illuminating example of this is the difference between development and research practice in UIC case 3. The actors had very similar laboratory activities centred on a particular material: The material arrangements and competence in doing the experiments were very similar, but the practice element of meaning in doing these activities were however different: the researcher wanted to explore research

questions and the company wanted to develop their product in order for it to be sold. In this way I could categorise the activities either within a research practice or within a development practice.

Sometimes during this analytical work I also discovered other types of practices than business, research or development practices, which were nonetheless the practices that the respondents tended to talk most about. In some instances there were activities centred on individuals and material arrangements that demonstrated a dependence on completely different practice elements. In the case of UIC 2 for example one person was involved in writing funding applications and managing some of the company business activities. He was disconnected from the practices I had identified and in which the researcher and company were engaging. This person described the materials he used, the competence he had and the meaning for doing them in a way that separated them from the activities connected to research or development. Thus, his practice had to be categorised as something else and in this case I labelled that as “brokering practice”.

Furthermore, even though the attempt has been to have the analysis centred on the practices, it was impossible to neglect the individual actors’ influence on the practices analysed. It was necessary to consider also the single actors because there were very few individuals involved in the UICs I have studied. This inherently made some specific persons important as I only had their personal stories to relate to. This might have made my explanations and conclusions become centred on the human actors rather than the practices. To counterbalance this risk, I have strived to bring out the practices more than the individuals both in the methods I used and in the analysis of the empirical material.

## 5. Samarbete = Collaboration

This thesis concerns a Swedish context and the empirical material (i.e. the interviews and most of the documents) were all collected and written respectively in my native tongue, Swedish. It was then translated to English. In large part, the text is also written towards a Swedish audience, towards policy and practitioners, who I hope see the use of this study in their day-to-day activities. This presents a small problem with the terminology used in the thesis that deserves to be noted and dealt with. Firstly, one has to translate the Swedish word *samarbete*, often used to describe the interactions between companies and researchers into an English word that roughly means the same thing. Consulting a thesaurus *samarbete* can translate to either *cooperation* or *collaboration*: Cooperation: the action or process of working together to the same end. Collaboration: the action of working with someone to produce something. There seem to be no apparent consensus to be found in the literature on which is the preferable term when studying how academ-

ia and industry work together. I have chosen to translate *samarbete* into *collaboration* because the academic literature on the interactions between university and industry seem to lean towards using *collaboration* as opposed to *cooperation*. The reason for this remains unknown to me. The other problem is that in Swedish the term *samverkan* can also be used to indicate connections between companies and researchers. The term *samverkan* can be translated into *interaction* or *collaboration/cooperation*. Therefore *samarbete* and *samverkan* can be translated to the same English words and can also both be said to mean “people doing work together” or something more general involving an organisational focus, e.g. “organisation working together” all depending who you turn to (Lindberg, 2009). This thesis is focused on investigating the practices involved in collaboration activities between small companies and researchers. The respondents of this study never made any effort in trying to separate *samverkan* and *samarbete* and thus a pragmatic view would be to not try and separate the two apart. I will use the word *collaboration* as a translation for both *samverkan* and *samarbete* to avoid confusion for the reader, but also in order to circumvent forcing my interpretation of the concepts onto the respondents in this study.

## Chapter V: SMURF – setting the scene

The next five chapters will cover the empirical material explored in the thesis. I have structured each chapter in the same way; I first outline a narrative from the perspective of the individuals involved in the UIC. Then in the last part of the chapters, I reorient this description towards the practices using my theoretical framework. I do this to highlight the differences between a conventional unit of analysis centred on individual human actors and/or organisations compared to a practice centred unit of analysis.

This dissertation focuses on how researchers and small firms perform work together in order to collaborate. The four case studies of UIC that will later be outlined sprung out of the SMURF-project over a three-year period. The group brought companies and researchers together and created conditions for which application/projects were to receive funding. This means that the UICs were not ‘naturally’ initiated and even though most of them began from either the researcher or the company initiative they still had to adhere to a set of criteria influencing the work they wanted to do. Therefore, it could be argued that the SMURF-project had a direct effect on how these collaborations played out. Because of this, it is vital to outline how and why the SMURF-project was launched as well as the day-to-day work that created these effects. I focus the descriptions on the discussions and activities that had an effect on which UIC-projects were funded by the SMURF-project.

This chapter of the thesis will also explain many of the organisations connected to the UICs and/or the SMURF project. This will help contextualise the thesis, putting the four cases into a larger frame of reference.

The basis of the story that will unfold below of how work was performed and decisions made within the SMURF-project was the meeting-minutes in combination with my own notes during the meetings, as well as interviews with the interaction leaders running the project. The reason for focusing on such a method is that much of the practices within the project were difficult to distinguish from daily work at UII or SLU-Holding and the focus of this chapter is on the SMURF-project practices, not the organisation around them. The meetings on the other hand were where all the activities they did connected to SMURF was summarised and discussed making it a suitable place for following how the project unravelled over time. Meetings have also been used by other scholars and argued for as important to understand wider organisational practices (Jarzabkowski & Seidl 2008).



## 1. The project - short summary

**SMå** företag i Uppsala Regionen samverkar med Forskare vid universiteten' or in short, **SMURF** was a three-year (2011-2014) collaboration-project between Uppsala University (UU) and the Swedish University of Agricultural Sciences (SLU). The aim of SMURF was enhancing small businesses' development and long-term competitiveness by improving their relationship with the universities of Uppsala. The innovation units at each university managed the project as a joint endeavor. The target groups were companies within Life science, Material sciences, Sustainable technologies and companies in the knowledge intensive social science service sectors. The industries chosen were intended to reflect the know-how and expertise of UU's and SLU's research. The project sought to create a platform that facilitated and financed collaborations between small companies and researcher from UU or SLU in small/short sub-projects. This was accomplished by handing out, to those who matched a set of conditions, 'innovation vouchers' which paid salaries for the researcher or materials within the collaborations.

## 2. The SMURF organisational network

In order for the reader to follow how the SMURF-project unfolded, it is paramount to understand that there are a significant number of organisations and activities that had a direct or indirect effect on the project and the practice of interest. Because of this, this section of the thesis starts off with a brief description of these organisations and how they are connected to each other and the SMURF-project.

### 2.1 Uppsala University

Uppsala University was founded in 1477 making it Sweden's first university and among the oldest university in all of Scandinavia. It is a large and subject-wide university with several scientific disciplines linked to engineering, natural sciences, medicine and pharmacists and humanities and social science. The university has a yearly turnover of SEK 6.8 billion and leans heavily towards research, 70 % of the turnover is connected to research and post-graduate studies while 30 % is on education. The university is also ranked top 100 in all major global rankings. In 2017, it had 41,470 registered students, equalling 24,623 full-time students and about 2,400 doctoral students. It has a teaching staff of roughly 1,800 (part- and full-time) out of a total of almost 7000 employees. The university has a strong presence all over Uppsala, spreading out across the inner parts of the city (uu.se).

## 2.2 Uppsala University Innovation (UII)

As already outlined in the introduction, UII is Uppsala University's designated body for commercialization of science and promotion of business and industry collaboration. Part of (or connected) this organisation is also Ånström Material Academy (ÅMA) located on a different geographical location it only focuses on assisting in commercialisation in the material/technological sciences at UU (Over the years after the SMURF-project ended ÅMA has become even more integrated with UII).

## 2.3 Swedish University of Agricultural Sciences & SLU–holding

SLU is a nation-wide university geographically divided into four locations: Umeå, Skara, Alnarp and Uppsala. It is a rather young university founded in 1977 out of the agricultural, forestry and veterinary university colleges, the Veterinary School at Skara and the Forestry School at Skinnskatteberg. The university has a different focus than other Swedish universities in being exclusively concentrated on biological natural resources (in a very broad sense). Their activities range from genetics and animal health to urban development and climate change (SLU.se)

SLU-Holding has employees at all these locations working on different aspects of commercialisation towards the researchers situated at those sites. This is the equivalent unit to UII at SLU. SLU-Holding is in many ways very similar to UII in a comparable mission (commercialisation/utilisation of science/creation of university spin-offs) but the organisation is smaller and the formal structure and governance differ somewhat. There is for instance, unlike UII and UU's holding company, not a division between the holding company and the rest of the innovation support organisation. Nowadays SLU-Holding and UII have strong ties and work jointly on a range of projects both formally and informally.

## 2.4 The Swedish agency for economic and regional growth (TvV)

TvV is a national government agency tasked with promoting entrepreneurship and regional growth. TvV's mission is to strengthen the competitiveness of Swedish enterprises. They focus on SMEs or future entrepreneurs directly and work to improve the general framework for doing business (tillväxtverket.se). Among other activities, the agency has a government mandate to manage and distribute funding from the European Regional Development Fund (ERDF) in such a way as to support projects that promote growth and job development. TvV organises its activities according to 'functional analysis regions': in short it means that TvV has divided Sweden into 72 regions based on how interdependent geographically close municipalities are regard-

ing employment opportunities and the workforce. The calls from TvV and subsequent handling of applications are managed on what geographical location it is sent from, e.g. an application from Uppsala would be sent to TvV East-middle Sweden. This has implications for what type of projects are accepted, as any application, in some way, must demonstrate how the region gains economic growth or employment (TvV, Samlad lägesrapport, 2012).

## 2.5 European Regional Development Fund (ERDF)

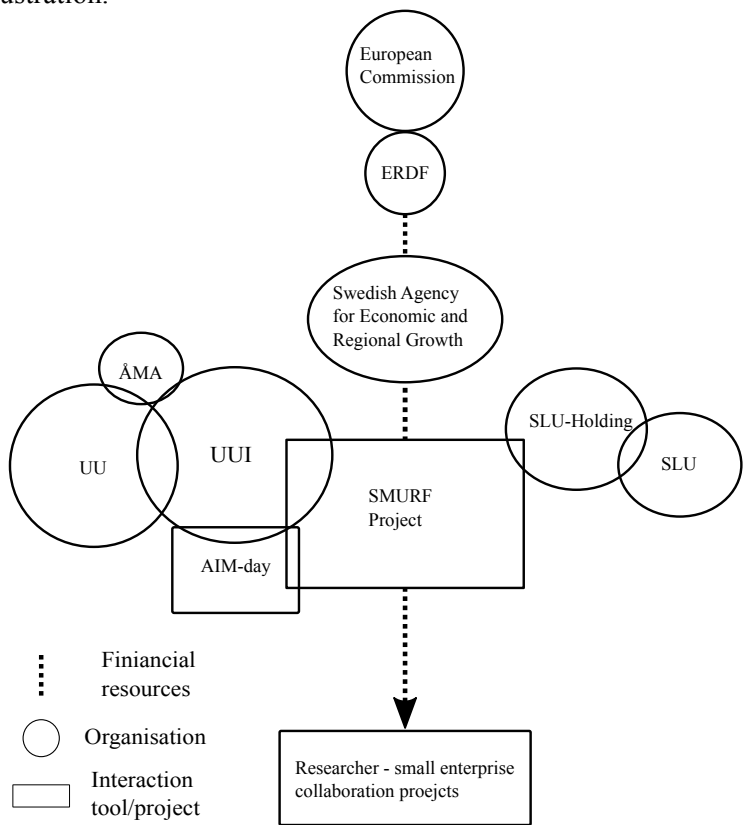
The ERDF is part of the cohesion policy implemented by the European Commission to even out the regional differences in the European Union. The fund's actions are designed to reduce economic, environmental and social problems in urban areas, with a special focus on sustainable urban development. It also gives particular attention to specific territorial characteristics, meaning areas that are naturally disadvantaged from a geographical viewpoint (remote, mountainous or sparsely populated areas). Sweden qualifies to receive funding from ERDF, but as it is considered one of the more wealthy countries in Europe, funding is somewhat limited. Nonetheless, Sweden received SEK 15 billion for the 'programme period' from 2007 to 2013. Over the years, ERDF has financed a wide range of projects in Sweden: all projects were said to have supported the regional or local economy by improving transport and communication networks, generating employment, helping business start-ups, increasing skills and training, cleaning up the environment or restoring tourism features (European Commission 2014). It was the ERDF that provided funding for SMURF through TvV.

## 2.6 The Academy Industry Meeting day (AIMday)

AIMday is not an organisation per se, but acts more like a tool for UII in fostering cooperation between industry and academia. UII relates to this event as one of their more central tools in order to implement their mission. AIMday is a one-day conference where researchers and industry representatives meet and discuss issues that interest them both, although with an emphasis on industry-related subjects. The event is focused on a series of small parallel workshops where specific questions posed by companies are discussed together with researchers. The questions have been carefully selected by the organisers (UII in most cases) in order to match participating researchers' interests. AIMday was one of the reasons why the SMURF project was initiated, but the event also had an impact on the project's progression (Baraldi et al., 2016).

## 2.7 How are the organisations connected in relation to the SMURF-project?

TvV was the organisation that was the main funding body for the project (along with the matched investments from UUI) through the mandate they were given to manage the monetary means from the ERDF. The ERDF is in turn closely tied to the European Union and the European Commission. UUI created the project and along with SLU-Holding formed the SMURF-project group and the steering committee, drawing staff and resources from their respective organisations and their respective university departments. ÅMA is part of UUI but somewhat separate. UU and SLU, the universities that UUI and SLU-Holding are part of, are also the second funding bodies through their staffs in-kind. AIMday used by UUI as a tool to connect researchers and companies so that they would apply to SMURF and start collaborating. The SMURF-project group along with the projects steering committee granted funding for a number of collaboration projects applications between a researcher and a business utilizing the ERDF funding. See Figure 8 for an illustration.



*Figure 8.* The organisations/tools that were involved in SMURF and how they are connected. The dotted line portrays the movement of resources.

### 3. Formulation of an application

During the Christmas Holidays of 2010, three employees from UUI were sitting in an office trying to write an application for a call sent out from TvV. The deadline was only three weeks away and they were worried that the money that TvV distributed might be running low and they were pushing for the application to be finished. The application that was being formulated at UUI that December was aimed at ERDF through TvV East region. It was an attempt to find funding for a project idea that had been evolving in the hallways for some time. Uppsala University support had over its, then, 15-year existence never really directed any major efforts towards SMEs. According to one of the heads of UUI, there was even a rumour circulating that UUI was particular bad at engaging or working with small firms which were not a university spin-off. However, one part of UUI had received funding in early 2010 in order to direct their efforts towards small firms that might benefit from the university material sciences. The initial idea for the application was to create a ‘pilot project’ similar to that but instead within the Life Science sector. However, it had come to the attention of staff at UUI that ERDF was fast running out of money to support any new applications. This meant that the application being formulated could be the only chance to get a hold of any money from ERDF; it might be a one-shot attempt. So without any lengthy consideration, the three employees decided to change the focus of the application and aim towards a much wider spread of business sectors. It was decided that life science, material sciences and the knowledge-intensive social science service sectors (from here on referred to as ‘HumSam’ as that is the term used by all the involved actors) should be the focus of the project. In the end, a forth sector was also added to the short list, something they named ‘clean tech’ (i.e. sustainable technologies), the reason being that they wanted to initiate a collaboration with the other university in Uppsala, SLU. The SMURF-project was at the time of the application the first attempt from UUI’s side to work together with its corresponding unit at SLU, SLU-Holding. A cut-out from part of the agreement can be seen in figure 9. One of the employees who wrote the application later mentioned that including SLU in the project was a means to increase the amount of potential small firms as well researchers that could be included in the project.



**Samverkansavtal mellan Uppsala universitet (UU)  
och Sveriges Lantbruksuniversitet (SLU) avseende  
projektet SMURF -små företag i Uppsalaregionen  
samverkar med forskare vid universiteten**

*Figure 9. A cut-out from the document specifying the collaboration arrangement between UU and SLU.*

What was also highly emphasised in the application was the focus on engaging small firms and in particular on small firms that previously had *no connection* with either UU or SLU. The general feeling at UII was that they needed to find ways to reach out to a group of companies “out there”, that there might be a group of small firms that they could target and still fulfil the obligations towards TvV and ERDF in order to finance such an idea. According to UII, as highlighted in the final application document, there were three main reasons why there, at that time, were so few small firms exploiting the available resources from SLU or UU. First and foremost, they lacked the economic means as well as the time to engage and work with a researcher. Secondly, small firms have virtually no possibility to fund basic research. Thirdly, the companies put the universities in the ivory tower high above their heads, i.e. they had an exaggerated respect of relevant research in regards to their own business. UII based these notions on previous experiences from work that had been initiated by ÅMA, the part of UII that had gotten funding for engaging with small firms in early 2010. UII was however in no way sure that this actually was the case, as one of the employees of UII (and later part of the SMURF-project group) put it:

If a small firm doesn't have any collaboration with a researcher and/or the university, they might just not have any such interest.

This was the reason for SMURF to be termed by all the persons involved as ‘a pilot’, as a way to try out something they were hoping might work: a means to explore if there was an interest from a group of companies that had never before worked with a university and thus were unlikely to have any connection within UII. The emphasis on new connections would later prove to be difficult, but at this time the employees writing the application saw this feature as one of SMURF's key qualities.

The application was now close to being finished, but a few things remained to be completed. First of all, the goal of the project should to be agreed on and written down. After a short discussion between the three UUI employees, this was set as: *“enhancing small business development and long-term survival by improving their relationship with the universities of Uppsala”*. They also had to formulate indicators that corresponded with not just the goal but also the call from TvV. Otherwise, it was unlikely that they would get any funding. These ‘indicators’ were selected with the hopes that they would match what the project team was able to do in regards to the overall goal. These indicators were also said to reflect the process applied by the SMURF’s project team in their daily work of engaging researchers and small firms. It was later strongly underlined that, at the time the application was written, these indicators were merely an estimate of what the project team might be able to manage within the three-year timeframe. Listed below are the finalised indicators in the application:

Number of SMEs met in information purposes:	200
Number of participants in different events (AIMday, SME meetings etc.):	
Companies:	50
Researchers:	200
Number of fruitful meetings between SMEs and academic researchers:	42
Number of projects/companies conducting networking activities as a result of participating in SMURF:	10
Number of patents and scientific articles with the academic researchers as well as employees in an SME listed as authors/inventors:	10

As ERDF is meant to stimulate economic growth, any project that applies for money was expected to demonstrate that it could contribute to such a development. Similarly, TvV’s mission is also to stimulate economic growth through various means, e.g. by supporting different project endeavours. Therefore, the three employees added ‘20 employment opportunities’ as the overall indicator for economic growth. Just like the rest of the indicators, this was also said to very much be an estimate of what might be accomplished during the project period. Over the three years, all of these indicators came to be both debated and renegotiated. After spending many days on the application, the three employees could finally take a well-deserved Christmas holiday and send the draft to TvV. A few months later TvV approved the application and thus the SMURF-project was born (TvV, ID 158493), the letter of approval can be seen in Figure 10.

**TILLVÄXT  
VERKET**

En investering för framtiden



EUROPEISKA  
UNIONEN  
Europeiska  
regionala  
utvecklingsfonden

**MEDDELANDE**

2011-05-27

Ärendeid: 158493

Uppsala universitet  
Uppsala Science Park  
Att: Andy Browning

751 83 UPPSALA

**Beslut om medel från Europeiska regionala utvecklingsfonden**

Ni har beviljats projektmedel enligt bifogat beslut.

Information, råd och anvisningar hittar ni på [www.tillvaxtverket.se](http://www.tillvaxtverket.se), Östra Mellansverige under rubriken **Genomföra projekt** (och i underrubrikerna **Information för projekt, Blanketter och dokument, Grafiska riktlinjer**).

*Figure 10. the letter of approval for the application*

### 3.1 Assembling the project team

The first thing that needed to be decided now was which of the personnel at UII was to be devoted to working with SMURF. There was first of all a project manager, or coordinator, for the entire SMURF-project. He had a long career in the life science industry as a project manager. He had been one of the first employees at UII and was now head of operations at UII. He was given the main responsibility for the project. The rest of the project team varied over the years between six and ten people and consisted of a mix of employees from UII and SLU-Holding.

As the project was aimed at four different businesses sectors (life science, material sciences, clean tech and 'HumSam') this division was used as a way of structuring work around the project. For each business area, there were one or two responsible interaction leaders that had either experience within the particular sector or a relevant academic degree (or both). Each interaction-leader was assigned to work primarily towards companies and researchers within his or her area of expertise and experience.

## 4. Year 1, work begins

The first meeting took place at one of the conference rooms at UII in the beginning of May 2011. SMURF was for all the persons involved something new; they were treading new ground and much of the early work in the project reflects just that.



- It must be as SME within the EU definition of no more than 250 employees.
- The project team must be able to include the SME in the targeted businesses sectors (life science, material sciences 'HumSam' and clean tech)
- The researcher that collaborates with an SME cannot have any ownership in the corresponding company
- Uppsala University's holding company or SLU-Holding are not to have equity in the SMEs included.
- The project must have 'academic quality', i.e. there should be a something in it for the researcher(s) collaborating with the SME.
- The project is forced to adhere to the 'de minimis rule'. Under state aid, a company cannot receive grants above the threshold of EUR 200,000 over three years.

It was also said that in order for the team to find a work process for how to manage any projects, they should initiate one or two 'pilot projects' as soon as possible. The team felt that they could be less strict on what type of SMEs they would use as 'pilots': the focus of those early projects was to find a well-structured process to manage the administrative parts of SMURF. In the same meeting, the team decided to try and work towards a model where they would try and push any possible collaboration project to first apply for a small 'pre-study' funding in order to evaluate the idea. If it all went according to plan and the collaborating partners still found it fruitful to continue working together, they could then apply for the larger 'full-study' grant. The larger grant should also have some in-kind funding within the budget in order to make sure that there was commitment from the SME.

They also decided that, in order to keep track of all that was happening with regards to the UICs and how the project was developing, some type of administrative tools would be needed. Among those documents were two Excel sheet's that became very important. One was used to keep track of all UICs coming into SMURF and the other to keep track of the indicators (see Figure 11)

1 okt - 31 dec 2012

		1 okt - 31 dec 2012 (Underlag behålls av respektive person)							
IB	Indikator	Lars-Eric	Andy	ÅMA (Torbjörn)	SLU (Björn, Andreas)	HumSam (Anna, Martin)	Ingrid		
-90	Antal SMF's träffade informationssyfte	5	9	20	5				
0	Antal deltagare i olika aktiviteter								
0	AIMday			6					
0	Företag			50					
0	SMF möten	3		2	2	23			
0	Företag								
0	Forskare	10			5	13			
0	fokus möten								
0	Företag								
0	Forskare								
0	övriga	5				3			
0	Forskare	3							
-145	Summa	8	0	8	2	26			
-322	Företag	13	0	50	5	13			
	Forskare								
25	Antal fruktbara kontakter mellan SMF's och akademiska forskare			3	2	2			
36	Antal projekt startade efter AIMday eller likande möten			3					
9	Antal projekt/företag som deltar i networkingarbete som en följd av att ha deltagit i projekt			1					
1	Antal initierade samverkansprojekt med potential att påverka folkhälсан positivt								
2	Antal initierade samverkansprojekt med potential att leda fram till att miljövänlig teknik introduceras på marknaden			2	2				

Figure 11. One of the Excel sheet's used to keep track of which indicators (see list above) were met or not. Each interaction leader had a column that he or she was to fill in when an indicator was completed.

The next meetings of SMURF's project group were held only a few weeks later at the end of May. In general there were quite a number of meetings in the early stages of the project. Already at this early stage a few project suggestions were brought to the table that had potential to be used as 'pilots'. However, nothing was finalised until later.

Shortly after this meeting, an AIMday with a focus on cancer-related issues was scheduled to take place. This was the first time SMURF could be used as a way to find funding for any aspiring SME-researcher collaborations. It was therefore of high priority to finalise and decide on any ambiguity the project team might have. It was specified that any application should be handed in during the event and that the team would try and push for applications that clearly specified utilisation, feasibility and academic quality. The expectation was that the event would generate 4-6 pre-study applications. During AIMday-cancer, the convenors tried to market and push SMURF-funding to anyone present at any of the day's sessions. The group created a pamphlet with all the information they thought was essential as can be seen in Figure 12. The pamphlet stressed the pre-funding grant, which was meant to be a way to 'try out' an idea that later could be more structured, if successful, through the full-study grant.



*Figure 12. : Part of the front page of the pamphlet handed out at information meetings and AIM-days. Translated to English it reads “An offer from Uppsala’s universities to small businesses”*

A while later the ‘pilot-projects’ were finally initiated. Altogether, there were four different collaborations, two originating from SLU and two from UU. It was important for the team that these collaborations stayed in close contact with the project group in order for them to get feedback on what worked and what needed to be improved. In the following weeks and with the use of those pilots, the project team was able to more clearly sketch out and develop a work procedure to lean on.

The process that developed, and was later formalised, started with rallying SMEs to the SMURF-project via information activities aimed at getting them in contact with UUI, SLU Holding or more directly with SLU and UU researchers. This was done within two, sometimes interlinked steps: (1) in-

formation activities that ranged from spreading information about SMURF to relevant actors (via e.g. the homepage or SME meetings arranged by the municipality) to informing about SMURF during a specific AIMday, and (2) personal contacts from within the interaction leaders' large network of connections with companies.

Engaging a researcher to interact with an SME in a specific collaboration project was accordingly similar, but somewhat different: (a) a researcher and an SME made a connection on their own, for instance through an AIMday, so that the researcher already had an interest in a UIC-project; or (b) the interaction-leader exploited their knowledge of the university organisation and scientific areas and asked a specific department or an individual researcher if they were interested in the issue expressed by the SME. If the SME was brought in without any prior relationship with any researcher at all, there was often a need to re-formulate the initial problem specified by the SME as to establish sufficient research height and engage a researcher. This last step often took considerable work from the interaction-leader, much more than what was expected from the start of the project. There was a clear need to push the SME in the 'right' direction so that a researcher might find the question posed interesting enough.

All in all, the process of finding collaborations and enrol them within SMURF should follow a procedure that meant (1) finding SMEs that participate in some kind of information meeting, (2) engaging them and (3) formalising the collaboration project.

It was decided that any project that was brought to the project group, regardless whether it was a pre-study or full-study application, should have a presentation on the project specifics and what they wanted to accomplish. It was also decided that during the same presentation there ought to be a discussion on if the UIC-projects might benefit from having a business coach come in and assist in the work. After a short discussion on the role of the business coaches, it was said that the project group should try and steer the projects towards the needs of SMEs. This was to ensure that the companies felt that they got something from working with a researcher.

Another AIMday, this time with a focus on material sciences, was just around the corner and once again, the project team saw a chance to find possible new candidates that could be enrolled into SMURF. The same procedure as the last conference was to be used: market the funding opportunities within the AIMday's sessions and in the general area with pamphlets and posters.

One thing that was discussed during one of the meetings was how they should reach out to SMEs that did not have any connection to UU or SLU? This was a bit of a paradox, by definition the personal or organisational networks that UU and SLU-Holding were part of seemed unlikely to yield any SMEs that had never worked with a researcher. A solution to this was to try and reach out to organisations that might come in contact with SMEs which

were not directly tied to any of the universities. The examples discussed were Uppsala Municipality's Trade and Industry unit which had gotten wind of the project and shown some interest in using it. Uppsala Innovation centre was also mentioned, which is a business incubator in Uppsala and part of the network of UUI.

The following meetings were still very much on how to structure and manage the application process and how to market SMURF in order to have SMEs applying for projects.

- Somewhat of an issue for the group was now how to best use the business coaches and how this service should be offered. Can the interaction leaders in the project group be a business coach in a project? Perhaps they could, but it cannot be budgeted as an extra cost, it has to go into the account code in the budget.
- How much funding should a project receive from the SMURF-budget excluding the mandatory in-kind funding from the company itself? After a short discussion, the amount was set to a maximum of SEK 50,000 for a pre-study and SEK 250,000 for a full-study. It should be clear what costs and in-kind contribution the company had in the project application budget.

During one of these meetings, the group was able to decide on a more structured and formalised routine on how to work with the collaboration projects: After the SMURF project team had agreed that a collaboration project fulfilled the formal requirements and had potential to bear useful results for the SME, one member of the project team, the researcher and the SME, should cooperate in order to write a project plan together that incorporated all of their different agendas. The proposed collaboration project had to be relevant for the researcher in a way that was both interesting and useful for his or her research. It had to specify how and in what way the SME would benefit, namely that a need was met or a problem was solved. Lastly, SLU holding or UUI had to verify that a project plan for the collaboration was specified in such a way that it both fit the regional growth goal of SMURF and helped reach the more specific indicators stipulated for SMURF (see above). After the SMURF-project group formally approved a collaboration project application, UUI and/or SLU Holding should no longer be involved, except for the occasional follow-ups through e-mails or phone calls concerning how the collaboration project was progressing. Collaboration between one of the universities and the company was accordingly formalised in the project, which received financial aid from SMURF. However, no money should move out from the university to the SMEs. SMURF was to pay invoices that came from the involved university departments to cover the salaries of the academic researchers working in a specific collaboration together with the SME, as well as other material costs or laboratory rent.

The group also formalised this ‘ideal process’ of application procedure in a document that was sent out to companies and researchers applying for funding. A copy of it can be seen in Figure 13.

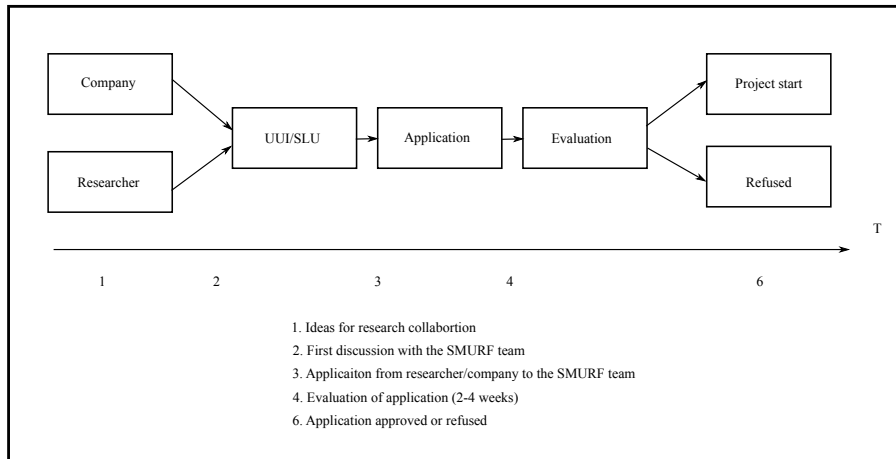


Figure 13. The formalised application process

The invoices from the researchers’ own department were decided to be the main formal mechanism used by the project group to follow up on individual collaboration projects, but there were often personal calls from the responsible interaction leader to the SME or researcher. Upon its conclusion, the SME and the researcher should summarise the collaboration project’s proceedings and results in a final rapport, also stating if the value for the actors had been achieved according to the project plan. At this stage, the SMURF interaction leader in charge of a project inquired if the SME would like to apply for additional funding for continuing the collaboration with the academic researcher, either within SMURF (if the first collaboration was a pre-study) or some other type of funding from regional or national agencies. The activities conducted after a collaboration project’s completion were termed ‘networking’ by SMURF managers, and were viewed as a pivotal component of SMURF. In this context, ‘networking’ was specified from the project group as either a deepened relationship with the same researcher that had been collaborating with the SME or the SME applied for additional funding with a new contact from the universities or for some other financial support that required a connection to a university.

## 5. Year 2

During this first meeting of the year, the group decided all project team members ought to request the companies wanting to apply for funding to

provide the number of employees as well as yearly turnover to make sure that all companies given funding matched the set criteria.

The project team also decided to write a template on what an application should look like. In this way, it would be clear what was expected of the company and the researcher that got funding from SMURF, as seen in Figure 14. It was however thought that this document should not be too rigid; SMURF should be seen as an experimental workshop for companies and researchers wanting to work together

1(2)



**SMURF INNOVATION VOUCHER: FULL STUDY APPLICATION**

Company Name:	University:
Company org nr:	Institution / department:
Contact persons (incl. tfn nr / e-mail):	Contact persons (incl. tfn nr / e-mail):

**Background** Provide a short background description to the project

**Project description (max 1 page)** Briefly describe the planned activities, including timelines where possible.

**Value for the company** Summarise the importance of the project for the company and how the project can lead to the company's future economic growth.

**Value for the participating researchers** Describe why the project is of interest for the participating academic researchers.

Figure 14. The template of SMURF-applications. This is the full study application, but the pre-study looks very similar.

One thing that was still a bit of a headache for the group was the lack of project applications that requested a business coach within the project. Perhaps it was a marketing issue? If this feature of the project was marketed

more, then the requests might increase. It was however suggested that funding allocated to that service might be moved and used to fund additional project applications.

Much of the work that influenced the project took place outside the meeting rooms where the interaction leaders searched, found and pushed for companies and researchers to send an application to the project-group and initiate a UIC. The meetings during the beginning of the second year were increasingly used for feedback and control for new applications coming into the project. The focus was to try and get as many applications for the group to evaluate and as such increase the possibility of handing out more innovation vouchers.

It was around this time that the financial situation was becoming a problem. The person responsible for the project administration was just about to finish with the documentation from 2011. It was clear that the project was lagging behind in spending and the question was what could be used as co-financing/in-kind funding from UUI and SLU-Holding. No clear answer was given other than the importance of the entire project team to meticulously account for everything they could in relation to work related to SMURF. Otherwise UUI and SLU-Holding would be forced to pay for much more of the SMURF-project than intended.

Because of this, SMURF was facing a major obstacle. There were not enough activities and actions from the project group (employees of UUI and SLU-Holding) to cover the costs of handing out more innovation vouchers. As many of the approved UIC-projects were in an ambivalent stage with papers unsigned or only an oral agreement, it was unclear how much more funding the project could hand out without risking UUI and SLU-Holding paying for the project. So it was determined that before the project group could report more time working within the boundaries of SMURF (project managing in the UICs, marketing and so on), no new applications could be approved.

The people present at the meeting wondered what SMURF as a project should accomplish to be *seen* as successful. The common consensus was that SMURF is about the needs of the SMEs. If the companies that get to work with a researcher say they have benefitted then the project is successful. For the SMEs, the project should also be the start of a long-term relationship with one of the universities in general and the involved researcher in particular. At the same time, some people questioned how this should be measured to be sure this had been the case. No one had a concrete suggestion of how to best accomplish this.

In late April, the project manager of SMURF sent an email to the project group explaining that now, after about a month after the 'application ban', reporting of time from the interaction leaders was finally catching up and more innovation vouchers for UIC-projects could be handed out.



During the following meetings, more and more decisions on UIC-project applications were being made through emails within the project group. There were fewer meetings planned for the remainder of the year than had been held during year 1. The ‘ban’ on financing new applications had just recently been lifted and meetings were mostly focused on the ever growing project database in the Excel sheet. In the meetings, the project group also made the conclusion that financially the project would never be able to reach the estimated budget. There were not enough activities from the interaction leaders and they saw no reason for that to change. Because of this, the project manager sent in a request to TvV to cut SMURFs budget significantly. This did not have a noticeable effect on the previously funded UIC or the ones who later got funding. Instead, the lower budget meant that the project group was less pressured to hand out more innovation vouchers as fewer UICs could be given funding.

In total, 16 UIC-projects had been funded and either started working or finished with their activities during 2012.

## 6. Year 3

The reason for providing the reader with a story of SMURF was to highlight those aspects that had a direct impact on the UICs the project funded. In the third and final year of the project, meetings between the project group became sporadic and much less frequent as work focused on bringing new UICs into the herd. The process, activities and routines that had developed over the two years that had gone by were established and did not change significantly during year 3. More UICs applied and got funding through SMURF, making the final number of UICs 27. The third and final year of the project was mostly about new applications coming in to the projects. Most of the decisions were made in emails between the interaction leaders in the project group. After the budget had been cut, the work was more straightforward and the process more streamlined. A lot of focus was directed at finalising the project, making sure all UIC-project reports were handed in and everything was accounted for in the books

## 7. Summary and conclusions of the SMURF-project

The work the project group did during the project lifetime defined the UICs that they funded. They created a framework and a process of finding and selecting projects that fit that framework.

Much work during the beginning of the project and during the first year was focused on answering the many questions surrounding the project as well as establishing routines for handling a variety of processes:

3. The layout of project applications and what information applications from a company and researcher should have
4. Criteria for which type of companies should be included in the project to get funding
5. How to deal with the co-financing from SMEs.

Two processes that emerged during the first year were the process of finding and handling project applications. The first one was how the interaction leaders found UIC-projects. There were two primary sources that the interaction leaders used when finding and/or pushing for a company to apply for funding with a researcher: through marketing SMURF at events that companies in the target group might take part in (e.g. AIMdays or municipality company information meetings). Even more important were the personal networks that each interaction leader brought to the table as well as the networks offered by the members in the steering committee. This was followed by the interaction leaders formulating an application together with the company and the researcher. The application had to adhere to all the parties' requirements as the application was in effect the joint project plan for the UIC.

The second process can be summarised into 3 logical steps: 1) the project team made a joint assessment if an application was to be rejected or approved; 2) an agreement was signed together with the company and the researcher; and 3) after the UIC-project had ended, an invoice was sent to UII from the researchers' department specifying what costs the department had in relation to materials or salary. Most UIC-projects had a timespan between 3-6 months. In this way, no financial means were transferred from the university to any company: this was managed by providing the companies with an innovation voucher used to pay the researcher working with them (as well as material costs).

There were many instances where these frameworks were under renegotiation and sometimes a decision was overturned because of what happened with the UIC and the difficulties the interaction leaders faced finding possible candidates. For one thing, it was decided that the project group should try to find any projects regardless whether they had connections with UU or SLU in the beginning in order to try out the application process. But in general, the basic criteria listed above were kept intact and formed the basis for the application evaluations and continued work.

When work was approaching an end for the UIC-project, invoices from the researchers' own department were decided to be the main formal mechanism used by the SMURF project group to follow up on single collaboration projects. Upon its conclusion, the SME and the researcher summarised the collaboration project and the results in a final report, also stating if the value for the actors had been achieved according to the project plan. This document was sent to the project group and archived. At this stage, the SMURF

interaction-leader in charge of a project inquired if the SME would apply for additional funding for continuing the collaboration with the academic researcher, either within SMURF or some other type of funding from regional or national agencies.

In some instances, the interaction leaders had to work hard in order to initiate a UIC. They could not just hand out funding to anyone applying. They had to balance the needs of the researcher with the needs of the SME according to the structure and criteria they had decided on. This proved difficult in some instances and especially with those SMEs that had never previously worked together with a researcher. It was less common that a company found a researcher and from there approached anyone in the SMURF-group, the applications coming out of AIMday were an obvious exception. Most of the time, the interaction leaders acted like matchmakers, finding companies and then matching them with researchers at one of the universities. The group did put some efforts into marketing SMURF towards a variety of channels, but in the end it was the interaction leaders' own networks along with AIMdays that facilitated a flow of UICs towards SMURF.

During the second year of the project, SMURF really seemed to take off with plenty of applications and approved projects. However, the project also faced a number of hurdles with no projects requesting a business coach and much less anticipated project management from the interaction leaders in the specific UIC-projects. Since much of the criteria and processes were known by everyone in the project, more and more of the evaluation process was moved from the meeting into emails. An application attached in an email was sent out to the entire group and if everyone agreed that it fit the established goals and criteria of SMURF, the application was approved. It was a general reliance on each interaction leader's ability to rally companies to the project; if that person felt sure a project could fit in SMURF and an official application was produced, it most of the time got approved by the group.

In the end, only two projects used a business coach. This limited use of business coaches can be interpreted in two different ways: (1) the companies and the researchers felt that they had had enough experience working with companies/university researchers that they did not need the extra help; or (2) the practice that was part of the project was so close to their counterpart that there was no need for a facilitator of those practices. Both of these points to the difficulty the project-group had in finding companies that were far from the universities and would have benefited from having a business coach when collaborating with a researcher. One of them (Metahyd) already had a business coach, provided by another innovation office, with the same role that the SMURF-group pushed for. Nevertheless, the project group decided to continue paying that business coach.

The results generated from each of the 27 UICs that the SMURF-project gave funding to can be seen in Table 2 and in Appendix 1. After completion, a project report was sent in specifying what had been done, how the work

had progressed and what to do in the future. The document also described what type of value each company and researcher believed he or she had gotten out from the collaboration. The table also shows which SMURF-defined business sector each company was included in and how much funding the SMURF-project contributed to each project. It is interesting to note that a majority described getting 'new knowledge' from the collaboration as its major value and only a few claim to have developed something tangible and new.

		Funding from SMURF	SMURF defined industry sector	New knowledge	New product/ service/method	Improved product/ service /method
1	<b>Mercodia (two projects)</b>	<b>320,000 + 57,000</b>	<b>Life science</b>	x		
2	Cebix	(part of a mercodia project)	Life science	x		
3	Skogsbackens ost	50,000	Life science		x	
4	Glucos Biotech (two projects)	50,000 + 263,000	Life science	x		x
5	Synartro	250,000	Life science	x		x
6	EcoEtanol	250,000	Life science	x	x	
7	VasaTech	250,000	Life science	x		x
8	Björks Rostfria	50,000	Material	x		x
9	Damasteel	50,000	Material			x
10	Sverige Grepen	50,000	Material	x		
11	<b>Metahyd (two projects)</b>	<b>50,000 + 200,000</b>	<b>Clean Tech</b>	x		x
12	Lembke Mekaniska	250,000	Material	x		x
13	Parans Solar Lightning	250,000	Material	x		
14	<b>Svenska Aerogel (two projects)</b>	<b>35,000 + 210,000</b>	<b>Material</b>	x		
15	Kontigo	250,000	HumSam		x	
16	Fjällbete	250,000	HumSam		x	
17	Vallonbruk I Uppland (Two projects)	27,000 + 250,000	HumSam	x		x
18	APRtech	170,000	Clean Tech	x		
19	Tolpargoni	250,000	HumSam	x	x	

20	Destination Tämnaren	244,000	HumSam	x		
21	Destination Älvkarleby	250,000	HumSam	x		
22	Upplands Friskvårdshus	245,000	HumSam	x	x	
23	Business- nätverket Turism Forum	50,000	HumSam		x	
24	Lo- kalkapital	220,000	HumSam			x
25	Imagina- tion Studi- os	215,000	HumSam	x		x
26	Wildlife Sweden	50,000	HumSam	x		
27	<b>GisGrup- pen</b>	<b>250,000</b>	<b>HumSam</b>	x		x

Table 2. Funded UICs. Companies that are part of the embedded case studies are in bold.

One of the main goals of SMURF (*the* main goal as some of the interaction leaders would say) was to create long-term relationships between the included companies with the universities, since these companies basically have no capability to fund basic research. Many of the companies agreed to that statement and, for a majority of them, the possibility to create new contact within the university was the main reason to initiate a UIC-project.

The overall goal that SMURF had, to create 20 employment opportunities over the project period, was from the interaction leaders' point of view largely unobtainable. However, the interaction leader did not think that the chosen indicator applied to the work they did and did not think it was a goal they would obtain or could influence. First of all, it will always be the other actors, the SMEs, who have the direct power to act in such a way that this goal or specific indicators are met. It will be hard for a small project like SMURF to impact employment levels. It is also not certain that such a blunt tool used to measure economic growth will demonstrate the very thing it seeks to measure. Many companies claimed through the interviews that they had gotten great value from the collaboration and that the business had grown because of it, but it did not generate any employment.

## 8. The practices within SMURF and its effect on the collaborations

There were a number of activities that were performed during the SMURF-project that had a direct impact on the four case studies and the practice analysed within them. In fact they would likely never have come about without the project. As this thesis takes a practice approach it is therefore essential to highlight the connections between SMURF's practice and the practices in the specific collaborations. To put it differently, what the interaction leaders did, what happened within the SMURF-project, formed the pre-condition for how the practices within the funded UICs developed.

The practices that constituted the project were first and foremost what I will call an 'administrative practice'. This practice was formed around the administrative and managing parts in the project. This practice was divided over a few individuals, but was predominantly carried out by the project manager. Secondly, I call the other practice involved in SMURF a 'brokering practice' of which all of the participating interaction leaders along with the project manager were carriers. In this way, the admin defined the inner workings of the project: managing people, coordinating resources, creating a structure, defining how work should be done, etc. The brokering practice was about what happened in relation to the UICs: finding companies and researchers, reaching out to networks of people, writing project applications together with the companies and researchers, etc. These two practices were then intertwined and connected as both of them affected the other throughout the project. They should not be seen as clearly separated because, like all practices in the same site, they are interdependent on one another (Schatzki 2009).

I identify two separate practices being part of the SMURF project because not all the activities within SMURF could be group under a single 'administrative practice'. I put those activities together under a different practice, a 'brokering practice'. Practices are said to be common observable entities and as some activities could not be fitted into elements of one, then logically they must be part of another.

The administrative practice contained a material arrangement containing some project management tools: e.g. an Excel chart with all the project applications, Power Points and an electronic folder with all the project documents. There is competence from both the material arrangements in the knowledge that has been inscribed in the tools, but also in the individuals at the centre of this practice. The individual carries knowledge and experiences on how to act in the appropriate way as a project manager, being structured, entrusting and communicative. There is also meaning in the successful managing of the project activities, in engaging people in acting in a way that will bring the project to completion and success.

The administrative practice is defined in part through the work that is done in the formulation of the application. The practice defined how activities should be managed inside the project and be performed towards SMEs without any connection to UU and SLU. The administrative practice also created selection criteria that then in turn connected to how the brokering practice was carried out. The second process that the administrative practice defined and in large part contained was the assessment of applications: if they should be rejected or approved. In such a way the administrative practice connected with the brokering practice and both practices mutually shaped what happened in SMURF.

Moving into the specific of what I call this brokering practice, it is defined as separate but connected to the administrative practice. The three practice elements that define it are a material that is mainly centred on the individuals. This practice does make use of material infrastructure like emails or the phone, but the body is the carrier of a special kind of competence and meaning within this practice. These individuals (the interaction leaders) possess double competence having combined experience in academic research and experience from managerial positions in business (Jonsson et al. 2015). They have been part of these practices and have lingering knowledge of them allowing this brokering practice to connect to a diverse set of other practice elements and practices within research and business. The practice element of meaning is directed to the successful mediation and connection of other practices. In fact, it is possible to define the interaction leaders as not only having a brokering practice; they are in fact broker individuals as defined by Burgess and Currie (2013):

Individuals belonging to overlapping groups who allow knowledge sharing between communities and actors who use their in-between vantage position to support innovation through connecting, recombining and transferring to new contexts otherwise disconnected pools of ideas

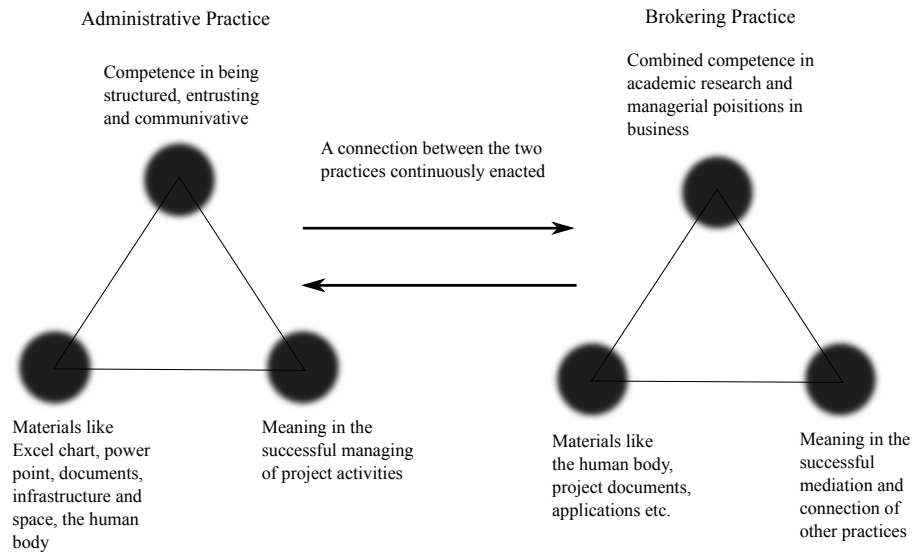
A large part of this brokering practice in SMURF is about the movement and bridging of practice elements between other type of practices, i.e. in this setting business and research. The brokering practice is largely able to carry out work through the individuals that carry it; they have social networks that allow the brokering practice to make connections with practices within the university or the SMEs. This was followed with how this practice influenced the UICs: the interaction leaders' brokering practice stretched to their involvement in the formulation of the application together with the company and the researcher. The application had to adhere to all the parties' requirements and the application was in effect the joint project plan for the UIC. In this way the brokering practice 'brokered' the UIC.

The activity of writing together the application was in turn connected to activities that involved marketing, which is also part of the brokering prac-



tice. Marketing was performed when finding and/or pushing for a company to apply for funding with a researcher (and vice versa), i.e. SMURF was advertised at events that companies in the target group might take part in, such as AIMdays or the municipality's company information meetings. These activities allowed for the brokering practice to connect to both business and research practices through the individuals that carried them.

In many instances the brokering and the administrative practice collaborated together in moving the project forward (see figure 15). These two practices were present in the same place and were able to connect in a variety of ways. Specifically one can see how the activities of the two practices intertwined in some parts of the empirical outline above.



*Figure 15.* The connection between the two practices involved in the SMURF-project.

The process connecting the practices involved in SMURF can be summarised as followed: after the SMURF administrative practice had decided through the individuals in the project that a proposed UIC application fulfilled the formal requirements (the criteria's listed above) and had potential to bear useful results for the SME, one member of the project team, the researcher and the SME, wrote the project plan that should allow for the possibility for a business, researcher and brokering practice to reach their inherent standard of excellency (Keat, 2000). By that I mean that the individuals (the interaction leaders) involved in the practices had the potential to perform the above-mentioned practices to its full (normative) potential. Practices always strive towards an inherent standard of excellence as outlined by Keat (2000). Every practice involves a set of standards that serves to identify what counts as a good or bad way to perform it, suggesting that there is always some way

of doing something to its outmost perfection, a normative ‘best way’. The proposed collaboration project had to be relevant for a research practice, and had to specify how the business practice would benefit, namely that a need was met or a problem was solved.

Lastly, SLU holding or UUI verified that the project plan for the collaboration was specified in such a way that it both fit the regional growth goal of SMURF and helped reach the more specific indicators stipulated for SMURF (see above), i.e. allowing both the project management practice and the brokering practice to reach their goals. The brokering practice was able to link the practice element of meaning between the business and researcher thus allowing a connection between them. The next section will deal with four cases of UICs funded by SMURF in a much more detailed manner, revealing how this connection between business and research practice can come about. In this scenario, even before the UICs have begun, all the practices performed by interaction leaders within SMURF have the potential to reach their standard of excellency. Figure 16 illustrates this process.

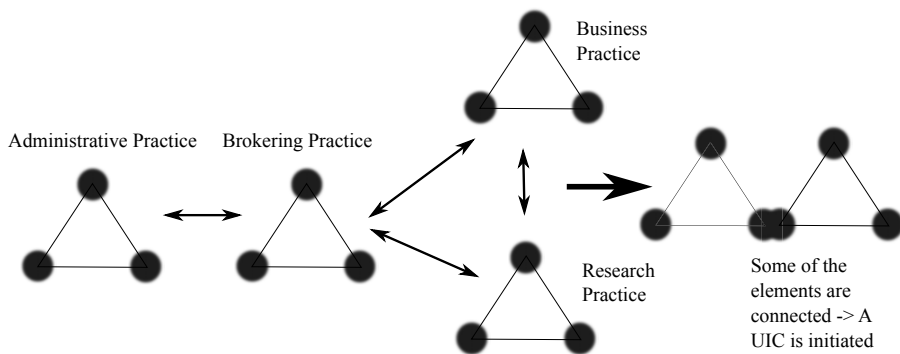


Figure 16. The connections between practice in SMURF and the selection process of UIC

The point of this outline of the administrative and brokering practices that were performed by the interaction leaders in the SMURF-project is to unfold the connections with the practices that will be outlined in the UIC-cases. These connections are listed below:

- It was emphasised in the application that the company and the researcher wanting to collaborate should not have done any work together before. It had to be a *new* collaboration. The project sought to create new long-term relationships between SMEs and SLU or UU, not encourage already existing ones. This meant that all the practices that collaborated in the UICs had to create new connections.
- The UICs had to have ‘academic quality’ but also ‘business relevance’ i.e. there should be something in it for the SMEs *and* the

researcher(s). The four UICs that are described below had to be structured in such a way to receive any funding, and this made the work they did both explorative (in the sense that it had to be research oriented in some way) and not a 'one sided consultancy delivery'. Both parties had to demonstrate a clear possible value gain from the expected results in the application/project plan.

- No money was to be moved from the university into the SMEs. SMURF was to pay invoices that came from the involved university departments to cover the salaries of the academic researchers working in a specific collaboration together with the SME, as well as other material costs or laboratory rent. In this way, the practices connected to the businesses had to manage a situation of shared resources
- It was decided that each individual collaboration project could be financed either as a smaller pre-study, receiving a maximum of SEK 50,000 or as a larger full-study, receiving a maximum of SEK 250,000. That meant that the SMURF-money could not sustain the involved practice for long. SEK 250,000 including overhead for a salary for a senior researcher does not get you past a few months of work (depending on the type of project).

The companies had to be small, no larger than 250 employees. The largest company granted funding only had 60 employees. It is well known that small companies are different than larger ones when it comes to innovation and external interactions, and this in many ways had implications for how work was done in these collaborations compared to how collaboration between universities and companies in general are portrayed in the literature.

## Chapter VI: UIC 1, The Material in the driving seat

This was one of the biggest collaborations within SMURF having a sizable amount of funding as well as commitment from both parties. The collaboration followed the work process that the SMURF project group had developed: first the two partners applied for a ‘pre-study’ grant in order to evaluate their idea, which then led to the partners applying for a larger ‘full project’ grant.

### 1. The company

Svenska Aerogel AB is a small business with 11 employees, defining themselves as a R&D company. Christer Sjöström, a professor emeritus from the Royal Institute of Technology, created the company early in 2000 but mostly as a means to get funding for his own research. This changed around 2010 when Christer after a long carrier in academia decided to retire and instead give his entrepreneurial idea a chance. He is now the main shareholder and chairman as well as Head of R&D in the company. Svenska Aerogel AB’s business is based on production of an aero<sup>6</sup>-like material called Quartzene, which unlike most of the conventional production steps of aerogel has excluded the costly and energy demanding ‘super critical’ phase. The technique they use is instead based on a method where silica is added to water to form a gel/slushy. The gel is then washed and dried through air blowing and the final product is a white powder that contains grains of varying size with very similar characteristics as aerogel. As the ‘super critical’ phase has been

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<sup>6</sup> Aerogel is a synthetic porous ultra-light material derived from a gel, in which the liquid component of the gel has been replaced with a gas. The result is a solid material with extremely low density and low thermal conductivity. Aerogels can be made from a variety of chemical compounds. Aerogel was first created by Samuel Stephens Kistler in 1931, as a result of a bet with Charles Learned over who could replace the liquid in "jellies" with gas without causing shrinkage. The liquid is extracted through a supercritical drying phase and produces Aerogel. This allows the liquid to be slowly dried off without causing the solid matrix in the gel to collapse from capillary action, as would happen with conventional evaporation. The first aerogels were produced from silica gels. Aerogel is not a designated material with a set chemical formula, but the term “aerogel” is used to group all material with a certain geometric structure. (Wikipedia 2016)

removed the gel must be kept as chemically stable as possible through all the stages or there is a risk of losing the materials aerogel-like qualities. Depending on the modifications of these stages the process yields different properties of the material, i.e. variation of pore sizes of the grains. Some stages in this process are patented, but not all, and the exact recipe is a closely guarded secret in the company. The company's business plan is based on the properties of Quartzene and the ability to adapt and customise aerogel for different applications constitutes the company core capabilities.

## 2. The researcher

Professor Klaus Leifer earned his doctorate in physics at the Swiss Federal Institute of Technology in Lausanne (EPFL). In his thesis, he focussed on materials analysis and in particular electron microscopy (EM) techniques. After finishing his thesis he worked as a researcher at EPFL concentrating on metallic multilayers, semiconductor nanostructures and beam induced deposition techniques. In Uppsala University he has become the research head of a small sub-group with about 12 people in the division of Applied Materials Science at the Ångström Laboratory. The group focuses on quantitative EM analysis of materials that take their functionality from nano-objects down to single atoms, the fabrication of nanomaterials and nano-devices. The establishment of structure-property relations is one of the main topics of their EM activity. They also develop new techniques with EM currently working with 3D electron tomography, electron magnetic circular dichroism (EMCD), fluctuation EM (FEM), strain analysis and quantitative EDS analysis<sup>7</sup>.

## 3. The projects

Christer Sjöström and Klaus Leifer first met at AIMday Materials in 2011. Christer sent a question to the conference organisers concerning characterising of Quartzene and Klaus was asked by one of the staff from ÅMA if he would be interested in taking part in the session. Klaus attended the session, gave a suggestion to Christer on how one might go about characterising Quartzene and the two began discussing how to practically do what Klaus had suggested. Together, they got in touch with ÅMA and it was suggested that they should send in an application to SMURF for a pre-study on their idea. Quartzene might theoretically have properties similar to other aerogels,

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<sup>7</sup> It is not of importance what each of these techniques actually entails. I only bring them up to highlight how important the EMs are for the research group and how most of the things they do is in relation to these devices.

but it was essentially a new material that, on a molecular level, was largely unknown even more so in relation to how conductivity changes when it is manipulated (e.g. when the material is compressed).

This collaboration was one of the largest within the SMURF-project providing SEK 35,000 SEK for the pre-study and then SEK 210,000 for the full study. The company and the researcher also put in their own resources making the total budget amount to SEK 395,000 SEK for the pre-study and SEK 410,000 SEK for the full study, respectively. The overall objective of both the projects was the understanding of the effects compression has on the thermal conductivity of Quartzene.

### 3.1. Pre-study

Funding for the pre-study was approved on 7 February 2012. The pre-study was used to evaluate the feasibility of an idea the company and the researcher had on how to characterise the material of interest. The collaboration activities consisted of using an SEM<sup>8</sup> at Ångström Laboratory to study the surface of Quartzene. The focus of the pre-study was to look for differences in pore structure between eight different samples of Quartzene. The work was done during 2012 shortly after the study was given funding. Although these initial and explorative investigations met with some difficulties (e.g. the test/sample preparation and the charging of the samples proved very demanding) the pre-study was considered successful as it achieved the overarching objective, i.e. to reveal the possibilities of the analyses utilised.

The work that was performed in this study exploited two EM techniques at the lab in Applied Materials Science at UU. There were no activities required from Svenska Aerogel in this first study as they supplied the Quartzene produced in their facility as described in the presentation of the company above. Work within the project was done in 3 stages: 1) Analysis on eight samples and optimisation of analysis conditions. 2) Analysis of these eight samples under optimised SEM imaging conditions. 3) Analysis of five more samples. The pore-size and grain size distributions were said to be important parameters for understanding the Quartzene materials. Quantitative pore-filling methods are highly relevant to understand the functional properties of Quartzene and the microstructural analysis using EM techniques such as SEM and TEM<sup>9</sup> (Transmission EM).

The practice of performing an SEM or TEM is quite straightforward but involves a lot of fine-tuning to get the best possible result. The first thing that needs to be done is to prepare and load the sample: The sample with the

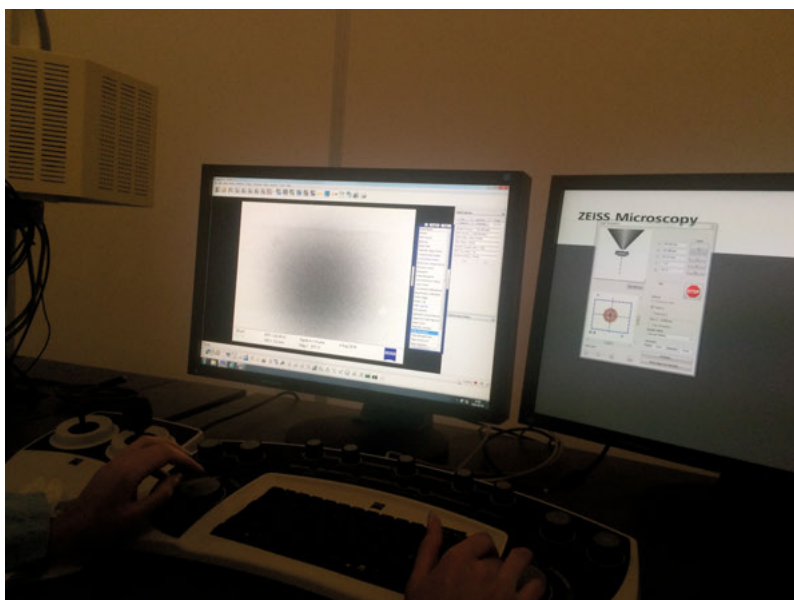
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<sup>8</sup> A type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons.

<sup>9</sup> An EM technique in which a beam of electrons is transmitted through an ultra-thin specimen, interacting with the specimen as it passes through.

material in question is placed on the sample stub; the SEM chamber is then ventilated, allowing the chamber to reach nominal pressure. Then the sample is put into the sample chamber. The sample compartment is closed and pumps turned on allowing the system to reach vacuum. Air within the chamber could interfere with the electrons possibly giving a blurred image output. The sample is now loaded and ready to be analysed. By using 'auto focus' in the SEM software the technician acquires a focused image of the sample to use as a starting point. It is then a matter of manually adjusting the exterior knobs and using commands that correspond to different functions of the SEM-software (magnification, focus knobs, fine focus knobs and stigmation, seen in figure 17) in order to get the clearest focus as possible on the area of interest of the sample. Depending on the sample and aim of using the SEM this may take several hours of meticulous work adjusting the focus between different magnification levels until a good enough picture can be captured. Generally, the more skilled and/or experienced the person operating the machine the faster this is achieved. What is termed 'a good enough image' is to some extent a judgement from the technician, although there is a technical limit on quality depending on the specification of the EM.

When a good enough image has been produced (well enough focused and aligned), it is possible to take a measurement of the sample-area in real-time. This was particularly useful in the aero-like material in this study as the pore size was the main focus of the work. However, since time with an SEM is often limited, as it is a shared machine that needs to be booked, it is more common to use software on the image for further examinations of the material. This was the case in this project and the program used was called Imag. The program allows for further improving the representation: calibrate the image according to scale, make some changes on the image for better contrast as well as reducing the existing noise on the image. The technician can then manually measure every particle or automatically measure hundreds of particles and get a histogram of particle size diameter/frequency for the region of interest.



*Figure 17.* Showing the knobs and keyboard that control the EM and a very blurred picture of the sample-area

Early in the project there were difficulties of getting any images of the material with the SEM analysis, as the silica molecules become charged when bombarded with electrons. The UU laboratory technicians managed to optimise the acquisition times, electron beam current and acceleration voltage and found the best conditions for imaging. In the second step, the lab carried out a refined analysis under these optimised imaging conditions.

The full analysis report was delivered to Svenska Aerogel AB, read by Christer and then discussed together with Klaus on how to proceed. After the first analysis, Svenska Aerogel sent more samples and the pore sizes were analysed at the Ångström Lab again under the same optimised SEM imaging conditions. An analysis report was once again delivered to Svenska Aerogel. Svenska Aerogel was after this first study very interested in further analyses and continued collaboration with Klaus and his group. From Svenska Aerogel's position, the information they could deduct from this rather small study was mostly known beforehand.

It did not give me anything essentially new that I didn't know before, it initiated the collaboration and caught the eye of and interest of Klaus, et al. As an old academic you know what a researcher wants is something challenging that can give interesting results - Christer Sjöström

The study was ultimately a way to reel Klaus and his group into a deeper collaboration with more commitment and more (perhaps) funding. Fittingly, just after the pre-study completion, the division of Applied Materials Science



at Ångström Laboratory was about to install a new SEM of very high quality and different technical specifications and it was theorised that it too could be used to further analyse Quartzene samples. Klaus suggested that using a FIB<sup>10</sup> on the samples could also be a way of acquiring novel information about the Quartzene material. Additionally, Christer and Klaus wanted to explore the possibility of using FIB in order to reach the inner structure of the material.

### 3.2. Full project

The full project was approved on 20 December 2012 after the SMURF project group reviewed the pre-study report and the full study application. The larger project was essentially a continuation of the analysis strategy from the high-resolution SEM work from the pre-study. The practices performed were also essentially the same. The difference was that a new SEM was used in this project that enabled a significantly higher imaging quality on the Quartzene samples. The new SEM provided extended features for imaging of isolating samples as well as a FIB depth analysis and TEM-3D tomography. The strategy for the analyses was divided into three milestones: 1) SEM to obtain a true high-resolution image of the surface of the Quartzene, 2) FIB to cut the sample and obtain depth information at high resolution, and 3) TEM 3D tomography applied to the Quartzene material to enable imaging of the material. The project was carried out during a nine-month period in 2013. The project time plan was divided into three milestones in which the partners were to meet after each milestone completion or every two months: 1) SEM: analysis of pores of up to 20 samples, 2) FIB: analysis of eight samples, developing depth imaging and taking first steps for 3D FIB imaging, and 3) TEM: 3D tomography on two samples. The Ångström Lab carried out most of the actual work within the project, but Christer along with another person from the company took part in at least two experiments. Work essentially meant samples being sent to the Ångström Lab from Svenska Aerogel's production facility and experiments and analyses were done and information on the results were sent back to the company, similar to within the pre-study. But, in this study, Christer was present on two occasions.

The end result of the project was described by both partners as very beneficial. More precisely, the research value was specified in the final report as

Demonstration of a completed toolset for characterisation of porous silica media in the spatial domain is of significant interest to the academic community. Once the correlation between thermal conductivity and the porous struc-

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<sup>10</sup> FIB resembles an SEM. However, while the SEM uses a focused beam of electrons to image the sample in the chamber, an FIB setup uses a focused beam of ions instead.

ture of these powders can be quantitatively demonstrated, it will be published in a peer-reviewed journal.”

The company highlighted similar values in the same report:

Contribute to the deeper understanding of how the composition of the nanoporosity of the material facilitates the set of important properties of the products, regardless whether this applies to thermal insulation, molecular filtration, or other main industrial application areas. The Quartzene materials are always used as ingredients in other material matrixes, and further analytical studies of the above mentioned character of samples from such end-use products can also be foreseen.

Klaus is used to working with companies and is often asked to do different types of material characterisation or called upon as an expert and adviser. He does this not primarily as a way to forward his own research; instead he mentions two reasons: (1) as a duty or service that every researcher should be involved in as a contribution to the surrounding society and (2) to be aware of “*what’s out there*” in order to keep both his own research relevant and educate students and PhDs in the needs of the companies. This type of smaller cooperation is often a bit problematic: they take time, often have little scientific aim and there is not really a great deal of money coming into the department. He instead thinks that the best types of collaborations are those where the company is either willing to invest time and money or applying for funding together. The companies are then more committed to do something substantial.

The projects with Svenska Aerogel were different for Klaus for two reasons than other types of projects that he had worked with over the years; Svenska Aerogel is a small company, while most of the work he has done has been with larger companies where it might be difficult to communicate or bureaucratic. The smaller Svenska Aerogel instead gave direct access to key persons and information could flow more freely between Klaus and the company. He felt that they could establish a more informal relationship and this made work much easier with Svenska Aerogel. Along with others involved, it was a “great chemistry” and “open climate” where information could flow freely between the parties. Klaus and Christer developed an informal way of talking with one another, emails and phone calls were made directly between them and with little regard to formal etiquette<sup>11</sup>. The second reason that made this collaboration special for Klaus was due to Christer’s long career as a professor and in depth knowledge about research and insights into the academic world; he understands what is required to work with a university very well.

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<sup>11</sup> In all other cases, I have gotten excess to emails that were sent between the actors in the project(s). In this case, I therefore cannot give an example of the communication practices that were involved in the work other than the description above.

As Christer was knowledgeable about the wants and needs of a university researcher, he could balance the tension between doing interesting research, i.e. providing value for Klaus, and also delivering value to him and the company (specified as one of the demands in the overall SMURF-project). Christer accepted a more explorative approach for analysing the samples and thus gave the opportunity for Klaus to find room for interesting research questions within the collaboration, as Christer puts it:

It is a matter of always finding a win-win situation – Christer Sjöström

In this collaboration much of the work seem to have been driven by the curiosity of Christer and Klaus in that one was seeking to further the understanding of the Quartzene material and the other in develop new methodologies for EM with this essentially new material. For Christer this collaboration was about his aim to develop new composites that incorporate Quartzene, and understanding their material would increase the success in accomplishing this. It was a matter of being able to help any customer that would use any of their future products and a deep understanding of their material is essential for him. Klaus could contribute with knowledge on how material characteristics on the micro scale, something the company didn't know much about.

Still Klaus highlights some issues that he faced when working with Svenska Aerogel: as a way to protect company secrets about Quartzene he was not given all the exact properties of the material, only the information that he needed to perform the particular analyses specified in the project plan. This was not a problem in doing what needed to be delivered, but it did prevent him from elaborating on what other experiments or analyses he could do with the samples. Thus, this did not give him the opportunity to utilize his full potential as a researcher.

None of the parties could immediately after the full-project had ended point to any clear, concrete, outcome from the projects. There were no joint publications and no new people employed at Svenska Aerogel connected to the work with Klaus. Christer was, however, very positive overall about what had transpired in both the projects as such and the continued collaboration between him and Klaus. There were few tangible results that came out of the project. Instead, it was the deepened understanding of Svenska Aerogel's product that Christer viewed as very beneficial. But beyond that, Christer emphasised the relationship he and Klaus had established over the years. He hoped that they could continue to work together for a long time. He felt that Klaus possessed expertise that they lacked and, together with the state of the art equipment at the Ångström Lab, Klaus and the rest of the group provided invaluable expertise and support.

The most important, if I have to choose even though this is one thing that apparently goes together, it is undoubtedly the relationship in the collaboration, but that we also got those concrete results – Christer Sjöström

Still, in the end, the full-study part of the project managed only to reach the first milestone, even if work was also started on milestone two. According to Klaus the laboratory work was very time-consuming, which then explains why they did not manage to reach all of the milestones.

In the beginning of 2014, Klaus and Christer got more funding, not much, but enough to keep on going with their shared work on questions that remained after the last SMURF funded project ended. Shortly after this funding ran out, as a way for Klaus to keep working with Svenska Aerogel, the company was asked and later involved with a university course where third-year chemical engineers worked on analysing Quartzene samples for Svenska Aerogel over three months. The amount of work was small, but still Christer felt that they got some interesting results in furthering the understanding of the material. Around that time, there was talk of hiring a joint PhD student who could continue working on analysing Quartzene. Klaus thought that the material was very interesting, purely on a research level and warrants a more thorough exploration. Christer saw it as a possible way to strengthen the relationship to Klaus and the rest of his group while also being very good for the company. Funding for such an undertaking was unclear in late 2014. Then, at the end of the same year, Svenska Aerogel hired a new co-worker, who, after some discussions with Klaus, became a co-funded PhD-student by Klaus' department. Both Klaus and Christer pointed out that this was an important step in deepening their collaboration together as well as partly a result from the funding they got from the SMURF-project. Klaus points out that the PhD-student will move the collaboration from having interlacing interest (characterisation and method development) towards the *same* interest and goals.

It's with this PhD-student we connect ourselves much stronger in building a methodology regarding material analysis together. We will grow more together now – Klaus Leifer

The projects that this new PhD-student was to engage in even more highlighted how Klaus and Christer structured their collaboration primarily around Quartzene in combining research on methods for analysing the material on one hand and product development on the other hand. Over the years, the PhD student will come to work with more characterising of Quartzene in a variety of forms with different EM techniques.

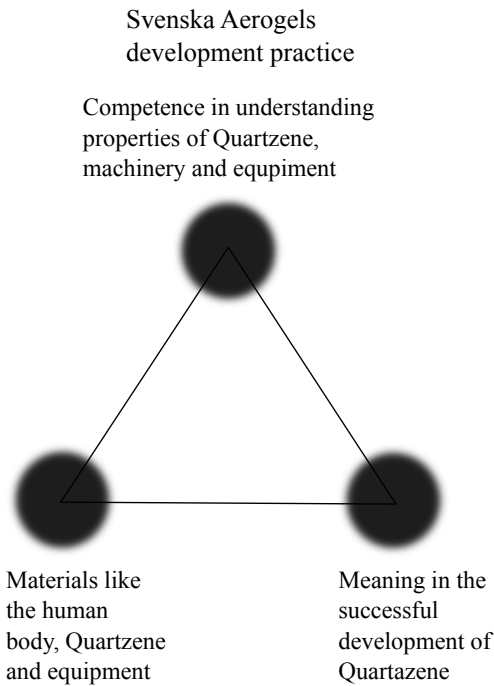
## 4. Analysing the practices, connections over sites and institutions

From a practice theory perspective, one must first try and sketch out and argue for how the practices of interest are arranged within this collaboration. Having no prior relation before the pre-study, one can see how the practices involved are connecting and developing. At centre stage was a type of research and development practice that was carried out by both Klaus and Christer.

All practices have a history and they are assembled with practice elements that exist out in the environment as resources (Shove et al., 2012). Practices always build on previous practices that have been developed into their present state, i.e. they do not just ‘pop-up’ and start to exist. So in order to understand what is happening within this collaboration, one must describe which practices are involved beforehand and then move into the interaction of those practices within the collaboration described above. Within this collaboration, it is also clear that two individual actors played an intricate part, Klaus and Christer, their agency was what had the most effect on the work that was done.

The company in this collaboration defines itself as “research heavy”; they develop a special type of product based on previous research from an academic setting. It is an attempt to ‘make business’ out of this development, creating a line of products that can be sold on a marketplace. As such, we can talk of two practices present within this company, a business and a development practice, of which some practice elements are shared. One part of the staff work in a laboratory and production environment and another part in marketing and selling the outcome of the development practice. The manufacturing of Quartzene is done in-house and is a delicate process that involves a lot of labour-intensive steps, machines and people alike. They also employ testing and laboratory techniques in order to try and analyse the outcome of the final product. Depending on the modification of production stages, the process yields different properties of the material; specifically the pore size of the Quartzene powder will vary depending on how the process is altered. It is this that constitutes the company’s core business as different sizes of the powder and pore size allow for diverse product usages.

This ‘development practice’ consists of a material element with machinery, Quartzene and equipment. There is competence involving both understanding of intricate machinery and knowledge on Quartzene. There is meaning in producing a product/artefact that can be useful for users and generate revenues. We can thus talk about this as a separate type of practice. It has an inherent drive towards the excellence of developing Quartzene (see Figure 18).



*Figure 18.* The development practice of Svenska Aerogel

Secondly the outcome of this development practice is connected to a business practice and the activities of marketing and selling Quartzene. Here very different practice elements come into play. There is practice element of meaning around the goal of getting this new product out into the market, competence in being able to understand what others value in Quartzene, and a material element in infrastructure (email, phone, etc.), the body of marketers and salesmen and Quartzene itself. This practice (being a business practice) is close to and depends on “the market” (Keat, 2008): it is about making money, to advertise, to sell Quartzene and in this way create resources for its own existence (see figure 19). Moreover, in this way it is also providing the conditions for the development practice to sustain itself. In such a way, these two practices are mutually dependent on each other in that they share Quartzene as both meaning and material. It also means that the development practice is connected to the institution of the market and depending on sharply different conditions than a research practice in academia.

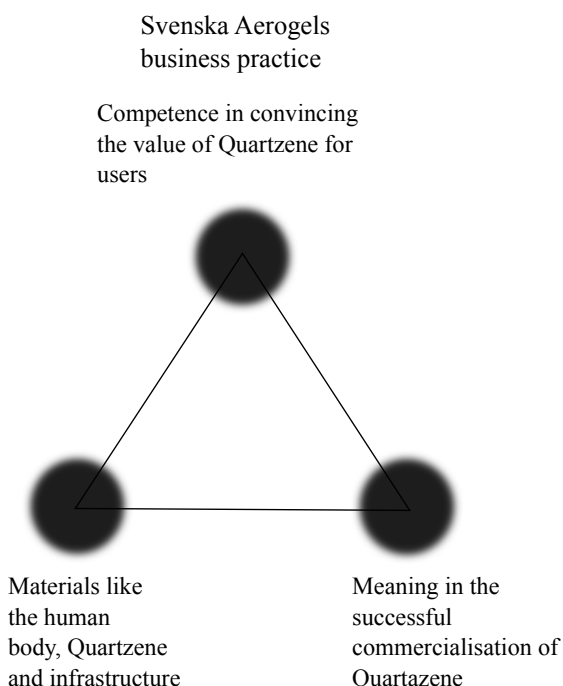


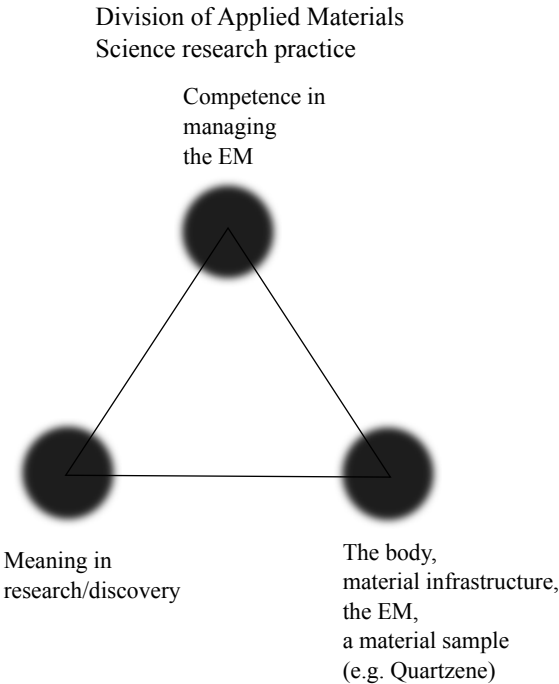
Figure 19. *The business practice of Svenska Aerogel*

The research group in Applied Materials Science at the Ångström Laboratory which has formed around Klaus Leifer involves EM analysis and fabrication of nanomaterials as well as developing methodologies for those applications. It is an academic research practice centred on a specific artefact, the EM, the competence and meaning of this practice is based around a material element and its specific techniques, i.e. 3D electron tomography, electron magnetic circular dichroism (EMCD), fluctuation EM (FEM), strain analysis or quantitative EDS analysis. Having the competence to perform a correct and proper analysis with the EM using these techniques is key within this practice.

This practice has an element of meaning in the production of internal goods (Keat 2000) that corresponds with ‘good science’ and has an inherent drive towards excellence within the specific institutional setting of a university in which it is present or dependent on to be sustained over time. In this case, standard of excellence is moving towards the production of research articles, or at the very least, the idea of discovery of new knowledge. The outcome of this practice will hopefully have enough value to be published in academic journals and, over time, give recognition to individuals and continually provide institutional resources for such practice (ibid.)

The practice elements that have been assembled and linked into a practice by Klaus and the people around him are based on this type of academic re-

search practice (see Figure 20). There is a material element consisting of the bodily performances of the human actors in a dialectic process with the EM. The EM and its related techniques is simultaneously the outcome of the practice within the research group just as much as an intricate material element (an artefact) within it. As this practice develops, it also changes the artefact as new methods for understanding materials (in this case Quartzene) are developed or new technical improvements are made. This in turn affects how the involved humans act around the EM, and thus this also leads to changes in the practice element of competence and meaning. It changes what they can and should do with the material element as the artefact (the EM) is inscribed with different types of agency and acts accordingly.



*Figure 20.* The research practice at the division of Applied Materials Science

This kind of academic research practice is in many ways closer to the type of development that goes on within a company than in what normatively could be called ‘basic research’. At the division of Applied Materials Science, the carriers see their practice as being close to practices that exists outside the institutional settings of academia. In fact, Klaus talks of the industrial application of these research practices, how he often works with companies in performing some type of project or investigation.

It is within these two sites with their different contexts and history (Schatzki, 2009) that this collaboration has its start. Having defined that, it is



now a matter of explaining how a connection between these two sites came to be formed.

The practices' first interaction was within the setting of an AIMday because one individual from Svenska Aerogel formulated a problem in relation to an artefact, Quartzene. The other individual from UU sees a possible interest within that problem. Another way of describing this was that the practices they both carry have related practice elements of meaning and competence that connects within this initial encounter in a given time and place. Without some elements being closely connected, or related, there would not have been an interest in taking part in such meetings between Klaus and Christer. The carriers saw the value of interacting precisely because their practices shared many attributes and could complement each other.

After that initial encounter of practices funding for the pre-study was approved on 7 February 2012. The pre-study was used to evaluate the feasibility of an idea the company and the researcher had on how to characterise the material of interest.

As the academic research practice was the focus in this collaboration, the activities were centred on using two main material elements within that practice, the EM at Ångström Laboratory and Quartzene. The focus of the pre-study was to look for differences in pore structure between eight different samples of Quartzene. Although these initial and explorative investigations met some difficulties (e.g. the test/sample preparation and the charging of the samples proved very demanding), the pre-study was considered successful as it achieved the overarching objective, i.e. to reveal the possibilities of the analyses utilised. The material (the EM and Quartzene) shapes the practices in this way. It is behaving in a manner that changes how this research practice was performed, the material 'resists' but conforms leading to the continuation of the involved practices.

How the hell do we prepare our powder which charges so massively and makes the particles race around like Formula 1-cars when you look at it in the EM? How do you actually do the analysis? It is a real challenge and that will make all the difference to how one proceeds with the analysis. I mean we knew this, but not that it would be this hard. – Christer Sjöström

There were samples of Quartzene provided by Svenska Aerogel sent to Ångström Lab in order to be analysed through a specific EM techniques that allowed for investigation of the samples. Some of the elements were modified or were replaced by others, the type of EM techniques changed, there were other material elements incorporated that differed slightly and new elements of competence that came into play. However, what stayed the same and could be said to have structured the practice were the Quartzene samples. It was this material that could be perceived to be in the middle of this collaboration and when new knowledge about it was learned, other elements

had to change in order for any work to take place. The sample became both a practice element together with other material components, but also a facilitator for connecting practices. Work was structured around/with Quartzene and through the elements of meaning, material and competence enacted over time in an arrangement that worked in the active process of doing. There were also other materials that acted as facilitators, e.g. lab protocols or project reports and analysis reports.

Through the story that was described above, one can see that the material within the collaboration played a very important part, both the EM and the Quartzene samples were at centre stage of the practices involved. It is the main focus for both Christer and Klaus. Because of the focus on materiality in the enactment of the collaboration, they are able to create a “*win-win situation*” (Christer’s own words) that complements each of the actor’s own sites. It seemed to have been one of the key success factors for facilitating the collaboration over the years they worked together. Klaus focused on the methods of investigating the material and Christer on the results. They didn’t really have to deal with any difficulty or any of their differences to perform the practices within the collaboration.

Furthermore, the full study was the continuation of what had been done within the pre-study. Again, most of the work was being performed in Ångström, but this time Christer was taking part in the laboratory work. He could take part because he is a capable practitioner with previous experience in similar research environments. He was able to carry out and understand the work that is done with the EM. He is not being recruited into the practice, he is not becoming a ‘full practitioner’ but he was able to translate that which happens in the lab to the development practice within Svenska Aerogel.

Christer with his long experience within academia was in this way able to not only integrate into the site of Svenska Aerogel much of the practice elements from the academic research practice, but also act as a broker between the different practices within the company. He carried with him practice elements of competence and meaning (from his previous life and experiences) which allowed him to become the connection between the academic researcher practice, development practice and the business practice (Brown and Duguid, 1998). This in turn meant that he was connecting different sites, different contexts.

Svenska Aerogel AB is a company and Christer also carries a practice based on market value propositions, i.e. a business practice that seeks to create external goods by selling a product/artefact towards potential customers. The company’s business plan is based on the properties of Quartzene, i.e. the results of the company’s research and development practice and the ability to adapt and customise their product for different applications.

As the academic research practice and development practices are connected over the years the collaboration develops, there was also an increase in resources invested within the collaboration, accumulating into the em-

ployment of another broker, the PhD student. This individual was however much more entrenched in both sites, she is (or will be) a full practitioner in both the company and the research group at Applied Materials Science. With this PhD-student, a set of education/pedagogical practices also enters the collaboration. Christer and Klaus must now educate a person together; this is likely to solidify the connections between the sites even more.

In conclusion: A connection was made between the academic research practice at the site of Applied Materials Science and the development practice within the site of Svenska Aerogel AB. The connection was at first done with the boundary objects (Nicolini et al., 2012) present within the collaboration, the EM and Quartzene. As the collaboration became more resource intensive Christer acted as a broker between the practices (see figure 21). The connection between the practices resulted in, or was further strengthened, through the employment of another broker, a PhD-student.

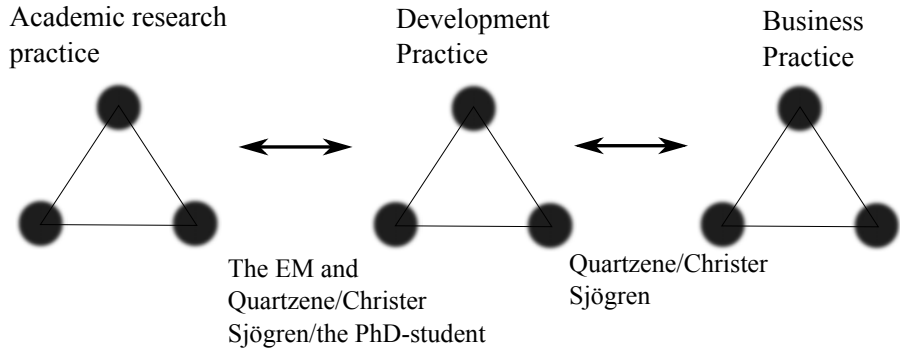


Figure 21. An illustration of the connections between practices within the UIC

## Chapter VII: UIC 2, the brokered collaboration

This was a collaboration that originated from SLU and SLU-Holding and was one of two projects within SMURF that involved a micro company (with no employees). Metahyd had at the time been provided a business coach through an incubator. It was this business coach that introduced Åke Nordberg to Sven-Olov Holm and also found funding for the collaboration from the SMURF-project. After some initial discussions on what Åke Nordberg might be able to contribute to Metahyd, they first applied for the standard pre-funding grant of SEK 50,000 and after its completion applied for full-project funding of SEK 200,000.

### 1. The company

Metahyd is a micro company founded in 2011 and managed by Sven-Olov Holm. The company is working with a new way to process biogas enabling easier transportation and storage. The gas is compressed, resulting in a solidification that can be transported in frozen form and then burned as fuel, shown in figure 22



*Figure 22. Burning methane hydrate also known as “burning ice”*

Biogas primarily consists of methane along with small amounts of other substances. When methane is put under enough pressure together with water it solidifies into methane hydrate. This process happens naturally in many of the earth's oceans but methane hydrate is also common in the outer regions of our solar system. The method that Sven-Olov Holm has developed artificially mimics this naturally occurring process. He is an inventor as this way of producing methane hydrate from biogas has not been done before and he has on occasion referred to himself as "the crazy inventor" (Oppfinnar-Jocke). Sven-Olov is very much driven by ideological reasoning in his entrepreneurial venturing and not any hope of making large sums of money. His hope is to *"solve the world's energy crisis [emphasised] and offer farmers a way to make it economically viable to exploit biogas"*. He founded Metahyd AB with the goal to make it financially feasible for farmers to use the biogas that is produced as a bi-product from anaerobic digestion of organic matter, which he think could present a unused energy source. At the time of his involvement with SMURF he had a small prototype facility in his mechanical workshop with a pump system that compressed methane gas with water. In early 2012 this pump system was an early model that on occasion would break down (see Figure 23). He once managed to shoot three holes in the roof of the workshop due to a failure with the release mechanism in the pumps.



*Figure 23.* The setup of making methane hydrate, methane gas and water are added and compressed in the metal pipes and methane hydrate is expelled at the top. This is the current model, prototype 5, which also includes a detergent in the process.

## 2. The researcher

Åke Nordberg is an Associate Professor at the Swedish University of Agricultural Sciences, in the Department of Energy and Technology. He previously spent 10 years employed at the Swedish Institute of Agricultural and Environmental Engineering (JTI) an industrial research institute involved in research, development and information in agricultural engineering and environmental technology. Today, he shares his time between JTI and the Department of Energy and Technology. He has a doctorate in microbiology and emphasises that his interest has always been in the biological processes involved in biogas. However, in the last few years, his interest has shifted towards focusing on the more general system questions in relation to biogas. As he has been working for many years at JTI, he is accustomed to working

with industry-related questions and applied research as well as the issues associated with such work.

Production of biogas is a biological process and as such it cannot be rushed; it takes time and time is not something companies tend to have a lot of. This is a common issue when working with companies not directly connected to the biogas market; they perhaps lack the understanding that these things take time. – Åke Nordberg

### 3. The facilitator

Before any application was even thought of and before any of the actors mentioned above had even heard of the SMURF-project, Sven-Olov had won a competition with his business idea at an incubator in Gävle, a town located 170 km north of Stockholm. The first prize in this competition granted him service from the business coach Lars Magnusson. Lars has many years of experience of being the CEO of a number of small ICT-companies, but since 2000 has mostly worked as a consultant selling his expertise in business development. He has for some years also been part of Uppsala Innovation Centre's network of "business coaches" and worked on and off with companies involved with the centre. Through having a personal connection to the incubator in Gävle, he was introduced to Metahyd AB and Sven-Olov. He accepted to be the business coach for the company, as he puts it: *"It was a fascinating technology and I could also see the potential for it, there was something to work with"*.

### 4. The projects

This collaboration was first given the standard SEK 50,000 for the pre-study and then SEK 200,000 for the full study. The company and the researcher also put in some of their own resources (mostly in kind) in the larger project making the budget SEK 260,000.

Before any work had commenced between Metahyd and Åke Nordberg, there was a meeting where Lars, Sven-Olov and Åke together tried to come up with ideas for an application to the SMURF-project.

Lars Magnusson, Email correspondence to Åke Nordberg (27 February 2012):

Hello Åke, tried to call you but with no luck.

I have talked to Sara Brännström [note: part of SLU-Holding and the SMURF-project group]... She wants us to meet and go through how we apply for funding [note: from SMURF]. We have booked a meeting with her

and someone else from their organisation together with me and Sven-Olov Holm on the afternoon at 4 p.m. on the 20 March. We should have enough time to talk about our collaboration before that.

Lars Magnusson, Email correspondence to Åke Nordberg, Ola Petterson (Head of JTI), Sven-Olov Holm (27 February 2012):

Hello!

A few remarks on what's happening Sven-Olov is waiting for a new pipe, longer and with Teflon coating, He has also managed to shoot a large hole in the ceiling. We have submitted the application to get SMURF-money for Åke's involvement in this. We begin with applying for a feasibility study. Meanwhile Sven-Olov is applying for a small funding grant, and I am looking to see if I can apply for something within Vinnova's verification and research & grow programmes.

At this time, they were trying to formulate a project plan that could be interesting for Metahyd and at the same time a research question that would incite Åke's interest. It then became Åke's job, with the help of Lars, to put together an application to SMURF.

Åke Nordberg, Email correspondence to Lars Magnusson, Sven-Olov Holm (20 March 2012):

Hello! Thanks for a good meeting.

Attached are a few lines on the application for the SMURF-application. Lars, feel free to edit the text if you think it is needed. I'll get back to you after I talked to the department accountant.

## 4.1 Pre-study

This pre-study was essentially a literature review where Åke Nordberg through his university employment could get access to databases and journals inaccessible to Sven-Olov. Through the Web of Science database and conventional Google search, he was able to gather information and data on experimental setups, parameter combinations, models/simulations of the process, energy consumption, etc. and forwarded his findings to Metahyd AB. With this he could put Sven-Olov Holm's product into a larger system and begin to understand how compressed methane hydrate could fit in, something emphasised more in the second study. Åke Nordberg also highlights that a visit to Methyd's production facility and on-going discussions with Sven-Olov Holm also took place throughout the project. This was done in order for Åke to familiarise himself with Sven-Olov's work, but according to Åke did not give anything more towards what was actually done within the pre-study as such. Other than a social visit, Sven-Olov's participation



was quite minimal, with the actual work being performed by Åke, the researcher. Sven-Olov was instead focused on working on his machine.

The short study first of all suggested three principal systems for use of methane hydrate and formation in biogas production. The second part of the study was to explore if there were any articles published on studies of systems in which hydrate formation/dissociation is used in the production of biogas. Only two academic studies were found to be relevant: In the first, the authors, using hypothetical modelling (based on theoretical calculations), evaluated hydration of a bio methane process as well as a process of hydration of carbon dioxide with respect to the energy balance. The second study also used biogas to produce electricity, heating and cooling needed for hydrate formation. The focus of the study was on the upgrading of biogas and any aspect regarding storage of the hydrate was not touched upon. The other study gave suggestions on a system where biogas is stored in order to even out the fluctuation of biogas production to match the need for electricity and heating during a year.

Parallel to the work funded by SMURF in the pre-study Sven-Olov was continuously working on making methane hydrate. When asked what he was doing in connection to the SMURF projects, his answers moved around topics like providing advice or counselling and guiding Åke towards topics that he thought useful for his business. To a large extent, Åke set his own agenda. Sven-Olov was working on a very different set of day-to-day activities. He was working on the machine used to hydrate methane gas (Figure 23). The process of making methane gas and water compress as energy efficient as possible requires a lot of fine-tuning. Each mechanical part needs to be fine-tuned to establish correct temperature, water, gas and pressure. A typical day for Sven-Olov running the daily business of Metahyd starts with getting a cup of coffee in his kitchen, he then proceeds to go outside and into his workshop just a few metres away from the house. He starts up the machine by first flicking on the converted ground source heat pump, which has been disconnected from the ground and is instead used to lower the inner temperature of the cylindrical metal pipes to about minus 20 degrees (seen in the middle of the machine in Figure 23). He then turns on the hydraulic unit that powers both a hydraulic powered gas pump and a small hydraulic powered water pump. The hydraulic pump simultaneously pumps water and methane gas into the metal cylinder connected to it. The machine is now running and slowly producing methane hydrate that is expelled at the top of the machine/metal cylinder (about 3 mm/min of crystallised methane hydrate). The rest of the day's activities are directed at tweaking the input of gas or water, e.g. he releases more gas into the gas pump adjusting the pressure while at the same time adjusting how much water is put into the water pump. This alters how much one stroke of the hydraulic unit pushes water and gas into the metal cylinder. This is a very hands-on and time-consuming process

meaning that he has to manually adjust everything and then measure that output of said adjustments.

Leading up to the end of the pre-study there was an increase of contacts between the two parties and there was a fair amount of mail exchanged. Lars stepped in again and handled the day-to-day contact with Åke and they started to discuss how to proceed and where to turn in order to find new funding.

Lars Magnusson, Email correspondence to Åke Norberg, Sven-Olov Holm (2 June 2012):

Hello!

Here are our notes on the meeting in Gävle. I am aiming to have a project meeting with us three and some other important stakeholders from e.g. JTI, Swedish Energy Agency, Innovationsbron in the first week of July

After a report from the pre-study was handed in, the partners expressed it to perhaps not be as useful for Metahyd than what was expected, but they all underlined that at least the report gave some interesting insights: First of all, it was confirmed that there was a need to more thoroughly understand the process of hydration of methane as laboratory data seemed to be scarce. Secondly, Åke Nordberg realised that an extended study theorising on methane hydrate on macro system level had the potential for some very interesting research. From Sven-Olov's point of view, this merely confirmed what he already knew about what was out there in the literature. Nevertheless, this pre-study resulted in a joint application with JTI, the Department of Energy and Technology at SLU and Metahyd towards the Swedish Knowledge Centre for Renewable Transportation fuels (F3). It was much larger than the pre-study and involved multiple stakeholders (for instance a master's thesis student). In short, the study analysed and compared three different scenarios for the use of methane hydrate at a farm-based biogas production with respect to energy and cost assessment (a complete explanation of what a system analysis involves will follow further down). This work gave indications that regardless of hydration of the produced biogas it is still not economically viable for the farmer as the switching cost is probably too great. Both Sven-Olov and Åke Nordberg have pointed out several times that without the initial SMURF-funding the application and subsequent study to F3 would never have come about. In connection with this larger project, Sven-Olov was given a grant of SEK 300,000 from VINNOVA to aid in covering the costs of his trials to produce methane hydrate.

Lars Magnusson, email correspondence to Ola Pettersson, (Head of JTI), Ida Nordberg (researcher JTI) Åke Nordberg, Sven-Olov Holm (31 October 2012):

For your information. Finally a bit of luck!

Forwarded: From: VINNOVA@VINNOVA.se Subject: Ref.no.: 2012-03013, Method and equipment with potential to streamline storage, upgrade and transport of biogas. Date: 31 October 2012 15:35:20 CET

To: lars.magnusson@business-evolution.se

CONGRATULATION – You are one of the companies who will get VINN NU in autumn 2012.

Funding is SEK 300,000, to be used according to WIN NUs guidelines - at least SEK 150,000 for business development activities and the rest for other activities. We will send out a press release with information about the companies in the next few days.

Lars explains that he spent a considerable amount of time writing this application to VINNOVA, much more time than he was actually paid for. At that time, he believed so strongly in what Metahyd might become that he was willing to work pro bono.

A little while later, Sven-Olov looked into literature about compressing methane hydrate and came across an article that described that if one could include some detergents in the process (in this case Sodium dodecyl sulphate), the energy needed to produce methane hydrate could be sharply reduced, resulting in a more favourable process in relation to energy usage versus output. By incorporating the detergent in the process, Sven-Olov hoped to achieve a more favourable ‘proof of concept’ and then provide ‘better’ data for Åke to be included in the larger system study.

Lars Magnusson, email correspondence to Ola Pettersson, (Head of JTI), Ida Nordberg (researcher JTI) Åke Nordberg, Sven-Olov Holm (28 Sept. 2012):

A few notes about Metahyd. Sven-Olov keeps pushing on and has with the new design of the prototype managed to run a continuous process for many hours. The problem he is tackling now is finding the right mix to get the methane hydrates of sufficient quality for us to call it proof of concept. I am also having a meeting with Åke next week to try and get a continuation of the SMURF-project funding.

Unfortunately, due to a leakage of oil in one of the pumps Sven-Olov was not able to produce the proof-of-concept he hoped for and shortly after the lack of additional funding for development of his prototype forced him to stop working in Metahyd all together. Due to this, Åke Nordberg and his co-workers had to use hypothetical data in their calculations instead of actual experimental data, but according to Åke Nordberg they did however choose favourable enthalpy values allowing for a positive outcome.

Around this time, Lars, Åke and a few other collaborators were exchanging a lot of communication between themselves both with physical meetings, but mostly email conversations. The discussions boil down to how to formulate the application to SMURF as well as possible and what Åke and the others involved with him could contribute. It seems as if Lars is once again the main driver of the UIC. In the middle of March, they finally applied for a full study from SMURF.

Lars Magnusson email correspondence to Åke Nordberg (25 Feb. 2013):

Hello Åke! I hope the weekend has been good to you. Here is the first draft of the full-study to SMURF. I hope you can take the time and look through it and see if you agree on the aim. Also, let's work on each of our respective sections and talk again.

## 4.2 Full-project

After the pre-study and the F3-study had ended, it was clear that many questions were either left unanswered or had given rise to new ideas. Åke Nordberg and Metahyd then applied for a full-study grant from SMURF, which was approved on 3 April 2013. Once again, just like the pre-study, it is Åke's expertise and research practice that were the driving force within the project. He utilized the resources and materials available to him and with the help of a few others within his network of researchers and organisations, he was able to formulate and complete the project. The work involved in doing this was explained by Åke as *"using Excel and parts of lifecycle methodology in order to do calculation on methane hydrate on a system level"*. In practice, this meant building a scenario, or system, with his and his collaborators' knowledge about biogas systems and lifecycle analysis. They performed a set of calculations within that system, e.g. how much energy is required and how much cooling is needed. This is an art, as Åke puts it, that takes a rather long time: the calculations were complicated and it was time consuming to describe these systems and try to compare them and how they relate to one another. They do not use any particular IT program/system to do these analyses other than Excel, in which it is possible to build from the ground up with some initial data.

Sven-Olov once again talked of his involvement not in the sense that he was performing a specific practice towards the SMURF-project. The work that Sven-Olov was doing in relation to this larger project was instead pretty much the same as within the pre-study only this time he had the funding from Vinnova to fully commit to Methyad. For a short while, he was also able to employ himself in the company. He was able to have some parts manufactured that greatly eased his work with developing the prototype. But still, his work only slightly affected what was happening within the collaboration.

Nevertheless as the project plan was sent in to SMURF, the SMURF project group came back saying that the company needed to be more involved if the collaboration were to be given any more funding.

Andreas Scheibenpflug email correspondence to Åke Nordberg, Lars Magnusson and Sven-Olov (21 March 2013):

Hello!

I have received feedback from the SMURF-group on the application. The comments were on the company's own effort, is there anything that can be done with the budget so that Metahyd's workload increases? Besides that, the application looks very good.

The larger study somewhat shifted focus from theorising on local hydrate production and use on a farm level towards a centralised scenario. The purpose of this extended SMURF-project was that of a systems analysis model to compare a conventional partly upgraded system and storage of bio methane in the pressurised vessel with a system where bio methane is stored in hydrate form (as described above). The comparison was made with regards to energy, greenhouse emissions and costs of a fictional centralised biogas plant. In the reference scenario (CBG, compressed biogas), biogas was upgraded to vehicle fuel quality at the biogas plant before compression and storage in pressurized vessels. In the second scenario (bio methane hydrate), biogas was upgraded to vehicle fuel quality at the biogas plant before hydrate formation, storage, hydrate dissociation and final compression.

The results of this study showed that the reference scenario (CBG), with conventional storage of bio methane had higher energy efficiency, lower greenhouse effect and lower costs than the scenario with hydrated bio methane. The demand for electricity in hydrate formation and dissociation makes it important to try to streamline and optimise the power needed. It was also theorised that the addition of detergents (e.g. sodium disulphate) to reduce the pressure necessary for hydrate formation and integration of dissociation as well as use of available waste heat from thermal power plants could be a way to solve this problem. Estimates of the cost of hydrate formation, storage and dissociation were associated with considerable uncertainty, but the study indicated that the storage of bio methane hydrate in containers is more cost effective than storage of bio methane in pressurized vessels. One aspect that was not highlighted in this study was the possibility of using hydrate formation and dissociation for separating carbon dioxide from methane. There is evidence in the literature that this is at least theoretically possible. This would then mean that a special upgrading unit could be excluded. The report ends with suggesting that a future systems study could be of particular interest that illustrates the possibility of using hydrate formation

and dissociation, as upgrade technologies, and use of waste heat from thermal power plants.

After completion of the larger full-study and handing in the reports, the collaborators wanted to keep working together.

Lars Magnusson email correspondence to Åke Nordberg (20 Dec. 2013):

Hello Åke,

I do hope we get the opportunity to keep working together, as there is hopefully a potential in developing the project further but also, as it has been stimulating and nice. I wish you a happy holiday!

From Åke Nordberg's point of view, the pre-study did not give him any greater research insights; instead, it was the general question on hydration of biogas that he saw as interesting. It was short and did not lock on to what he normally works on more than it being a focus on biogas. As his background is in microbiology, he had no understanding of the chemical process involved in the hydration of biogas. He instead offered his access to databases and his expertise on a macro system level of biogas. He is a well-funded researcher and had no financial reasons to get involved with Metahyd. The motive for getting involved was more his own curiosity. He thought that Metahyd's idea of making storage of biogas easier could be interesting to look at. This changed after the pre-study when Åke Nordberg now saw a very clear research focus that could present novel insights. It was this realisation from which the application to F3 grew out that allowed for a much more comprehensive study and in-depth calculation. This work gave indications that regardless of hydration of the produced biogas, it is still not economically viable for the farmer as the switching cost and installation of the needed technical parts is probably too great. For Åke Nordberg, the results of this study had the potential for a high scientific impact and he shortly after the study submitted an abstract to a conference and later presented his findings at the same conference. It was, however, never intended to be a full journal article as there was not enough time or funding for Åke to continue the work.

The bigger SMURF-project application was a direct result of the F3 study. This project instead looked at a scenario where biogas was used on a centralised level in comparison with the original idea that Sven-Olov started with when founding Metahyd. This report shows that it is actually the non-hydrated form of biogas that has the higher energy efficiency, lower greenhouse emission and lower costs, i.e. similar to the result from the pre-study. This was of course worrying for Metahyd as Sven-Olov's whole business idea was built on the belief that if biogas is hydrated, it will be economically viable and present a new energy source for farmers. However, Åke Nordberg was very clear that the scenarios the report outlines were making assump-

tions that might be questioned and if they were to change could make hydrated biogas more economically feasible. The results of that report were also something that Sven-Olov keeps returning to in the interviews we had after the full project was over. It seems, to him, that some of the assumptions Åke and colleagues made were a bit peculiar and sometimes even wrong, e.g. he does not think that there was any need for an upgrade facility and some of the enthalpy values could be questioned. So according to him and with those small changes, the report was quite useful for him.

At the end of 2014, not much had happened with the collaboration between Åke and Sven-Olov. There had been some initial discussions on how they might find new funding but no real luck. Sven-Olov was also getting further and further away from working on his machine as he needed to make a living that gave him a salary as he had no funding left to keep working with Metahyd.

Lars Magnusson's email correspondence to Ida Norberg, Åke Nordberg (4 July 2014):

Hello,

Short about Metahyd, quoting Sven-Olov:

“Development of the pumps during the 1st and 2nd quarter this year has been conducted at a low rate because of high workload elsewhere. However, it is not completely stopped and small adjustments have been made to the equipment, and a new hydraulic pump with the possibility of three times flow and an advanced electronic control to this has been purchased. In late July, I expect to be able to do a new test drive.”

Except the above quote it is likely that Sven-Olov will get more work through CollabitOil. The risk is that Metahyd will slow down even more than what we previously thought. Aside from that, Sven-Olov's own finances might benefit from this later; it still feels greatly disappointing that such an exciting innovation is not in a better position to develop further as it looks now.

It was made clear in the last round of interviews that this collaboration is in many ways still dormant with only one point of interaction during 2015, which was more of a social call. But both Åke and Sven-Olov point out that if the possibility for more funding would arise they might want to move forward and continue working together. They know what to move forward with. There is a *potential* for more work if the obstacles for such a venture would be removed. Sven-Olov has in the meantime moved away from his experiments doing other types of work. At the time of writing this text, Metahyd has a very low, or no activity, due to lack of funding.

Both the pre-study and the full project were essentially managed and carried out by Åke Nordberg with Sven-Olov Holm acting as a sounding board.

Sven-Olov was working on the experimental part of the project, trying to hydrate the biogas in his facility. Secondly he was trying, with the help of Lars Magnusson, to find funding and create a viable business. This was of course important, but it does not seem to have had a great impact on what transpired in the SMURF-projects. This has many explanations: for one thing, Metahyd is only a part-time job for Sven-Olov Holm and he has neither the resources nor the time to perform a study of the kind that Åke Nordberg can. Secondly, the questions Sven-Olov Holm was struggling with required both access to and insight into journals and the scientific process, which he lacked. Åke Nordberg could therefore carry on with the work in the estimated time without worrying if the project could be delivered in time. This is also reflected in the very little friction that seems to have taken place between Åke and Sven-Olov: both of them were very clear that the work collaboration was very smooth without any issues worth mentioning (this was perhaps because of the minimal interdependencies between the two parties).

Following the email conversation over the years, it is clear that there was indeed very little dialogue between the academic researcher and the company on the projects as such. The emails almost exclusively concern work leading up to new applications for funding. There is very little mention of the work that Åke was performing for Metahyd. This highlights yet again the clear separation of labour between the two. It is also interesting to look at the role that Lars Magnusson played as a business coach in this collaboration. He seems to be the main driving force in moving Metahyd forward on the business side, as Sven-Olov was focused on the technical aspects of his machine, unable to see beyond the best practice of making methane hydrate in order to solve his issues. Lars is the main facilitator, the project manager or broker in this collaboration that makes work happen. He points out that without him there probably would not have been any projects between Åke and Sven-Olov; they were just too far apart and as he puts it “*somebody had to step in*”.

Sven-Olov Holm was never able to point to a clear financial (quantifiable) gain from any of the SMURF-projects for his company. He was for a short time able to employ himself in Metahyd, but he attributed that more to the funding he got from VINNOVA than the SMURF-projects. He instead highlights other less tangible values. He is for one thing very clear that he is very pleased with the results from the collaboration. It is at first glance hard to see why, as all three projects (including the F3-study) gave results quite disappointing (or at least uninteresting) for what he was trying to accomplish with Metahyd. But as he does not really agree with the results of the last report, he still thinks that there is great potential in methane hydrate for the future of biogas: it is just a matter of time. What he kept emphasising in all of the interviews was how valuable it was for him to be engaged in the discussions with Åke Nordberg and the network he was able to find through SMURF. To

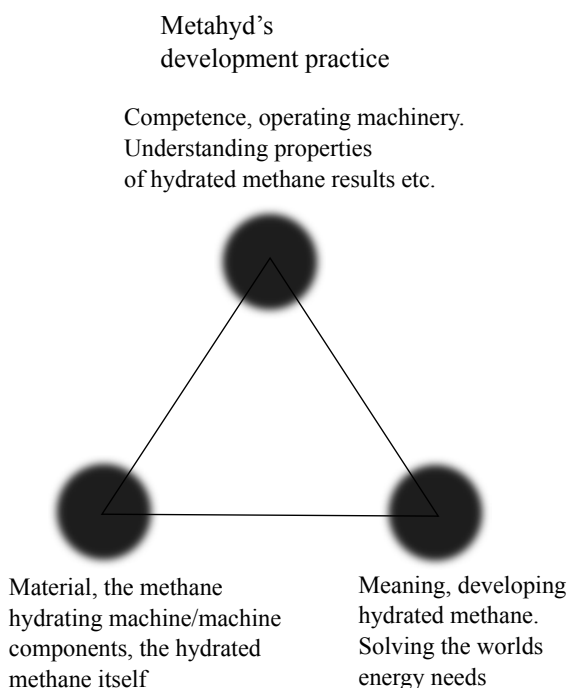


find knowledgeable people he could discuss and perhaps work with (later) was one of the main reasons for applying for funding from SMURF: *“it is a matter of attaching yourself to the right people so you don't come off like some crazy nut.”* What he also expressed as beneficial for him was that these projects pointed out what he must fight against in the future. *“I have the technical aspects and now I know what I need to work towards accomplishing with the financial aspects, that is very good!”*

## 5. Analysing the practices: the brokering practice at the centre of work

There were three practices in this collaboration. There was one development practice centred on Sven-Olov Holm, one academic research practice centred on Åke Nordberg, one brokering practice centred on the broker Lars Magnusson. Just like in UIC 1, one must first outline the sites that the practices originated from. This case presents itself as somewhat different than UIC 1: there is a brokering practice that clearly plays an important role. So within this collaboration it was not only the boundary objects or a broker that physically brought practice elements with them. In this collaboration, a complete *brokering practice* was facilitating work, a type of practice in the same manner as the interaction leaders carried in the SMURF-project (see chapter 5).

The development practice (seen in figure 24) was situated at the site of Metahyd AB, at Sven-Olov's home in Gävle. Meaning within this practice is found in the ideological reasoning from Sven-Olov: *“To solve the world's energy crisis [emphasised] and offer farmers a way to make it economically viable to exploit biogas”*. It was about making it feasible for farmers to use the biogas produced as a bi-product from anaerobic digestion of organic matter. There was also meaning in creating a product and a machine that works, in the engineering craftsmanship. Competence was to understand the mechanical properties of hydrating methane and the knowledge on how to build a machine that works. The material element was the methane hydrating machine and the hydrated methane. There was also a business practice connected to this development: it was required in order to provide resources for the development of the methane-hydrating machine.

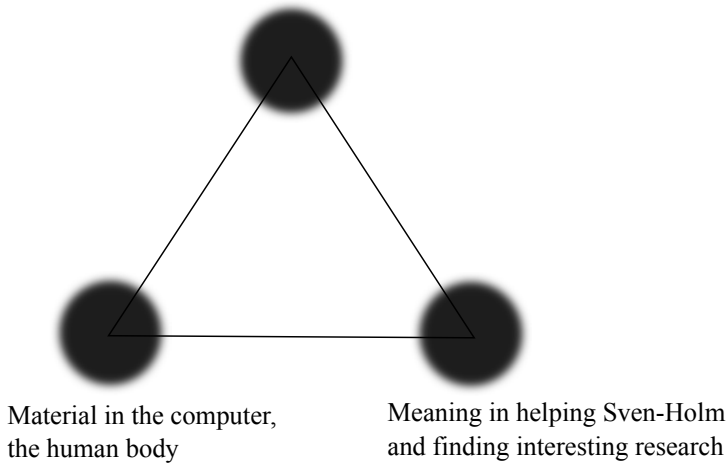


*Figure 24.* The development practice at the site of Metahyd AB

The second practice prominent in this case was an academic research practice which comes out of a site within SLU. It was this practice that was at the centre within the collaboration and could draw resources from SMURF and its institutional setting. This context differs in almost every aspect from where the development practice was taking place. This was a site centred on the production of science (Keat, 2000) as primary institutional resource. The research practice at Åke Nordberg's site (Figure 25) concerned very different materials, competences and meanings beyond the difference in institutional resources: this researcher practice was about system modelling with biogas. There is competence in having the skill in solving complex calculations, being able to use a computer and associated modelling systems, understanding research results. There is meaning in conducting interesting research. There was a material element that involved the body in connection to using a computer in managing the calculation and simulations. It was a practice that does *not share* any practice element with the development practice of Metahyd (compare the elements from figure 24 and figure 25).

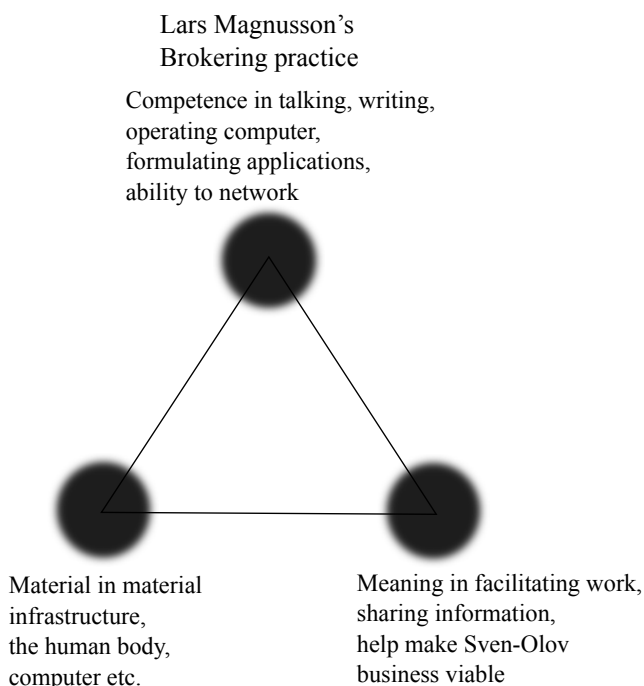
Åke Nordberg's  
Research practice

Competence in using a computer  
and databases, understanding  
research results etc.



*Figure 25.* Åke's practice when working on the literature and system analysis

The third practice, the brokering practice, involved in this collaboration is also something very different than the other two. It has a focus on tracing funding/funding agencies for this development work and creating a viable business out of Metahyd that will give the development practice resources to make the invention into a product outside a mechanical workshop. Through this there is competence in talking, writing, operating computer, formulating applications, ability to network. The meaning in the brokering practices consists of facilitating work, sharing information, helping Sven-Olov's business become viable. There is material centred on the human body, but also material infrastructure like the phone, computer or internet. This practice main contribution within this collaboration was as a mediator and facilitator of practice elements. The brokering practice was carried by Lars Magnusson and formed through his actions and activities (figure 26).



*Figure 26.* Lars' brokering practice that facilitates work between him, Åke and Sven-Olov Holm

From the different practices one can go further and look at what happened within the collaboration as such.

What was noticeable in the description above was the clear difference between the site of Metahyd and the site of the academic research practice. The materials they engage with, their everyday work and the results of their practices were fundamentally different in the performed practices of collaborating 'in the now'. As they perform their different activities, one centred on literature or modelling a system of biogas production while the other is pre-occupied with producing a 'proof-of-concept' with the material methane-hydrating machine. They were dependent on very different practice elements (meaning, materials and competences). Some connection could however be found within the element of meaning, as they are both interested in the methane hydrate.

It is clear when following the conversations in the emails that the brokering practice played an intricate part in firstly the initiation of the collaboration and later in different stages in between the execution of all the projects Metahyd was part of, including the two SMURF-projects. The practice was able to find resources through a network of people and managing communication.

Lars Magnusson was in many instances acting in the same way as the interaction leaders in SMURF. They were all acting as a broker (Brown and

Duguid, 1998; Etienne Wenger, 1998; Haas, 2015; Burgess and Currie, 2013) that is enabling knowledge transfer and/or connection of practice elements from one site to the other. In this way, the brokering practice was connected to both the development practice and the research practice. It was able to facilitate work on both sites by transferring or creating new practice elements as it was not only facilitating, it also created 'brokered knowledge' (Meyer 2010). The broker carrying the brokering practice transmitted experience and knowledge about other practices and introduces elements of one practice to another setting (Wenger, 1999; Cohen & Levinthal, 1990).

Furthermore, the brokering practice was engaging in communication activities between the sites; it manages this by the use of the material infrastructure of emails and phone calls. For instance, there was an email conversation communicating elements of meaning between the practices through the discussion on what to include in the applications to SMURF. This processes ended up being quite straightforward and even more affirms the role of the brokering practice in this collaboration; Lars formulated an application (an activity within the broker practice) and as the connection to a research practice was already present, it was tweaked to allow for a more researched oriented project. The application was then sent to the SMURF-project group and yet another project can commence thus granting more resources to the practices within the collaboration. In fact it is clear that broker practice is acting as an extension of Metahyd and in other instance as a facilitator of the project work.

There were minimal interdependencies between the research and development practice over the years that work within the collaboration progressed. The individuals also expressed how smooth the collaboration had been without any conflict. The broker practice was 'in-between' managing any friction that might have occurred, translating practice elements to both practices.

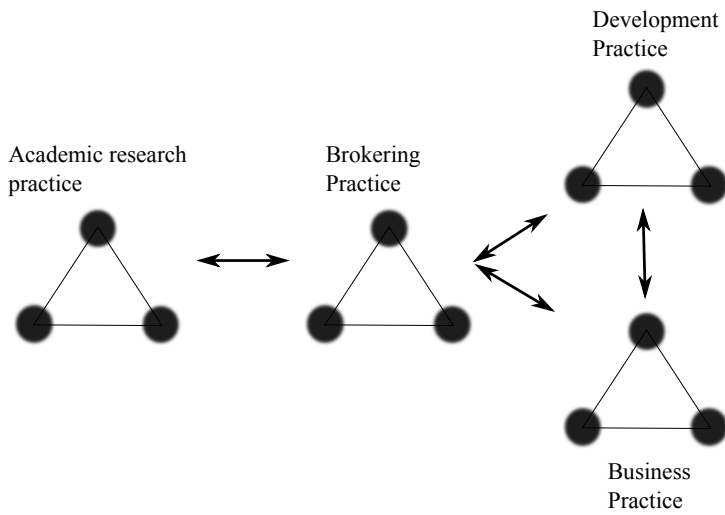
Lastly, there were the results of the two projects from the funding provided by SMURF. The pre-study's main result seemed to have been to point out a direction for future work for the collaboration. It was a short literature study, but it incorporated Metahyd into a network that later resulted in a joint application with JTI, the Department of Energy and Technology at SLU and Metahyd towards the Swedish knowledge centre for renewable transportation fuels (F3). Perhaps more importantly, at least in the eyes of the SMURF project-group, was that the pre-study developed into an application for a full-study project.

For Sven-Olov, the start, and subsequent continuation, of the collaboration was on its own also a result as he actively sought a connection with a university. The development practice was isolated from the university before this collaboration, which would give it legitimacy. Through attaching itself to a research practice that was within a rather different site, it was increasing its chances of staying alive and achieve its strive towards excellency. In this

way, it is clear that the individuals see a difference within the sites not only based on their specific practices. An academic research practice that is based within the institutional setting of a university is regarded as more legitimate than similar practices outside.

It's a matter of attaching yourself to the right people so you don't come off like some crazy nut. – Sven-Olov Holm

It is also interesting to analyse what the documents and interviews reveal on the results of the practices involved in the project. There was a literature review, an energy systems analysis, some experimental system modelling and some experimental data. There were some spare parts that Sven-Olov ordered for his machine, but that was from another funding source. This means that one could summarize the results as more or less the creation of *new knowledge* with a *potential* to link elements for new practices (Shove et al., 2012). This knowledge was codified and written down into a report and then transferred to Sven-Olov. It was not a tangible, material object that is created, even though a report can be seen as a boundary object in some aspects (Burström, 2010; Nicolini, 2012). When Sven-Olov received the report, he does however seem to interpret the results on what this new knowledge was telling him; something seem to have happened when this codified knowledge moved over to another site. This has to do with the inherent nature of knowledge. It does not just 'travel' from one site to another, it has to be abstracted from a local situation and 'reversed' back when it arrives in another destination (Shove et al., 2012). As Sven-Olov 'reverses' the knowledge he receives from the full study, he interpreted it in, for him, the best possible way that allows him to continue working with his innovation. In Figure 27 there is a schematic illustration on the process described above on how practices interacted and were connected. The brokering practice sits in the centred between the practices associated with the company and practice associated with the university.



*Figure 27.* An illustration of the connection between practices within this collaboration (the business and development practice are *not* in a hierarchal order)

## Chapter VIII: UIC 3, several practices linked together

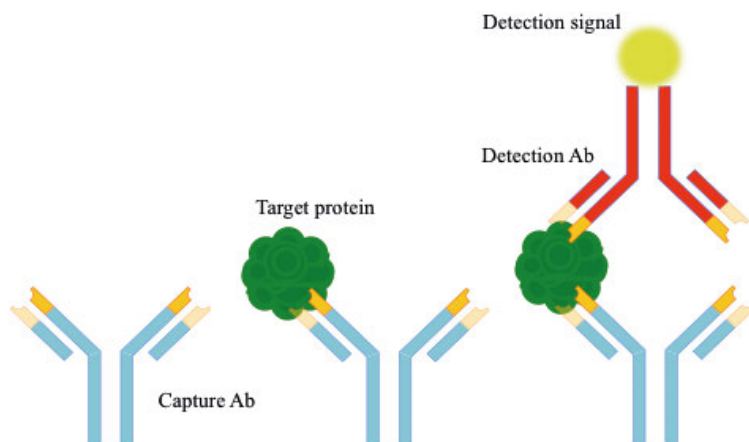
This turned out to be the largest collaboration in SMURF both in regards to funding as well as time and commitment from the company and the researcher. It was also one of the earliest projects that was funded and used as a reference “flagship project” for the SMURF-project group. Mercodia was also the largest company part of SMURF-project and through the years, I followed their involvement with Peter’s group and the responsibility was continually transferred between persons in the company.

A unanimous SMURF project group approved the project application on 31 January 2012. The application sought the highest amount of funding over a six month period, SEK 320,000. The two parties also put in resources of their own giving the project a total budget of SEK 487,000.

### 1. The company

Mercodia is a Swedish company that specialises in producing ELISA-assays (Figure 28). The company is a privately owned life science company with around 60 employees in Sweden and about 10 worldwide. The owner has remained the same since the company was founded in 1991. Mercodia have specialised their competence towards developing ELISAs in the area of metabolic diseases and in particular assays for insulin, C-peptide and pro-insulin both for humans and rodents. They do however produce ELISAs towards a wider range of other antigens and also develop new assays on demand having in-house laboratory facilities and plenty of corporate researchers employed. Their customer base consists of companies as well academic researchers in several countries. In general, they have a strong base in many research settings being regarded as one of the top companies in the world in regards to quality of their ELISA assay products.





*Figure 28.* A simplified picture of the general principles of an ELISA. ELISA is an analytic biochemistry assay that uses a solid-phase enzyme immunoassay (EIA) to detect the presence of a substance, usually an antigen, in a liquid or wet sample (Ab – antibody).

Their focus is development of ELISA and not explorative research. Such notions are left to their university partners. One manager is clearly making a distinction between what Mercodia does and what transpires within a university. The quote below is illustrative of how Mercodia seems to reason:

I mean we do development more than curiosity-driven research, but I guess that depends on what you put into a research concept – Annica Carlsson

## 2. The researcher

Peter Bergsten is a professor at the Department of Medical Cell Biology at UU. He has for a long time investigated mechanisms of beta-cell secretory dysfunction in obesity and obesity-related development, meaning he is a diabetes researcher. He uses both *in vivo* (processes performed or taking place in a living organism) approaches, where young obese individuals are examined, and *in vitro* (a process performed or taking place in a test tube, culture dish, or elsewhere outside a living organism) approaches utilising isolated beta-cells and islets of Langerhans. At the time I followed his work, he was also scientific coordinator of the EU-project “Beta-cell function in Juvenile Diabetes and Obesity”.

Peter Bergsten is also the head of a research group that is joined together around mechanisms of lipotoxicity<sup>12</sup> in beta cells. This research topic is ad-

<sup>12</sup> Lipotoxicity is a metabolic syndrome that results from the accumulation of lipid intermediates in non-adipose tissue, leading to cellular dysfunction and death. The tissues normally affected include the kidneys, liver, heart and skeletal muscle.

dressed in in-vitro studies by using various cell and molecular biology techniques, but also in in vivo studies by measuring the level of circulating free fatty acids, hormones and inflammatory markers. There are about 20 people within the research group of varying academic degrees and titles. Together they run a number of different projects<sup>13</sup> that incorporates in-vivo and in-vitro practices often involving external partners, both academics and companies, e.g.:

- A project about the role of ER (endoplasmic reticulum) stress in the lipotoxic action of free fatty acids on beta cells.
- Understanding the mechanisms of toxicity induced by long-term exposure to fatty acids. This project is done in collaboration with partners in Geneva, Switzerland.
- A project about the role of FFAR1 (Free fatty acid receptor -1) in fatty acid-induced effects on beta cells.
- The effects of free fatty acids and non-carbohydrate metabolites that are elevated in obesity on hormonal secretion from human islets. The project focuses on how free fatty acids of different types and other metabolites that are elevated in plasma during obesity affect the secretion of other hormones other than insulin from the islets of Langerhans.
- The effects of fatty acids on insulin secretion and mitochondrial respiration in a human beta-cell lineage.
- A project focused on the effects of metformin on improving changed insulin secretory pattern from palmitate-treated model of human pancreatic islets and investigating the underlying mechanisms by exploring mitochondrial respiration, ER stress and apoptosis.
- A study on the changes in hormones and metabolites in childhood obesity and the progression to impaired glucose tolerance (IGT) and type 2 diabetes (T2D) diagnosed by the oral glucose tolerance test (OGTT). This is done through the Uppsala Longitudinal Study of Childhood obesity (ULSCO) cohort. Here some of the work is done in collaboration with SLU.

### 3. The project

One company representative and Peter Bergsten first met on AIMday diabetes, which took place in early 2012. Mercodia had sent in a range of questions and one of them caught Peter's attention. Before the AIMday session

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<sup>13</sup> I have chosen not to explain the technical terms used in the examples. Instead these projects are meant to highlight what the research group is involved with, what connects it and who its external partners are.

Peter was well acquainted with Merckodia's products and the company, having been a customer of them for a long time, ordering hundreds of ELISAs for his research group each year. He had however not been involved with any type of collaboration with them before this project got started.

The parties decided not to apply for a pre-study grant being confident that their idea was good enough to go for the larger amount of funding. The formal goals of the project specified in the project plan were for Merckodia focused on developing a new product, or rather modifying an existing ELISA-assay into a new ELISA-product in order to detect a protein that had an unclear connection to diabetes. For Peter Bergsten, the work in the project was mostly aimed towards using this new product to gain insights into diabetes. The potential to look at this protein and its unclear connection to diabetes was for him very fascinating, but in order to get to that stage, the two parties first had to work together in order create this new product. The goal of the company and the goal of the researcher came together in this way to form something they could both work towards.

The project was divided into two parts, one cell study and one patient study, i.e. one in-vitro and one in-vivo trial. The first thing that was done took place in Merckodia's facilities: a few laboratory researchers in Merckodia's R&D division made an early prototype of an ELISA-assay that targeted the wanted protein. Creating a prototype that was able to detect the protein was not that difficult, it is a very different story when the same test is used with blood or other types of serum and the interference and cross-connections with a range of other proteins could present a problem in that no or too little detection signal is produced. The next step was then to extract samples of blood to test if this ELISA could detect the wanted proteins without too much interference. This prototype was sent by mail to Peter Bergsten's group and became the foundation for the work. At Peter's lab, they tested the ELISA with blood samples and the result was sent by e-mail to Merckodia's R&D lab. Some discussions between Peter and Merckodia took place and the test was adjusted accordingly; this process of back and forth went on for a little while with face to face meetings, phone calls and emails until both parties felt happy about what the test could demonstrate.

The next step was to do the actual in-vivo study so that the ELISA test could be evaluated in a 'real-life situation', enabling also Peter to explore his research questions. The clinical patient study was here performed in the following manner: Forty obese individuals and twenty lean control individuals were fasted over night at Uppsala University Hospital. On the following morning an oral glucose tolerance test<sup>14</sup> was performed. Samples were collected and plasma separated. Insulin, C-peptide and pro-insulin was measured by the ELISA kit supplied by Merckodia in addition to the glucose test.

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<sup>14</sup> The glucose tolerance test is a medical test in which glucose is given and blood samples taken afterward to determine how quickly it is cleared from the blood (Wikipedia)

In the in-vitro study, human insulin producing cells, human islets and human B-cells were exposed (or not exposed) to a type of fatty acid and the B-cells also to C-peptide. The C-peptide concentration was based on the value obtained from the previous patient study. An ELISA kit from Mercodia was then used to analyse for the presences of C-peptide, pro-insulin and insulin. All of the laboratory work during this process was done at Peter Bergsten's laboratory involving two of his PhD students.

Throughout the project work, there were regular meetings and/or emails sent back and forth between the company and the researcher as a way of communicating and discussing the results of the trials and how the ELISA could be further developed. Both Mercodia and Peter highlight that this was a way to manage the different competences each of them possessed and the different goals they wanted to achieve.

We did some technical stuff here and they did some tests over at their labs –  
Annica Carlsson

Shortly after the project had ended in late spring 2012, it was clear to both parties that they wanted to keep working together even though none of them could trace a tangible result from the SMURF funding. The ELISA that was used did not directly transfer to a product for Mercodia even though that was their initial hope. Peter emphasised first of all the scientific output of the project, meaning that he got some new knowledge from the results from the patient and cell study, but equally important was also how the project allowed for him and Mercodia to establish a relationship. He thought that the establishing of industry partners was not only important for him, but for academia in general. It could provide PhD students with employment after their thesis work as well as future fruitful partnerships. He was in fact able to engage four of his own PhD students within this first project with Mercodia.

Directly after the project ended, Peter managed to get Mercodia on board on an application towards a call from VINNOVA in trying to develop a new ELISA towards detecting a protein called Glicentin. This project resulted in much more tangible results than the SMURF-project in that a new product (seen in figure 29 below) was put on the market and two publications were published in connection to this work or from utilising the new assay. Work was carried out in a very similar manner as described above.



*Figure 29.* A photo taken in Peter's research lab showing boxes of the Glicentin ELISA-assay. There is also a 96 well Microtiter plate (in pink in the middle of the table) used for doing the ELISA lab

Fast forward a bit and Peter is yet again able to include Mercodia in another project, a joint application towards a call from SciLifeLab<sup>15</sup>

Annika Carlsson email correspondence to Peter Bergsten (9 October 2013):

Hello!

The decisions go quickly here. Mercodia has decided to join SciLife innovation pilot for companies, so together we can write an application to get possible project funding. The application form is in the email below, the deadline is the end of October. Can you look at the relevant parts for your gang and we can look to see what's relevant for us and then we can write something good?

Indeed, Peter also kept pushing to get Mercodia into more projects, but now with a lot more actors and much larger scope.

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<sup>15</sup> Science for Life Laboratory, SciLifeLab, is a national centre for molecular biosciences with a focus on health and environmental research. It is a collaborative arrangement between four universities: Karolinska Institutet, the KTH Royal Institute of Technology, Stockholm University and Uppsala University. (Scilifelab.se)

Peter Bergsten email correspondence to Robert Gunnarsson, Annika Carlsson (Mercodia) Jarl Hellman, Anders Forslund, Niclas Abrahamsson, Niklas P Nyström, (Uppsala University Hospital), Fredrik Rorsman Department of Medical Science Uppsala University, Jonas Bergquist, Kumari Ubhayasekera (Department of Chemistry Uppsala University), Ernest Sargsyan, Levon Manukyan, Hjalti Kristinsson, Johan Staaf, Hannes Ohlsson Jing Cen, Azazul Chowdhury (Department of Medical Cell Biology) (21 Feb. 2014):

Dear all, The Endobarrier story has developed rapidly during the last week and I would like to meet all of you next week and discuss a Horizon 2020 project, where you all could be participating. The deadline is March 11. The reason for the short time-line is the recent annual meeting in Beta-JUDO, which I had to focus on. After we came back about a week ago I read the H2020 call texts and identified an interesting call.

Topic: presentation and discussion about “Gut-JUDO”, H2020 project proposal. Where: BMC (I will book a room). When: this is the tricky part, I propose late afternoon. TASK (all): go to the Doodle and put in your dates.

There are quite a few persons on the list and I realize that some of you don’t know each other. But if we do this right and swiftly there will be excellent opportunities to change the “not knowing each other” within a joint project.

At this point the project is still forming and I would like you to be confidential about it.

Mercodia’s reflection on their commitment with doing projects with Peter had much to do with his way of coming up with ideas and suggestions that they could tag along with.

He comes up with ideas and we, you know, just tag along – Annica Carlsson

When Peter is asked about what a “typical collaboration of a similar kind (like the one with Mercodia) looks like?” he starts by explaining that most of the time he approaches a company giving suggestions and ideas on how they might work together and how they might benefit from a collaboration.

Over the course of this entire collaboration, they met regularly over the years and both Mercodia and Peter described the dialogue as productive in order to shape the products they have worked on. Peter believes that his expertise is the reason they want to work with him, but also to get access to patient samples to test their product on. It has nonetheless on occasion been difficult to manage the different priorities: Peter had to acknowledge that Mercodia’s main focus was to create a product, something which occasionally collided with his own interests. The managing of this clashing interest has been a learning experience for him and also something that he could build on

and create an interest that he could exploit for his own research group. Mercodia being a company with a core competence close to Peter's research, he also felt that being able to directly communicate, and work, with them allowed him to really get to know key persons within the company. That in turn gave him a direct channel to the company and allowed him to go beyond the scope of the initial project and discuss possible new product developments of ELISA-assays.

Mercodia is a company that on most of their R&D project in some way involve academic researchers and they work actively to find collaboration partners at universities all over the world. In the case described here, one of the responsible persons at Mercodia also had a personal connection to the research group and had previously worked and earned her doctorate in the same department. She however asserts that with the available funding from SMURF they could go ahead and initiate a formal collaboration, something that might have happened without SMURF, but the project provided a real opportunity to go forward with the idea that Peter had suggested. The type of collaborations that Mercodia initiated through SMURF was unlike any of the company's previous engagements with academia in that their academic partner was given the resources and that the work needed to be more structured through a project plan/application. Mercodia valued that the project gave them university contacts and access to patient material and a deeper insight into the specific levels of Insulin, C-peptide and pro-insulin in obese adolescents. The two publications that followed the study could also create an increased exposure to a scientific community and new customers and markets, perhaps leading to increased revenues for Mercodia over time.

For Mercodia, these types of collaboration do come with some difficulties and concerns that need to be thought through or perhaps handled. The collaborations with Peter and his group were no different for them than other academic researchers: Time constraints within the company make it difficult to assign responsibility for a collaboration of this kind that is, often, outside a single person's regular work responsibilities. It is also quite frequent that a researcher's interest is not the same as the companies.

The researcher says that we are supposed to look at this question but most of the time we are interested in something very different'. It's like sell vs. producing good science – Annica Carlsson

Normally, they handle such an issue by dividing the project in to several parts where they agree to help the researcher with something of his or her interest as long as they agree to do the same for Mercodia. This however often requires some negotiation within the company, as it is difficult to see how the company will benefit in the short term. One of the managers in Mercodia therefore points out that it can be very beneficial to be a small company; there is no corporate head office far away that decides on what to

do. In smaller organisations, you have much more freedom to make your own decisions on how (or if) to proceed with collaboration. Because of this, it is also essential that one ‘clicks’ with the researcher or work will be less than productive. They also saw some risks with engaging themselves in these kinds of projects: perhaps there are promises that will be broken even though the company puts in a lot of resources, there might be sharing of sensitive data even though confidential disclosure agreements have been signed, this is even more so with researchers than other companies as they are not used to handling sensitive data and might accidentally “spill the beans”. In this collaboration, because Peter is such a dynamic and inspiring person, the work came rather easy. Mercodia also underlined the important aspect of having a written agreement, as this type of document provides both parties with a sense of security.

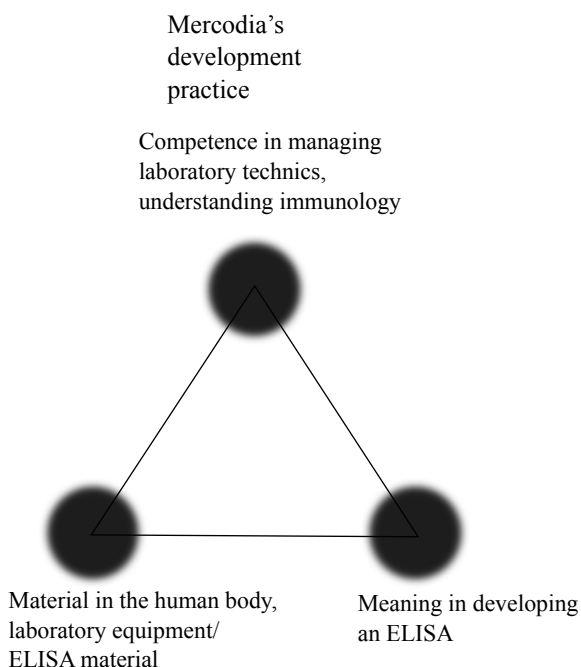
Over the years after the SMURF funded project, the two parties, in collaboration with others, did manage to create two new products that Mercodia now markets and sells to companies and researchers, one Glicentin ELISA and one Pro-glucagon ELISA. Peter’s group produced two articles using these two assays. One of the managers in Mercodia points out that this sort of work (working with academics) often comes with a lot of negotiations, uncertainties and on occasion unclear value for the company.

#### 4. Analysing the practices: multiple practices connected through a broker

In this case there were a number of different, but related practices that came together, shared and exchanged practice elements between one another by being involved in the collaboration.

The collaboration concerned two different sites. Firstly the company with a development practice centred on the ELISA technology. The company is focused on a practice around producing and developing this technology. There is meaning in developing ELISAs in the best possible way, to adjust it and make it work; there is competence in understanding immunology and the properties of ELISA parts, and the material element is the able individual body of the lab personal and the ELISA kit along with the laboratory equipment (figure 30).

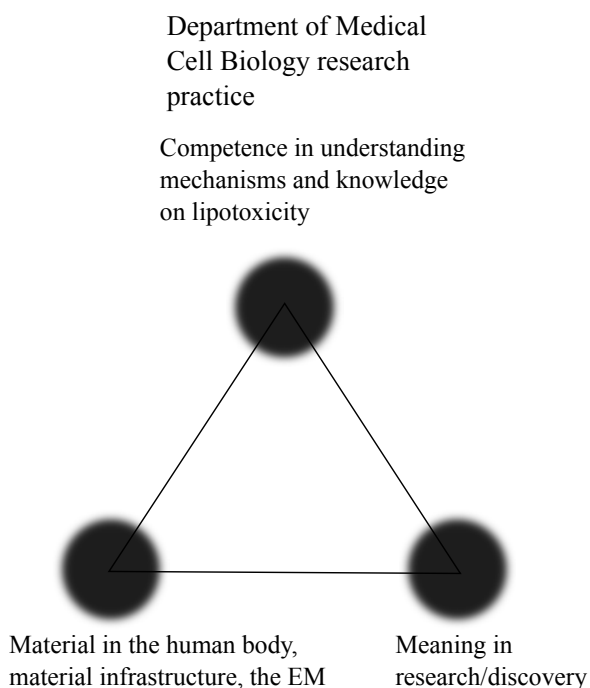




*Figure 30.* The development practice of Mercodia

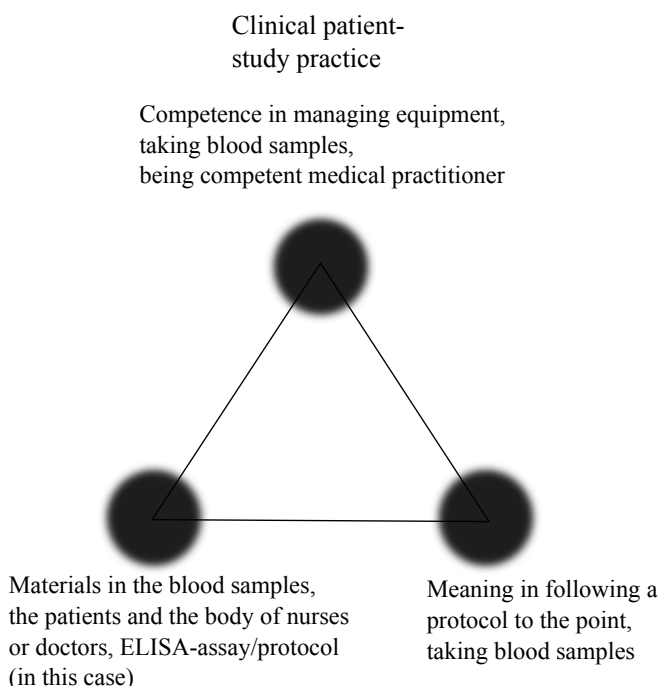
Just like the previous UICs there was a business practices connected to this development practice (see the description in UIC 1) and in the same way they were mutually dependent on one another in their institutional resources.

Peter Bergsten and his groups have an academic research practice built around knowledge, technical capabilities and technologies centred on lipotoxicity in beta cells. There seems to be a fair amount of variations in this research practice, judging from how Peter described his group and the number of projects they are engaged in. Still it has the properties of a practice around some common materials, meanings and competence as seen in figure 31. There is competence in this practice within the understanding of knowledge of laboratory techniques and machines, and mechanism of lipotoxicity. Meaning is the discovery of new knowledge and claiming recognition on this new knowledge. Material is found within the body of individuals working in the lab, human serum or blood, machines and protocols, e.g. ELISA. The practice is also, just like the cases above, dependent on the institutional resources of academia.



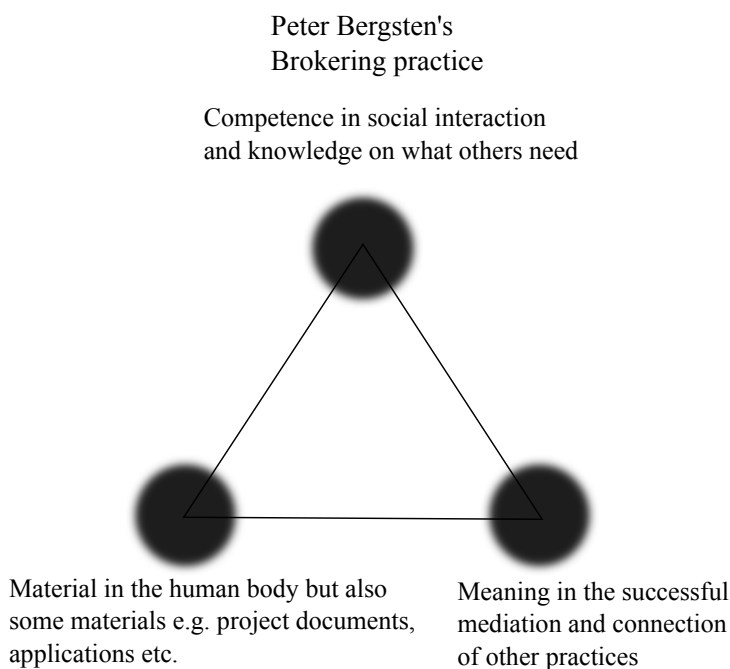
*Figure 31.* The academic research practice within the Department of cell biology in the collaboration

There were more practices composing the collaboration process between Mercodia and Peter Bergsten than in the other UICs described in this thesis. There was also a “clinical patient-study practice” that incorporated practice elements from both Mercodia and the Department of Medical cell biology. This practice was both spatially and temporally separate, with activities isolated from the other two practices (development and research practices). This clinical research practice is needed because the other two practices cannot accommodate everything that needed to be done. For work to continue there were more activities involved and as described in the case the patient study add such notions. This is practice with a competence elements based on managing blood test, knowledge on techniques and how to follow strict research protocols, and on being a competent medical practitioner. Meaning is found in performing activities to the exact specifications of the medical protocol. Key material elements are the blood samples, the body of the patients just as much as the body of nurses or doctors and there was also, in this instance, a material element of an ELISA-assay/protocol. Figure 32 depicts these connections.



*Figure 32.* The clinical patient-study practice

Lastly there was a brokering practices present in the collaboration: Peter Bergsten acted as a broker and was carrying this along with the research practice and was "at the heart of things" (seen in Figure 33) between the three above practices throughout the whole collaboration with Mercodia. This brokering practice was able to create elements of meaning, transferring materials and offer parts of competence element to the other three practices. It was virtually the same brokering practice that was part UIC 2, although with some variations within the individual practice elements. Moreover there was one individual who has travelled between both sites (UU and Mercodia). She had experience in both the research practice and the development practice having been employed in the research group and now working at Mercodia. She, just like Peter, was also able to act as a broker and create connection between the different sites when work was carried out.

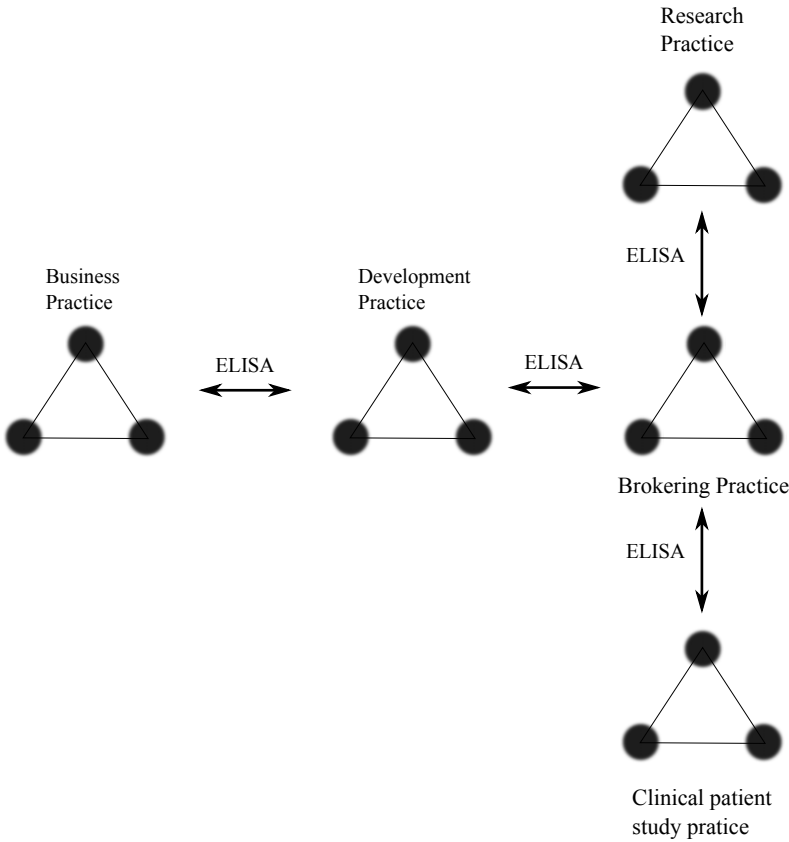


*Figure 33.* The brokering practice in this collaboration mostly carried by Peter Bergsten

Moving into the work that was done: the practices were connected through the activities of a broker and a boundary object, Peter Bergsten and the ELISA test respectively. Once again a brokering practice has the centre stage, this time it is connecting practices from actually more than two sites (Mercodia, UU and Uppsala University Hospital). All three practices are able to find meaning in creating a test that is viable in-vivo. The ELISA can be produced towards specific antigens in-vitro, but it is far more difficult to create a test that can be useful in blood or other types of serum where the interference and cross-connections with a range of other proteins presents a problem in that no or to little detection signal is produced. The material element part of the research practice thus “resists” and it needs to be adjusted and fit in order to be useful. It is through the modifications of the material artefact, the ELISA, that the process of work is structured and all the involved practices are collaborating. Creating an ELISA that can be useful for a research practice is the aim of the work within this UIC.

The practices came together and connected in the project in the following way and an illustration of these connections between practices can be seen in Figure 34. A patient study is performed, i.e. the clinical study practice: Forty obese individuals and twenty lean control individuals fasted overnight at Uppsala University Hospital. On the following morning, an oral glucose

tolerance test was executed. Samples were collected and plasma separated. Here, one practice is creating parts of a material element, the blood samples.



*Figure 34.* The collaboration between Mercodia and Peter Bertsten’s researcher group understood as practices performed in different places and in different times but connected with each other.

Then, the research practice takes over using the artefact created by the development practice: Insulin, C-peptide and pro-insulin was measured by the ELISA kit supplied by Mercodia in addition to the glucose test. In the cell study, human insulin producing cells, human islets and human B-cells were exposed (or not exposed) to a type of fatty acid and the B-cells also to C-peptide (provided by another company). The C-peptide concentration was based on the value obtained from the patient study. An ELISA kit from Mercodia was then used to analyse for the presences of C-peptide, pro-insulin and insulin. All of the laboratory work during this process was done at Peter Bergsten’s laboratory involving two of his PhD students.

In the beginning of the collaboration, the brokering practice is connecting practices that can be useful as Peter Bergsten is performing his activities.

This is successfully done and the cell study is initiated. The cell study is divided between two sites (Mercodia and UU's laboratory). Work starts with the development practice at Mercodia R&D: they possess the material elements in the ELISA-kit, in depth competence on how it works and a meaning structure in performing a type of product development, modifying the material element and creating a specific artefact (the ELISA-assay). This artefact is then used as one of the material resources for another practice in a different location, the research practice at Uppsala university. This material element, the artefact, allows for a research practice to be performed. Peter and his group are able to use a resource that Mercodia does not have, real patient blood samples.

There is one practice performing the in-vivo study (including the development practices done by Mercodia); another practice performing an in-vitro trial and one practice coordination and managing this work, the brokering practice. These practices are all connected and influence each other in a specific time sequence that becomes an iterative process within the collaboration.

After the first trials, the brokering practice is once again active through Peter Bergsten transferring practice elements that allows for the development practice to be performed at Mercodia which change the ELISA accordingly. These three (brokering, development, research) practices are executed in an iterative manner over a period of time in order to produce a material element that is then used in another site (Schatzki, 2001). The next step in the work involved different practices and other practice elements joined together by the ELISA-assay, the patient-study. It is now practices that involved doing the in-vivo study so that the ELISA, the artefact previously created, could be evaluated in a "real-life situation". Patients, or more specifically their blood, now become the centre of attention in a hospital environment. The result of the samples in the study was evaluated with the ELISA that had been developed in the first process. In this way there are five practice involved within this collaboration (the fifth one is a business practice which is connected to the development practice, but it does not play a direct part in the work that is done by Peter Bergsten's group).

This pattern of different practices collaborating developed into a process that was continually performed throughout the rest of the collaboration. Carriers of practices in both locations continually produced elements that follow after one another in the creation of new practices. This way of analysing collaborations of practices is close to how Shove et al. (2012) describe how certain practices (like conduction of a surgical operation or steelmaking) suppose and require the reproduction of others, e.g., shipping captains depend on harbours and docks and a global network of people capable of faithfully reproducing docking practise when called upon to do so. In such instances, a sequence of practices is important, where one practice produces

elements (meaning, competence or materials) on which another depends: via pre- and co-requisite practices collaborate (ibid.).

What this case also demonstrates was how the brokering practice carried by Peter Bergsten was able to connect multiple practices. But he is not alone in bringing practices together. A material, the ELISA-kit/assay/protocol is at every stage as a material practice element. He was the driving force for the initial project to get going and he was the one who wrote most of the application towards the SMURF-project. His activities when the project activities start were not directly involved in the day-to-day laboratory work practice with the ELISA-product; instead he acted as an advisor and coordinator for his research group, influencing the academic research practice, not being directly involved in it. Members of his research group performed the laboratory work described in the text with him at the helm overlooking, leading and managing the discussions with Mercodia. What was also clear was that by being a carrier of a research practice at UU, he had access to resources most companies do not have and was able to bring it into the collaborations he initiated and/or facilitated. This is the reason that he was able to carry out a brokering practice so successfully.

The research practice and the development practice share some important connections; the result of the development practice (the ELISAs) is for instance able to easily be incorporated into the research practice as a material element. Both sites (Mercodia and UU) had similar material elements and competences. Still, the practices were not the same and they stayed separate having different elements in their constellation, with the development practice closely connected to a business practice. This was evident in that the element of meaning differed between practices.

## Chapter IX: UIC 4, Collaboration centered around one practice

This was a collaboration that originated from SLU and SLU-Holding and was the last project that the SMURF-group granted funding for before closing the books. Because of SMURF's timeline, this collaboration was immediately put under time pressure to start work, as there was a risk that they would not get reimbursed for their expenses. The project requested the maximum sum of SEK 250,000 from SMURF and the two partners put in the same amount themselves making the project budget total SEK 500, 000. Having a history of both professional and personal connections, they went straight for the larger project without first applying for the small "pre-study". As time was a factor, academic and the business partners were advised by one of the SMURF-project group members to go for a full-study grant and skip the pre-study phase. The project was quite short in many ways, as can be seen in the description below.

### 1. The (two) companies

GisGruppen AB is a consultancy firm with only two employees Mikael Schröder and Erik Lundborg. They are both landscape architects and studied at SLU in Uppsala. They provide consultancy services in business development in relation to geographic information systems (GIS). GisGruppen has its core business in work with feasibility studies, investigations, system architecture and education on aspects of GIS, categorising themselves as a service company that sells consultancy hours. When the company got involved with the SMURF-project and I started to follow their work, the company had just recently gone from zero employees to two. Previously Mikael and Erik had their own individual one-man consultancy company and were also employed at a larger consultancy firm, but in November 2012 they quit their jobs and started working together 100% as GisGruppen. The hope for the company was that the outcome of the collaboration would become a product to sell and market, a strategic attempt to broaden their business portfolio. Mikael and Erik had divided the different contracts that GisGruppen was engaged in and Mikael was responsible for their involvement in this project. Erik's part in the company was generally toned down slightly over



the years that I followed this collaboration as he got more involved with running his rural farm, leaving much of the business to Mikael. Instead, or rather in addition, Mikael decided that because of the sheer amount of work that needed to have done in developing the product that they needed help from someone. He arranged for another consultant to assist him in the development while he managed the more GIS-related questions and technologies. This one-man consultancy company called Arctic Tiger was given part ownership in the licensing agreement between the company (at this point companies) and the researchers. This collaboration had in effect turned into a triad. However, because of the very close connection between Mikael/GISgruppen and Arctic Tiger/Tom Blackmore and also how the two structured the practices when working with the researchers, I will simply refer to them as one entity rather than two.

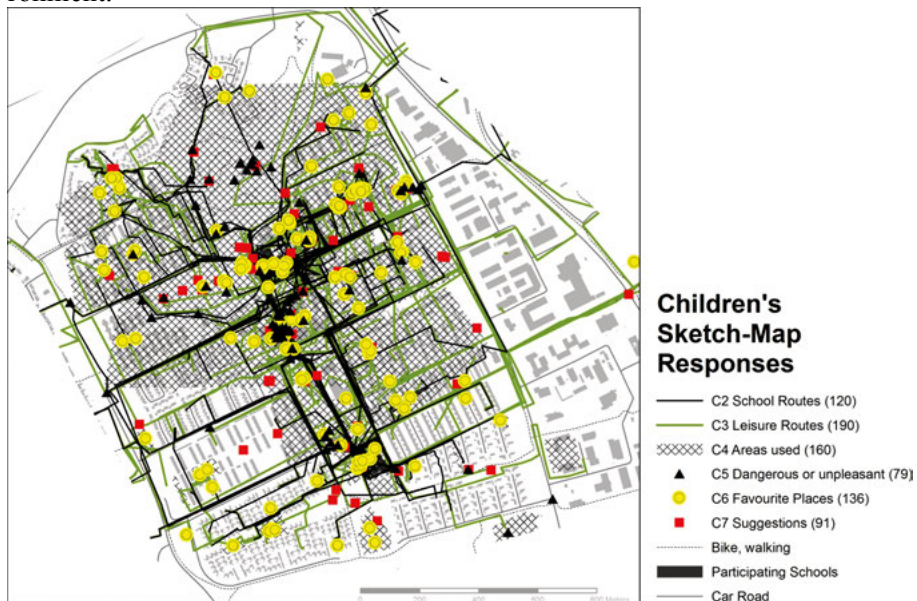
## 2. The researcher(s)

Kerstin Nordin did her undergraduate studies in landscape architecture during the early 1980s. She then worked many years in the parks and recreation administration in Stockholm as a landscape architect. Since 2001, she has been a lecturer in landscape planning at the Department of Urban and Rural Development, Division of Landscape Architecture at SLU. She has long divided her time between lecturing and working on her PhD, which essentially meant developing a *Children's Maps in GIS (CMGIS)* (more on that below) methodology. After publishing four papers in relation to this work, she defended her thesis in 2015 called "Att sätta barn på kartan" (Placing children on the map). Part of the collaboration described in this case had a direct influence on her PhD.

Involved in this collaboration with GISgruppen was also another researcher, Ulla Berglund. She was a colleague and main supervisor for Kerstin in her PhD project (she has since left SLU). Ulla has a PhD in Urban Design at the KTH Royal Institute of Technology and has published research papers that relate to *CMGIS*. Ulla has been a large part in the development of this product. Kerstin took much of the main lead within this project and even though Ulla had an influence on what transpired, it will mostly be Kerstin's voice in the description that follows. For both Ulla and Kerstin, the main goal of the collaboration with the companies was to develop a product that could provide them with data for research papers; they had no interest in any possible financial gain that might ensue after finishing the project.

### 3. The project

*CMGIS* is a survey tool with one essential difference from most other tools and software out there in that it is map-based instead of the more conventional purely question based. It is a digital map questionnaire for children around 10 years old with the aim to understand how they use, experience and would like to improve their outdoor environment. Additionally, when possible, the children's teachers are also asked about the outdoor environment and its relation to educating these children (Nordin 2015). An example of how a result from one of these digital maps might look after a questionnaire has been filled in can be seen in Figure 35. This method can be used as a way of managing how to plan an urban environment that takes into account how children view their surroundings. For Ulla and Kerstin this is a research method to learn more about how children relate to the physical, outside environment.



*Figure 35. The result of a survey done in relation to the SMURF-project in an unnamed Swedish municipality*

This collaboration was an attempt to try to improve this survey method so that it could be marketed, sold and subsequently used by municipalities all over Sweden. There had been a number of earlier versions of the product developed in collaboration with other actors, but none that really worked in a satisfactory manner according to Kerstin.

Mikael and Kerstin actually knew each other long before any project was ever conceived of. Mikael and Erik had worked at the Department of Urban and Rural Development in 2001-2002 in a research project with Kerstin as their main supervisor. Kerstin and Mikael also worked together on a project

at the County Administrative Board of Västmanland. Mikael had also worked on helping Kerstin evaluate an earlier version of *CMGIS* in 2009-2010. During the years leading up to the project, they would occasionally see one another at conferences they both attended or just randomly encounter one another moving in conjoining social circles. When this happened, they often talked about starting to work together again on *CMGIS* if a situation where both available time and resources would arise. During a chance meeting in the spring of 2013 at Uppsala central station, they once again got to talking and this time they decided to have a go at it and try to find resources together. Because of Mikael's previous connection with the Department of Urban and Rural Development and his time as a student at SLU, he knew that SLU-Holding existed. Kerstin, being employed in the Department, also new of SLU-Holding and together they made inquiries into any funding opportunities for developing their idea.

Kerstin underlined in all the interviews we had how much difficulty they struggled with in working with other partners in earlier development of *CMGIS*. Because of all these issues, Kerstin and Ulla have been close to just giving up in trying to create a product that would work and could generate data for them.

We have had such incredible difficulty to communicating with others we worked with, we were actually very hostile towards each other in the end –  
Kerstin Nordin

For the researchers, it was very important to find someone that could understand what they wanted to achieve. Someone they could trust. With Mikael (and Erik's) previous history and knowledge about the product Kerstin and Ulla had great hopes for this collaboration. The project plan was approved by the SMURF-group on the 30 of August 2013.

Björn Ingemarsson, Email correspondence To Mikael Schröder (31 August 2013):

Hello Mikael! Thanks for a clear and good finalisation of the project plan. We [the SMURF project group] approved the project yesterday. I'll come by Monday and arrange with the contracts agreements. It has to be signed by all parties (5 copies).

When this project eventually got started it was very quickly realised by Mikael that there was much more work than he originally thought. As a consequence, their investment in this product had to increase if there were any hope of finishing something they could market and sell to a municipality. It was around now that Tom Blackmore (Arctic Tiger) came in as an assistant developer with an expertise that matched and complemented Mikael's.

The first thing that needed to be done, which had begun some time before the SMURF-project application, was to establish what the product should be

able to do and the project's demarcations. They also had to find a common goal that fit both the company's and the researchers' interests. This was not something difficult as the researchers actively sought someone to commercialise their product and GISgruppen saw a business potential. So after some initial discussion, the project goal was specified as: *The project aims to capture and commercialise the experience and knowledge that SLU's research team has developed around CMGIS, in order to broaden its use and application.* One of the goals for GisGruppen was to make the product more versatile.

It could be like maps for old people or whatever. It's like a service you buy, it's like your going into SJs [note: Swedish railway] homepage and buy a ticket to get on a train and you choose from where you want to go, destination and when you want to travel and with these comforts and then you pay. – Mikael Schröder

If they could make *CMGIS* more flexible, they would have a range of different products they could market towards potential customers. But the first thing that had to be done was to make *CMGIS* work in a sufficient way that also took into account the requirements from the researchers.

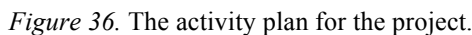
This project was very much a matter of making something already existing, but non-functional, work in a satisfactory manner and not about building something from scratch. It seems as much of the work which took place in this project had to do with establishing how to solve the technical issues that plagued the product while still producing something that could satisfy both the company and the research goals: commercialise, i.e. make money for the company, and in so doing gather data from the product, i.e. do research for the researchers.

The first step in working in this collaboration was to compile a list of demands for what *CMGIS* should look like and be able to deliver as a service/product. This was done through workshops, or rather brainstorming sessions, where both the researchers and companies participated and tried to pin down all of their requirements and how the solution should look and work to allow for smooth use of data and functionality. They had a few of these sessions during the initial work within the project: it was essential to establish a common ground so that work could begin. Mikael explained that it generated a hefty amount of information that needed to be documented and put on paper so that he and Tom knew what to work towards.

What followed was developing an IT-system solution that matched the requirements from the workshops and also incorporated parts of previous versions of *CMGIS*, so that all data collected with earlier versions did not go to waste. This was also what took up most of the time and labour within the collaboration, making it the most significant step according to the collaborators. They chose to build a solution from scratch instead of choosing an ex-

The next step was for Ulla and Kerstin to go through the entire methodology and processes associated with using *CMGIS* with Mikael and Tom. Creating a working IT-solution was only the first step. To be able to commercialise the product, there was also a managing/communication process that starts with instructing children and teachers on how to use the product and ends with collecting and compiling the data gathered in a satisfactory manner. This was then followed by workshops with the customer on how they might use the results of the survey. After this step, termed “method education”, GISgruppen should know enough to manage the product on their own without any considerable need of assistance from the researchers. As Mikael already knew much about the system, it was not a particularly difficult or time-consuming step, but still regarded as important in order to create the best possible product since the end goal of the entire collaboration was a successful commercialisation of *CMGIS*.

Tidplan och aktivitetsplan



To clarify what this activity plan covered and how it relates to the work process described above, I have translated it to English below and also put in some clarifying remarks:

1. Specification for the technical solution required for the method to work: The new solution takes advantage of previous experiences, requirements and knowledge of the product's various parts and what it takes to make it work, built on SLU's previous research. This is to be put into a working IT-software.

2. Development of pre-conditions for the IT-solution:

- I Feasibility study, choice of IT-system solution
- II Development of Prototype/Mock-up
- III Establish development and operating environment (hardware / software):
- IV Book subcontractor for development (Tom Blackmore/Arctic Tiger)

3. Modelling and adaptation of the data model, based on previous experience

- I Modelling

4. Development of the IT-system:

- I Development of a system solution
- I Testing and adjustment of the designed system's solution
- II User test of system solution

5. Packaging the method/product

- I Development of the first version with user-guide and training package towards municipalities and/or schools.
- II Management of development / technology solution

6. Reporting to the SMURF-project. 15 December 2013.

7. Method education from the researchers:

- I Training and certification for GISgruppen
- II Supervisory support in the practical application of CMGIS

8. Observation and quality assurance from the research team

9. Design of graphical user interface

10. Product with available map

The activities of the researchers concerned mostly the points 1, 7 and 8. The other steps were done by the companies. However as the researchers and

the companies were in continuous dialogue with one another the researchers' opinions still had an impact on how the project turned out. Although this process looks linear and straightforward, the actual work within the project was often iterative and challenging, as highlighted by Mikael:

If everyone seems to agree, you move on to the next step, so it is all the time a check at every step, do we talk the same language? There is a hell of a lot of iterations. Then we'll go ahead and make a development and then we have a ready solution, but another part is perhaps not at all clear, so maybe we are forced to go back and redo some of the things we did because other parts are not at all clear, we might have to redo stuff in the database to fit into the requirements that we might have missed our misunderstood – Mikael Schröder

The SMURF-project was only the start of this collaboration and the final report that was sent into the SMURF-group (14 February 2014) after the project makes that clear. It specifies that the main focus was on knowledge exchange and laying the foundation for what was to come further ahead in developing the product. The process and practices described above stretched over all the years until they successfully managed to create a viable, functioning product that could be sold to municipalities. This took another 2 ½ years of work, much of it unfunded.

When asked if this collaboration differed from other types of collaboration Mikael previously had, he explained that yes, there was a clear difference in that they and the researchers made a commitment and an investment towards doing something *together*. In other collaboration they had been part of, there was less of mutual commitment.

This collaboration was so much more of an active participation from us/me than what I have done previously. – Mikael Schröder

Mikael points out that Kerstin and Ulla have been very clear on what they want in this collaboration. This has made work much easier in that they could create what they called a “win-win situation”. Still, it seemed like there was never any attempts to produce any research results from the collaboration in itself. The focus was to create a working product that only at a later stage could be used to collect data for Kerstin and Ulla for future work. This made this project focused on commercialisation above all else and the researchers' role became having an overview and supervising work to establish that they got what they wanted.

I am not really taking part in the practical work in the project. It is more about supervising and controlling that we are on the right track - *Kerstin Nordin*

This UIC is to this day still active and it probably will be for the foreseeable future given the nature of this project and the work that followed.

#### 4. Analysing the practices: collaboration within one practice

Just like three other cases this collaboration concerns two different sites. One focused on development and business practice and another with a focus on a research practice. The practices were in this way also dependent on two different institutional resources in their strive towards excellence.

However, unlike the other three UICs, this collaboration was characterised by the previous personal history and close connection between the collaborating partners and a strong focus on commercialisation of research. It is in fact Kerstin and Mikael's previous history that is the whole reason for them to start working together. They have the same or similar educational background, share a similar professional language and are privately acquainted. They met a number of times before the SMURF-funded project got started, partly because they have the same interest in GIS-related questions. They were for a short time even part of the same site and within the same research practice with Mikael working at the SLU department. When asked on how close the two are in relation to what they do in their day-to-day activities: *"Would you have been able to sit side by side with her [Kerstin] as a researcher in her department? Mikael: Yes, I could easily do that. When we get together we often discuss her research and methods. I mean there are differences in what I do and what she does but we are close, for sure."* This highlights the effect individual's history can have on the connection between practices and how work developed in the collaboration.

In the work that takes place most of the practices are concentrated on two carriers, Tom and Mikael in their attempts at building a working IT-product. Ulla and Kerstin have previously performed practices that resulted in the method for evaluating how children view their outdoor environment (an early version of *CMGIS*). This was before the collaboration described above took place. The result is that they hand over much of the work to the companies involved in the process of making *CMGIS* commercially viable. The project goal is also clearly focused on commercialisation of research. At the core of the collaboration is Tom and Mikael's practice, a practice around performing programming and writing computer code. The hope for the researchers was that this product would generate data that they can use in their academic research practices in a later stage. It was never possible to distinguish any academic research practices being performed as the project and collaboration unfolded over the years, only the possibilities to do so in the future. Kerstin's quote above is a clear indication of that.



So in this way the UIC becomes a sort of reversed share of workload compared to the other three cases. The development practice associated with the companies does most of the job and the researchers are incorporated into that practice through the activities they perform as inputs to the product development practice.

The project goal that was written down and specified within the project plan/application, arguably one of the collaborations boundary object, gives the same picture on how work was structured: *The project aims to capture and commercialize the experience and knowledge that SLU's research team has developed around CMGIS, in order to broaden its use and application.* It is clearly visible in the agreed on goal that was established beforehand that this project was to be heavily focussed on the development practice. The practice elements come together in the competence of the bodily notion of using a computer and understanding coding language along with managing CMGIS final version. There is meaning in solving the CMGIS issues and creating a viable product for users and academic research. Both of these elements are partially provided by the researchers' activities. The material element is composed of the body and the material infrastructure, like the computer, but also of more virtual "material" elements such as databases and IT development frameworks.

The process of development and the development practice was from a practice perspective structured in the following manner: A material practice element is recruited in an open source database called Couch DB and a number of frameworks as well as JavaScript. Using those material elements and the elements above, the practice is set into motion through an iterative process of writing code, debugging, and bug test, to test if the solution works, specify and test again. After some time of this a mock-up slideshow was produced and that was used to demonstrate to Ulla and Kerstin how Mikael and Tom wanted to build the product. Through their discussions, the practice element of meaning and competence is slightly altered and they proceeded to the next step and once again started to build the IT-program with the above process. The next step was for Ulla and Kerstin to go through the entire methodology and processes associated with using CMGIS with Mikael and Tom. Creating a working IT-solution was only the first step in the development practice: three more activities also have been performed and linked into that work: (1) There is a managing/teaching process linked to CMGIS in instructing children and teachers on how to use the product. (2) Collecting and compiling the data gathered in satisfactory manner. (3) This is then followed with workshops with a customer on how they might proceed with the results. As Mikael already knew much about the system and methodology, step 3 was not a particularly difficult or time-consuming step but still regarded as important in order to create the best possible product since the end goal of the entire collaboration was a successful commercializing of CMGIS. This development practice can be seen in figure 37. The activities that Ulla

and Kerstin performed, education and supervising work, were centred on the practice element of competence.

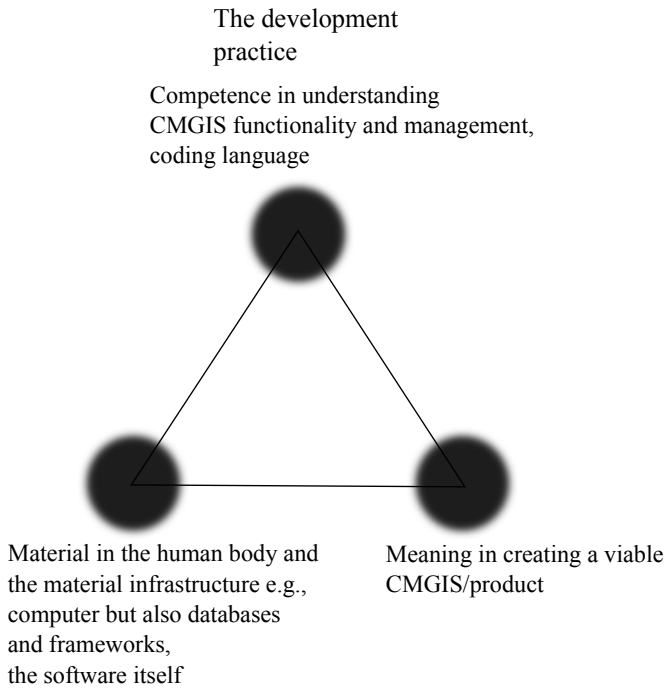
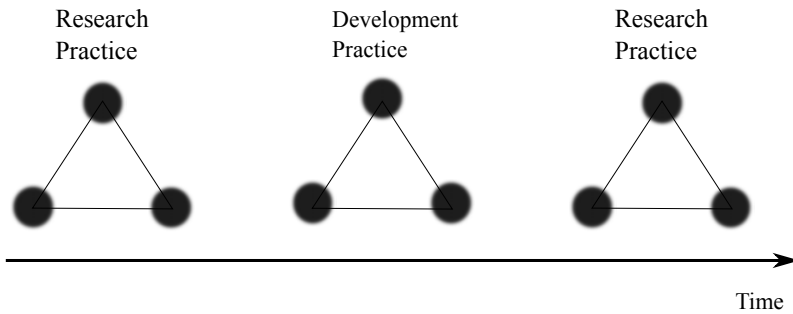


Figure 37. the practice of coding/building a commercial IT-system solution.

The sites of the companies and SLU are able to connect through the individuals as the work they do together form the development practice. In this UIC, the sites are connecting through one practice, not two or several like the other three cases. This difference has to do with the lack of an academic research practice involved in the work. The project was directed towards commercialisation of a product rather than a joint goal towards business *and* research. This way, the development practice became what used the available resources provided by the SMURF-project. What laid the foundation for the work was however very much an academic research practice, as the development of *CMGIS* is the result of many years of Ulla and Kerstin's research. But, this research practice has in fact already been performed in previous stage and will be performed again in the future. It was not actively partaking in what was done in the SMURF-funded project. Thus, this project demonstrates a connection with different practices over time, where a research practice is inactive and a development practice is performed. There is a temporal connection rather than spatial (see figure 38).



*Figure 38.* The temporal connection between the academic research practice and the development practice in this UIC

The closeness can be understood as if the actors were part of the same site: the practices that are creating the output and work within the collaboration include both Ulla and Kerstin and Mikael and Tom being present also in the same place. The academic researchers are both part of the development practice and provide practice elements to it. This UIC emphasises the importance of the individual in how practices are formed and developed, how the individuals' history impacts what type of practices are active in a given site and how those practices look.

The role of the researchers became immersed within the same practice as GisGruppen and Arctic Tiger. Kerstin and Ulla provided the foundation of the practice elements of competence (and in some way also meaning) in the practice that involved managing a future product towards customers when they instructed Mikael and Tom. They specified in the workshops what they wanted the solution to deliver so they would get the best possible data. Thus these activities (giving opinions and demands, instructing on how to use *CMGIS*) produced parts of the practice elements of meaning and competence incorporated in the development practices required in building a commercially viable version of *CMGIS*. This means that even though the actors described that they worked very close together, from a practice theory perspective most of the activities were carried out within one setting and with a particular practice associated with Tom and Mikael. The practices within the collaboration do only to a minor extent include the activities from Kerstin and Ulla. That is not to say that their influence was not important, they were just not a large part of the doings that created the outcomes of the collaboration. They instead bring in elements of meaning (asking to work together with GISgruppen/taking part in the demand workshop) and element of competence (educating the company in using the product).

# Chapter X: Cross-case comparison

In this chapter the four case studies are combined and compared against each other in some specific dimensions and their communalities and differences are highlighted. They are also analysed in relation to existing literature. I begin the cross-case comparison by summarising all the practices and their connections in each of the UICs. From that I juxtapose the practices in the different UICs in order to bring out similarities and differences. I then outline the facilitating factors for the UICs in comparison to the UIC-literature and also a practice theory perspective. I then discuss the outcomes of the UICs and lastly how adopting a practice theory approach reconceptualises the idea of a clear separation between industry and academia.

## 1. Summary of the practices in the cases

There are, first of all, the practices involved within the SMURF project – the administrative and brokering practices. The former was formed around the administrative and managing parts in the project. The latter was about work that was done in relation to the UICs: in order to broker between the academic and the industrial parties.

- The administrative practice had a material arrangement containing some project management tools, e.g. an Excel chart with all the project applications, PowerPoint presentations and an electronic folder with all the project documents. The practice also includes the infrastructure and space itself, along with the human body. There is competence from both the material arrangements in the knowledge that has been inscribed in the tools but also in the individuals at the centre of this practice. The individual in this specific instance carried knowledge and experience concerning how to act in the appropriate way as a project manager, e.g. being structured, entrusting and communicative. There is also meaning in the successful managing of the project activities, in engaging people in acting in a way that will bring the project to conclusion and success.
- The brokering practice is defined as separate but closely connected to the administrative practice. The three practice elements that define it are a material that is mainly centred on the individuals.

This practice does make use of a material infrastructure like emails or the phone, but the body is the carrier of a special kind of competence and meaning within this practice. These individuals had double competence in both in academic research and experience from managerial positions in business (Jonsson et al. 2015). They have been part of academic and business practices and have lingering knowledge of them, allowing this brokering practice to have the possibility to connect to a diverse set of other practice elements and practices within research and business. The practice element of meaning is directed to the successful mediation and connection of other practices.

In particular, the brokering practice acted as a type of connection in the initial steps of all the studied UICs, before their specific work had begun. Through the brokering practice the individuals in SMURF matched companies and researchers together, and formed rules that the UICs had to adhere to in order to get any funding.

In UIC 1, the practices were centred on a type of material, the Quartzene. The two individuals who played a significant part in the collaboration first interacted through an AIMday; the two could establish a connection because they both carried practices that shared many attributes. Work was then initiated and centred on incorporating two materials into the practice element of material, the EM at Ångström Laboratory and Quartzene that Svenska Aero-gel produced in their facility. There were three practices involved in this collaborating work.

- One development practice consisting of a material element with machinery, Quartzene and equipment. This practice included competence involving both understanding of intricate machinery and knowledge on Quartzene. There is meaning in producing a product/artefact that can be useful for users and generate revenues. We can thus talk about this as a type of practice. It has an inherent drive towards the excellence of developing Quartzene.
- There was a business practice with close connection with the development practice. This practice had an element of meaning around getting Quartzene out into the market, competence in being able to understand what others value in Quartzene and a material element in infrastructure (email, phone, etc.), the body and Quartzene itself. This practice was close to and depends on “the market” (Keat 2008). It was about making money to advertise, to sell Quartzene, and in this way creates resources (external goods) for its own existence and thus also provides the conditions for the development practice to sustain itself. In such a way, these two practices were mutually dependent in that they shared a common meaning and material element around Quartzene.

- Lastly, there was an academic research practice centred on a specific artefact, the EM: the competence and meaning of this practice is based on a material element and its specific techniques, i.e. 3D electron tomography, electron magnetic circular dichroism (EMCD), fluctuation EM (FEM), strain analysis or quantitative EDS analysis. Having the competence to perform a correct and proper analysis with the EM using these techniques was key within this practice. The carriers of this practice saw themselves as being related to practices that exist outside the institutional settings of academia, i.e. close to “applied research” rather than “basic research”.

In UIC 2, similar practices to UIC 1 emerged from the empirical material. This time however a brokering practice had a significant role in facilitating work in the collaboration.

- There was one development practice situated within the site of Metahyd AB, geographically situated in Gävle. Meaning within this practice was found in the ideological reasoning from the main carrier, Sven-Olov: *“To solve the world’s energy crisis [emphasised] and offer farmers a way to make it economically viable to exploit biogas”*. It was about making it feasible for farmers to use biogas produced as a by-product from anaerobic digestion of organic matter. There was also meaning in the engineering craftsmanship, in creating a product and a machine that worked. The competence was to understand the mechanical properties of hydrating methane and the knowledge of how to build a machine that works. The material element was the methane hydrating machine and the hydrated methane itself.
- There was an academic research practice involved. It had a competence element in having the skill to solve complex calculations, being able to use a computer and associated modelling systems and to understand research results. There was meaning in conducting interesting research. There was a material element that involved the body in connection to using a computer to manage the calculation and simulations.
- The third practice was the brokering practice. It had a focus on tracing funding/funding agencies for this development work and creating a viable business out of Metahyd that would give the development practice resources. In this brokering practice, there was competence in talking, writing, operating computer, formulating applications, ability to network. Meaning was in facilitating work, sharing information, and helping Sven-Olov business become viable. There was a material element centred on the human body, but also a material infrastructure like the phone, computer or the In-

ternet. The main contribution of this practice within this collaboration was as a mediator and facilitator of practice elements needed by the other two practices above. The brokering practice was also connecting to a type of business practice that looked very similar to the business practice in UIC 1.

In UIC 3 the work was structured in a very different way yet again. This time the connections between practices were shared between a material element, an ELISA-assay, and an individual, Peter Bergsten.

- There was a development practice within Mercodia centred on a material artefact called “ELISA”. The practice was structured around producing and developing this technology. There was a practice element of meaning around developing this ELISAs in the best possible way, to adjust it and make it work. There was competence in understanding immunology and the properties of ELISA parts and its production. The material element was the able individual bodies of the lab personal, just as much the ELISA kit itself along with the laboratory equipment needed.
- Secondly, there was an academic research practice around knowledge, technical capabilities and technologies centred on lipotoxicity in beta cells. There was competence in this practice within the understanding of knowledge of laboratory techniques and machines and mechanism of lipotoxicity, and meaning in the discovery of new knowledge and claiming recognition of this new knowledge. Materials consisted of the body of individuals working in the lab, human serum or blood, machines and protocols, e.g. ELISA.
- There was also a clinical patient-study practice part of the collaboration. This was needed because the other two practices could not accommodate everything that needed to be done. For work to continue, there were more activities involved and as described in the case the patient study added such notions. This was a practice with competence in managing blood tests, knowledge on techniques and how to follow a research plan/protocols, and being a competent medical practitioner. Meaning was found in performing activities that adhered to the exact specifications of the protocol. The material element consisted of the blood samples and the bodies of the patients just as much as the bodies of nurses or doctors. There was also, in this instance, the material element of an ELISA assay/protocol.
- Lastly there was a brokering practice present in the collaboration. Peter Bergsten acted as a broker, carrying this along with the research practice, and was “at the heart of things” between the three practices throughout the collaboration. This practice created ele-

ments of meaning, transferring materials and offered parts of a competence element to the other practices. It was virtually the same practice that was part of UIC 2, although with some variations within the individual practice elements.

The last collaboration, UIC 4, represent a somewhat different picture compared to the other three. Work in this constellation did involve academic researchers and a company (indeed two companies) just like the three UICs above. It was also specified that there was research and commercial values, just like the other collaborations (i.e. the demand specified by SMURF was met). However, it was only possible to account for one practice within the collaboration, a development practice. Both the researchers and the companies contributed to its assembly, but really the practice was centred in the work that the companies performed. What the researchers provided was essential, but their research practice was not really involved during the SMURF-funded project I followed and thus fell beyond the time limits in this study (more on this further down).

- The development practice was about the construction of an IT product called *Children's Maps in GIS*. The practice elements came together in the competence of the bodily notion of using a computer and understanding coding language along with managing the final version of *CMGIS*. There was meaning in solving the *CMGIS* issues and creating a viable product useable for users and academic research. Both elements were partially provided by the researcher's activities. The material element had different degrees of materiality e.g., the body and the material infrastructure, like the computer, but also virtual databases and frameworks.

## 2. Comparing the practice in the four UICs

The theoretical approach I have taken into doing this study brings an important distinction in relation to most other theories. It is to view *practices* as the fundamental unit of analysis, not individuals and not organisations/institutions. It should also be repeated that my unit of analysis has been centred on the practice performed *in the collaboration as such* in order to address this thesis purpose and research questions. It has not been to explore all the practices that are envelope day-to-day activities within the company or academia. This is important as it limits the scope of the phenomena investigated, but it also means that many practices that the actors are likely to have carried are not included in the description of the UICs. In particular, in this chapter I want to demonstrate how the approach I have adopted addresses the lack of studies focusing on the question of how a UIC between a small firms and academia is performed. This approach also helps to counterbalance



the heavy focus in the literature on the motivations of single actors in engaging with a UIC and the interest that has been put on efficiency/facilitation/values of UICs rather than on their process of work. Furthermore what is also evident is how all of this understanding that has been built up in the literature sees a clear divide between universities and companies. That there are diverse cultures, different resources and viewpoints, which need to be handled: in fact, one might claim this entire research area is built around this difference. It is not to say that such conclusions are wrong, since differences do certainly seem to exist looking at the cases above. However, as there are no attempts in the literature on analysing, problematise, or focus on how UIC-work is done in practice the question still remains on what might be found with such a focus. A practice theory perspective demonstrates how work, the “doings”, were structured and carried out in these collaborations. The aim has been to try and look at UICs from a different perspective not present in UIC literature in order to broaden our understanding and solve some of the gaps found in this stream of literature. In particular, I have dedicated much effort to showing *how* UICs between small firms and researchers are performed through a qualitative multiple case study method. Taking such an approach sharply differs from what the previous literature has done. In the UIC literature, the common approach has historically been to focus on datasets on patents, licensing, academic entrepreneurship and co-authoring (Perkmann & Walsh, 2007). Simply put, a practice approach complements our knowledge on UIC because it emphasises different features than what previous scholars have brought forward.

Although the specifics of all the practices within the collaborations were diverse, they also shared a lot of similarities. This is because they started off with the same premise: they were the outcome of the administrative and brokering practice within the SMURF project. To be included in SMURF and receive funding there had to be, at the very minimum, some sort of focus on both research *and* business. It is also evident that all cases incorporated practices linked to research or business (development), even if UIC 4 is different from the others in this regard (the research practice pre-existed and will possibly follow the business practice).

The cases demonstrated a pluralistic way of forming and handling work within collaboration of this kind. It would be very hard to abstract a simplistic model of how UICs are formed and performed from a practice perspective, which has instead been proposed by other scholars from other perspectives (e.g. Tuten & Urban, 2001). Practices, even though they could be talked about as being similar, always depend on a site and its contextual premise. There might be much that is similar between two research departments within a university and we can talk about how their day-to-day activities involve a ‘research practice’, but there will always be a difference in the individual practice elements. There are different meanings on the reasons for engaging into a research project: what concerns and is interesting to do, how

those things should be done, i.e. how we usually do them, what ought to be done and what is right to do in a certain situation. There are also differences in the element of competence: what type of knowledge is needed to do something in this particular setting, knowledge on how one is to perform, act and/or use a skill is how one becomes a competent practitioner in this setting. For instance, if we choose to only focus on meaning it will bring out the motivation on individuals and how they relate to research. This is likely to be different between individuals within a department and even more so between another department in another place. It is when the connections between practice elements into a practice are made that similarities emerge between sites. When competence, meaning and materials are brought out together then it makes sense to talk about a research practice that is present in various sites. In this way a vastly complicated world of practices emerges and abstracting a simplistic model would not be useful. The focus on practices instead brought out the difference between the practices in the cases just as much as the similarities. It has revealed *how* work can be performed in such constellations.

During the interviews, all actors across the cases stressed that their collaborations were all, to varying degrees, explorative. Rather than being a one-sided delivery or “consultancy-type of service”, they were instead described as being co-creation processes in which the work of both sides had a direct effect on the results. A practice theory analysis also showed that this work indeed required both human and material resources that originated from all the sites involved. For example, in UIC 1, the results from the investigation on Quartzene from the research group generated motivation (meaning) for the company to continue with the collaboration. The academic research was in turn dependent on the Quartzene samples, a material element, provided by the company. In UIC 2, Åke Nordberg’s academic research practice provided legitimacy for Sven-Olov’s development practice and thus motivated him to be part of the collaboration. Similar conclusions can be drawn from UIC 3 and 4. From a practice perspective, such results do not seem surprising. If the social world consists of social practices that are put together with practice elements that exist as resources to be used “out there” (Shove et al. 2012), then carriers performing a practice would want to find those elements that allow for practices to continue. One can see the different constellations and how the actors constructed them together within the cases. In general, this formation came rather easy; there were some difficulties that needed to be handled but in general the practices that were involved in the collaboration could be performed “*without much hassle*” (as described by one of the interviewees). This is somewhat a circular argument; without the successful construction of practices and practice connections there would not be any collaboration. Nevertheless, in some way or the other the UICs were dependent on practice elements that came from *both* the researchers and the company site of the collaboration.

I would like to claim that it was precisely this that enabled these collaborations to be formed and endure throughout the time of this study: both parties had to engage in the work and provide something in order for work to be performed. That in turn required commitment and made the carriers motivated to continue working as practices generated more practice elements (and practices) for both the researcher and the company. To put it slightly differently, the results of each practice generated new practice elements for both the researcher and the company and this motivated them to keep working together over the period of time I followed them.

## 2.1. Connections between the practices from different sites in each UIC-case

The facilitators/connections between practices did not create a full integration between different practices, that is, the research practices did not become a business practice during the collaboration or vice-versa. The connections acted instead by translating from one practice to another.

The SMURF-project and the brokering practice affected all the UICs in this way. The interaction leaders who were part of a brokering practice in a sense “spoke a common language” within both the researchers’ and the companies’ practices. They inscribed their agency into the applications that the UICs had to adhere to and by doing so made different interest in the work shared between the individuals within the company and the research institution. One interest in business and one interest in research were in this way merged and thus could be potentially capitalised by both. This was created from the beginning of the collaboration, before work had started. When work involved the practices described above other facilitators “took over” after these initial human and material practice connections lost their “brokering function”.

Some facilitating factors were more pronounced than other in the cases and each case demonstrated varying degree of uniqueness. They are listed in table 3 below along with a short description.

	UIC 1	UIC 2	UIC 3	UIC 4
The practices that are involved in the performance and work of the collaboration.	Two practices: One development and one research practice.	Three practices: one development, one research and one brokering practice.	Four practices: One clinical patient-study practice, one development, one research practice and one about brokering.	One development practice involving activities from both researchers and companies.

Main connection/facilitator between practices involved (excluding objects or activities with less impact).	Two brokers (Christer Sjöström and PhD student), but no specific brokering practice, and two boundary objects (Quartzene and the EM).	A broker (Lars Magnusson) and a specific brokering practice.	A broker (Peter Bergsten) and a specific brokering practice. A boundary object (ELISA)	Only one practice, connection between individuals rather than practices. The connection between practices is instead of a temporal nature
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Table 3. practices and their connections in the four cases

UIC 1: Work structured around two types of connecting boundary objects, the electron microscopy and the Quartzene material. There were also two individuals acting as brokers. The first one (Christer Sjöström) was the connecting point between practices through most of the collaboration. The second broker (the PhD student) entered the collaboration in a later stage. However, these two individuals did not perform a separate and specific brokering practice like in UIC 2 and UIC 3

UIC 2: Two different sets of practices were connected through a broker and a brokering practice that coordinated and managed work across the sites of research and business. In some instances the broker also carried the company's business practice acting as a connection between research, business and development practices.

UIC 3: A broker (Peter Bergsten) and a boundary object (The ELISA) connected the four practices in this UIC. There was also a separate and focussed brokering practice predominantly carried by the broker. These connections allowed for four practices to become interconnected.

UIC 4: There was only one practice: a development practice centred on an IT product, *CMGIS*, involved in this collaboration. It was assembled with the individuals together with the material. There were, however, connections between the research practice and development practice but these were of a temporal nature (more on this further down).

## 2.2 Materiality as the connection between practices from different sites

Because the practice theory analysis I have undertaken always includes materiality, it is impossible to disregard the importance of "the material" in the UICs. The material and human intentionality is the result of a dialectic process between the two. Through enactment of real-time practices, human and material emerge together (Nicolini, 2012). In this way, I think it might seem

peculiar to have a separate section on “materiality”, as if to infer that it is something independent from the practices I have talked about above. That is not my intention. Still, in order to underline the impact of the different materials and artefacts involved, I have chosen to further highlight this feature.

All the cases had, in different ways, materials that were essential in the work that was carried out. Some commonalities can be found throughout all four UICs. It seems fairly obvious that some material objects or artefacts in the UICs have played a part in connecting the individuals’ part of different practices, e.g., project documents, project plans or emails. They were part of the discourse and coordination within the collaborations. They were a means to an end for the individuals in organizing what they did.

It deserves pointing out how essential the materials around us are for everyday life. This, obviously, includes a collaboration of any kind. Collaboration cannot take place without some form of materiality, but in the studied UICs some objects more than others acted like boundary objects, rather than only sharing information or as passive artefacts. The brokering practice within SMURF had an obvious impact in establishing a connection between the companies and the researchers. In particular the interaction leaders’ role as brokers can be connected to the application document, which also acted as a project plan, and which the involved companies and researchers had to fill in to receive any funding. SMURF had in this way a brokering function within all the UIC before they had begun working together. Through the interaction leader’s imprinting of their agency, their motive to engage the researcher and the company, a type of boundary object was created materialised in the project application/project plan. This formed the initial connections between practices within the cases in establishing a joint goal for development/business on one side and research in the other, thus bringing different social worlds together (Nicolini et al., 2012, Fujimura, 1992; Carlile, 2002; Akkerman & Bakker, 2011).

When the collaborations get going there is a shift of type of boundary objects in UIC 1 and 3; while in UIC 2 and 4 other facilitator and connections overshadow the connectivity of any particular material. In two of the case studies, UIC 1 and UIC 3, materiality in the form of boundary objects was more pronounced than in the other two UICs and played a pivotal part in the work just as much as connecting the practices involved. In UIC 1 these objects were the Electron Microscopy and the Quartzene samples, and in UIC 3 it was the ELISA-assay. These objects enabled actors to come together over disciplinary or professional boundaries between communities of work (Nicolini et al. 2012). What is interesting here is that there were separate types of boundary objects throughout the collaboration process. The project application/project plan was only a boundary object for a short period of time, i.e. in the beginning of the collaboration when work was to be structured and attempts to find funding were made. They were not stable through time, and at one point they ceased to be a bridge between practices (Nicolini

et al. 2012). After such issues have been dealt with, work starts to get going, i.e. the practices are either established or are performed. Then, other objects became much more important as the connectors of practices and practice elements.

In this way they moved between the different levels postulated by Nicolini et al. (2012). The project application/project plan was initially a primary object that explained both the “how” and the “why” for actors taking part in the collaboration. This was the case with all the UICs in the beginning of their projects/work. Then, in UIC 1 and 3, quite rapidly other objects replaced the project application/project plan: In UIC 1 the Electron Microscopy and the Quartzene samples, and in UIC 3 the ELISA-assay. They became the motivation and fuel (the “how” and the “why”) for work and thus the primary objects.

Materiality did not only connect practices from different sites, but it also shaped them. Just like a change in knowledge and competence may shape a practice, a material can act in the same way. In UIC 1 the sole purpose was to explore Quartzene in a new way using electron microscopy techniques. How Quartzene acted during these explorations thus shaped the practices involved. The problem was how Quartzene behaved when it interacted with the electron microscopy:

How the hell do we prepare our powder which charges so massively and makes the particles race around like F1-cars when you look at it in the EM? How do you actually do the analysis? It is a real challenge and that will make all the difference on how one proceeds with the analysis. I mean we, knew this but not that it would be this hard - Christer Sjöström

The material shaped the research practices in this way: it was behaving in a manner that altered how the practice was performed. The material “resist” at first but as the practice adapts the exploration is able to continue. The samples of Quartzene became in this way both a practice element together with other material components and also a facilitator for connecting practices. Work was structured around/with Quartzene.

In a similar way, the ELISA-assay in UIC 3 was the centre of the practices. It constituted the material element in the development practice, academic research practice and clinical patient-study practice. Thus, which results the ELISA-assay produced during the project had a direct impact in shaping how all these practices developed. It was never as outspoken as within UIC 1, but it seems clear that the development of the ELISA presented both problems and opportunities for this collaboration.

The ELISA could be produced towards specific antigens in situ at the research/development lab, but it was more difficult to create a test that could be useful in blood or other types of serum where the interference and cross-connections with a range of other proteins presented a problem. Through the

iterative process between practices, a specific working ELISA was created. Thus, a material element shaped the involved practices in the same way as within the collaboration between Svenska Aerogel and Klaus Leifer.

Although the other two collaborations did not have boundary objects as one of their main connecting factors they still had some materiality that formed and shaped how work was performed. In UIC 2, the methane hydrate played an intricate part as the connection between research and development. It provided a practice element of meaning and material for the development practice in building the machine that produced methane hydrate. It also provided meaning for the research practice in modelling for a system with compressed gas. It was not a boundary object in the way I have defined the concept because it did not travel between sites as a material entity. In UIC 4 there was a virtual material object, the *CMGIS*, which had a central part in bringing individual actors together, though not a boundary object, as there was only one practice involved in the work.

The importance of the material infrastructure was visible in all the collaborations above. They exchanged hefty amounts of email between them, and they also used machines and laboratories in their pursuit of doing work jointly. An important, but perhaps overlooked, essential tool in such processes are the information systems (emails, electronic documents, etc.). All these things, which I term to be the infrastructure of the collaborations, are “sunk in” (Nicolini et al. 2012) and not often reflected about, but were nevertheless arguably instrumental in the work in the collaborations. The material infrastructure is therefore a good example of notions in these collaborations that both the actors within them and UIC literature tended to neglect. They were, however, very important within the UICs as work most often took place over geographical distances and a flow of information and knowledge was necessary. In this way the objects moved between the different levels postulated by Nicolini et al. (2012). To be more specific the project application/project plan was initially a primary object that explained both the “how” and the “why” for actors taking part in the collaboration. This was the case with all the UICs in the beginning of their projects/work. Then, in UIC 1 and 3, quite rapidly other objects replaced the project application/project plan: In UIC 1 the Electron Microscopy and the Quartzene samples, and in UIC 3 the ELISA-assay. They became the motivation and fuel (the “how” and the “why”) for work and thus the primary objects.

### 2.3 Individuals as the connection between practices from different sites

Similarly to materiality, individuals also acted as the connection point between practices: they became brokers or carried a brokering practice that linked practice elements from different practices. Brokers and a brokering

practice did not always go together. The first notion is a way to conceptualise how human actors can be the connection point; the other is how a practice acts as the connection between other practices. Talking about the individual in this way is a bit methodologically problematic, coming dangerously close to individualistic or holistic explanations. My answer to such a critique is that I focus on the individuals as the *connection* rather than having individual agency as the main explanatory cause in the cases.

Individuals as the connecting point were evident in three of the cases, but in slight different ways. In UIC 1, there was not so much a brokering practices present as there where a broker, Christer Sjöström, meaning that there were no practice with activities towards *only* connecting the involved practices or sites, which would be the hallmark of a brokering practice. Instead there was one individual, who through his physical body along with his skill-set and previous experiences in academia brought with him (or enabled the transfer of) practice elements from one site to another. He could carry a research, development and business practice, which made him one of the most important connections between the collaboration practices. Instead, stressing the difference between brokers and brokering practices, in UIC 2 Lars Magnusson was not only a broker but was clearly carrying a brokering practice: what he was doing almost exclusively concerned brokering between research and development, e.g. writing applications, arranging meetings between actors and so on. He did not, nor could he, carry a research or development practice. He lacked the competence and reason for being part of it, instead his focus made him perform a brokering practice set apart from the other two practices in the collaboration. In UIC 3, Peter Bergsten in a way combined the broker role like in UIC 1 and with also an actual and separate brokering practice like in UIC 2, because he was able to carry both a research practice and a brokering practice. As individual, he became the connection point for four types of practices; a research practice, a clinical patient study, a development practice and a brokering practice. He could be part of and carry two of these having knowledge on academic research, meaning and competence in pulling together actors of complementary skills. There was then a clear difference between the three brokers, two of them (UIC 1 and 3) carried a research and/or development practice while the broker in UIC 2 instead only carried a brokering practice and on occasion also a business practice.

We should also not forget the brokers – the interaction leaders in SMURF – and the brokering practice they carried when interacting with the companies and the researchers. They were also clearly able to link practices together and not only through the boundary object they created. These individuals had a special type of competence and knowledge in business and academic research, making them mediators of practice elements in the beginning of the UICs. They were also connecting practices without themselves being part of the research or business site.



In UIC cases 1, 2 and 3, along with SMURF, these individuals can be grouped under the definition of a broker:

Individuals belonging to overlapping groups who allow knowledge sharing between communities' [...] 'actors who use their in-between vantage position to support innovation through connecting, recombining and transferring to new contexts otherwise disconnected pools of ideas (Burgess and Currie, 2013).

The definition of brokers can therefore encapsulate all these individuals. However, there are nuances that also need to be acknowledged. A broker can connect practices, but may do so in a variety of ways. Furthermore, this definition also brings out the importance of the individual as the point where practices become centred and connect, as opposed to only carried: "*The individual is the unique crossing point of practices, of bodily-mental routines*" (Reckwitz, 2002:256)

### 3. Spatially and temporally separated practices

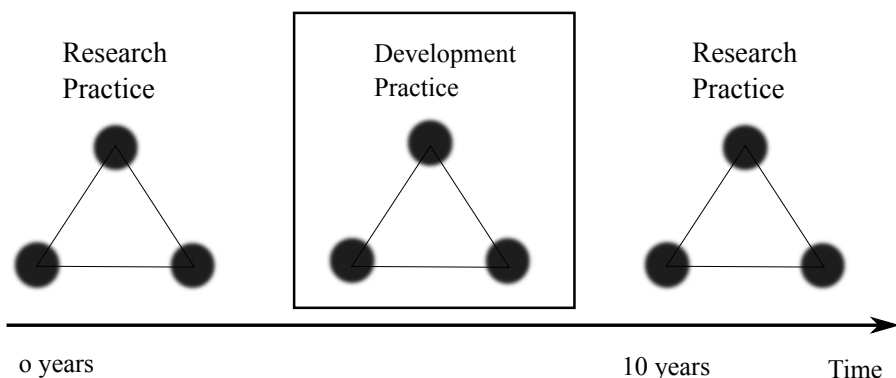
Looking at all the cases as a combined group, or for that matter, each individual case, it is interesting to reflect on *where* and *when* work was performed. Something that separated the practices in all four UICs was their dispersion in time and geographical distance. In particular, there was never an instance when a research practice performed at the same place as a development or business practice. This has to do with the difference between sites involved in the collaborations. Academia is an institution that allows (or sustains) a certain type of practice to exist (Schatzki, 2009). These practices should not be directly connected to the institution of the market. This is not to say that an individual who happens to move back and forth between a company or a university experiences a sharp distinction in the work he or she is engaged in. The activity in one institution doesn't have to be different for the human individual than the other *per se*. It is, for one thing, imaginable that the same laboratory experiment could be done in a corporate laboratory as within an academic research laboratory. Rather, it is the practices that are different. In particular, the practice element of meaning was different, as one concerns research and another is directed towards the market. It is in this way possible to differentiate between development practices and research practices in the cases.

Each space is more or less different from one another, e.g. one research lab could have a layout distinctive from the one further down the hall. There are other types of equipment or materials, or the room has been painted a different colour; one space is likely to be unlike any other. This is even more obvious when not only the material layout is different but also when the

individuals within one site are not part of another. In all but one of the UICs, UIC 4, work from a practice perspective was carried out in an iterative manner back and forth from one site to another involving different types of material arrangement and individuals.

When activities associated with a practice were executed in one space, their “product” (by “product”, I mean any thing/notion that enables or creates a practice element) was transferred to the other space and facilitated another practice. There was a transfer of practice elements of some sort. In some instances, a material object was sent from one site to another; in others, an email was sent with knowledge on how to perform a certain activity associated with a practice. For example, in UIC 3, the activity of testing with an ELISA assay for a specific protein in one space (the research department) had implications for another space (the company). Information was transferred through a material infrastructure, allowing for practice elements of competence to connect to material and meaning and activities that altered/changed the ELISA were performed. The result of this was then transferred back to the research department, which in turn sent both materials and meanings to the space where the clinical patient study was performed. The practices with associated activities played out in a similar manner in UIC 1 and 2. In UIC 1, the production of Quartzene by Svenska Aerogel created part of the material practice element for the Applied Materials Science department and in UIC 2 Sven-Olov product, the compressed methane created the practice element of meaning for Åke Nordberg.

However, UIC 4 seemed to have a different type of dynamic. This collaboration demonstrated how individuals, rather than practices, came together. However, this has to do with temporality and time scale rather than a difference in dynamics. It is only when the time scale is extended to both past and future that the same type of dynamic process as the other UICs are shown (as highlighted in the figure below). For UICs 1,2 and 3, their respective collaboration of practices were actively performed by a carrier over a period of four years. But UIC 4 was instead 10 years in the making and many more years to come because the research practice which laid the foundation for the collaboration was performed long before the SMURF-funded project, and was meant to be active again after the development practice had produced a working IT product (that was the plan at least but following such development was beyond the delimitations of this thesis research).



*Figure 39.* An illustration of the time-line on how the practices in UIC 4 were carried out with the development practice in the centre

However, the other practices – namely the brokering or administrative practice – which were part of facilitation of research and/or development practices, were not constrained to any specific place. These practices were performed in large degree through the material infrastructure, boundary objects and brokers. This is not to say that they were not affected by specific sites, but the nature of a brokering practice is how those who carry it are able to act in and move between multiple sites and/or facilitate the recruitment of practice elements.

This is not surprising, and it probably happens all the time around us. We just don't reflect on it to any larger extent. It is just one of the ways collaboration takes place between practices in different sites when there is access to large material infrastructures that allow transfer of meanings, competences and materials. However, this is still important to highlight, as much of the literature on UIC just seems to assume that collaboration takes place between actors in one space and at the same time. This dissertation has through in-depth case studies demonstrated that it is in fact the exact opposite. Most of the time collaboration partners performed their practices in different places and during different times. This implies that in such cases as described in this thesis the connections and transfer of elements between practices are dependent on something or someone to facilitate movement of practice elements across sites: there is a need of some type of connector.

#### 4. Small enterprises in UICs

This thesis has had an overall purpose to try and understand *how* collaboration between small firms and researchers are performed. The contributions from this thesis are therefore directed at this group of companies and UICs. The theory I have chosen is not particularly suitable in looking at this group of companies, but a practice approach brings the focus on “how” through

looking at the doings of social actors. Having such a research purpose along with corresponding questions is bound to provide some insights on how this group of companies perform UICs, simply because small companies are what constitutes the thesis' empirical material of the thesis.

This group of companies is generally recognised as having a low amount of resources at their disposal and thus has more constraints than larger companies in working in collaboration with universities (Ankrah & AL-Tabbaa, 2015). Because of the low amount of resources within the companies and the explorative approach of the selected UICs (except UIC 4 which had a clear commercialization focus), it became crucial that the researcher were able to drive the project forward and manage work on their own. They needed to be active and push for work to continue. The companies are in some manner depended upon the resources from their academic partners or for external funding. In such a way it was in the companies' best interest that practices involved were assembled from both sites and out of practice elements from both research and business.

Perhaps the limited commitment of time and resources by the companies was a success factor on its own: the company, but also the researcher, never made their collaboration a core practice within their daily activity over a long period of time. The project along with the funding was not so large that it required all of the company's resources. It could be paused when resources ran low and then re-started when new interests or funding emerged. The companies could keep working with their core business in different areas and thus not risk losing everything when the collaboration did not continue or activity became low.

The lack of R&D and in-house capacity to carry out technological research and thus the need to seek out universities as a way to mediate this is also said to be a strong motivator of UIC (López-Martínez et al., 1994; Ankrah & AL-Tabbaa, 2015). Regardless if a firm has in-house R&D, collaboration with universities is still highly valued as it might reduce risk and stretch limited resources (Schartinger et al., 2002). All companies in the cases sought, to varying degrees, to collaborate with a university researcher to gain access to practices (or resources) otherwise unobtainable for them, and as such were consistent with much of the literature.

Smaller firms are focused on survival and therefore participate in more relationships building (than larger firms) with universities that provide immediate solutions to critical issues affecting central business areas and core technologies (Santoro & Chakrabarti, 2002). Smaller companies often have specific needs when they engage with universities, central to their core competences and businesses performance (Peças & Henriques, 2006). Small high-tech firms that engage in university-based research are likely to exhibit a higher rate of return to R&D and have an advantage in exploiting university research as compared to their larger counterparts. The advantage of small firms in exploiting academic research is evident particularly when innovative

activities of small firms and university research are geographically concentrated (Fukugawa 2005).

In a few instances it was possible to see how academically based practices were considered better than others by some individuals, namely that the idea of academic quality brings a strong legitimacy with it. For one company, Metahyd, legitimacy was a key component in the reasoning for collaboration with a researcher. This is said to be less likely a significant factor for a larger company, even though it can be of importance (Ankrah & AL-Tabbaa, 2015).

From a more theoretical point of view, one of the notions of practice theory is that practices are always shared, and the people are carriers of a number of different practices in their social life. Throughout the years that the actors I followed worked together they developed social practices in their interactions, *together*. In these small companies, all practices that are needed to start and “make work happen” are put on one or perhaps two people. Thus the social, interpersonal practise between the company and the researcher within UICs of these becomes very pronounced. There is a lower degree of governance and much fewer bureaucratic routines that would require additional practices to handle and perhaps barriers to deal with in these smaller firms than in larger ones. This would mean that any attempts to initiate a collaboration from a university should have a interpersonal rather than formal approach (Peças & Henriques, 2006).

Related to such argument are the conclusions by Peças and Henriques (2006) that if a university is to foster the involvement of SMEs with universities, there needs to be an informal rather than formal approach. It can be concluded that the four case studies are all showing such scenarios and that the SMURF-project and its practices created a platform that was able to accomplish just that. The formalities required in filling in forms and formulating project plans were counter balanced by the brokering practices of the interaction leaders and were soon balanced by informal connections between researchers and company representatives.

## 5. Facilitating factors for the practices in each UIC - comparison to the literature

The practice approach and theory used this thesis has been applied to focus on the very basic social and material notions of how the actors worked together. There is also room to link the results of the case studies with the existing literature. The literature review in this thesis outlined what previous scholar has found to be facilitating (or hindering) factors for university-industry collaborations. Below I review the findings from the combined group of UICs in this thesis and what can be confirmed or problematized in

relation to the UIC literature. Table 4 summarizes these issues and also comments on the difference in the literature compared to this study.

One factor that was found in the literature is *the availability of resources* in a wide sense: if there are enough resources, collaborative work can commence/continue and without any resources work is unlikely to take place (Ankrah & AL-Tabbaa, 2015). The four collaborations had varying degrees of adequate resources to be able to do work. In general the SMURF funding only provided enough funding to allow for the collaborating partner to begin working together. It did not mean that they could continue after those resources were spent: all the companies were small and without the input from external funding work seemed to come to halt. For UIC 1 and UIC 3 the collaborators managed to find more funding through different channels and kept on working for a few more years. UIC 4 managed to continue working as the company used their own resources in finishing the product. For UIC 2 the collaboration ended after the second SMURF-funding ran out: there were no more resources to use from either the company or the researcher.

Three notions that were mentioned in the literature connected to the organisational structure of the university were the *incentive structures for university researchers* and *inflexible university policies*, including intellectual property rights (IPR), patents and licenses, and contractual mechanisms (Ankrah & AL-Tabbaa, 2015). Both of these notions seemed have been no problem in the cases of this thesis. The reason for this is probably that these collaborations were in some sense artificially created and a third party (the SMURF project) had put in mechanisms to handle such issues. Likewise, any issues with *inflexible university policies including intellectual property rights (IPR), patents, and licenses* (Bruneel et al., 2010) were also handled by the contractual agreement that the SMURF project provided and were not expressed by the actors as a problem. Moreover, in the studied UICs there was also a strong emphasis on the need to trust their partner, as the respondents did not think that an NDA could offer complete protection. It was the personal relationship between the researcher and the company representative that was key here, i.e. knowing someone was a “good person” to work with, who could guarantee that no breaches of confidentiality or misconduct took place within the collaboration. In small companies, like the ones in this study, that do not have more than a few employees, the researcher can keep interacting with the same person over the course of a collaboration and an interpersonal relationship can thus form.

*Leadership/top management commitment and support* have been linked to successful UICs (Ankrah & AL-Tabbaa, 2015). From the university there was perhaps not commitment as such. But through the SMURF-project the university management gave support and did not interfere in the work the researchers did. As for industrial management commitment, none of the companies discussed this as a problem in their interaction with the researchers. For three of the companies the same person that interacted with the re-

searcher were company owners or founders, hence representing their leadership. The flexibility and direct access this allowed was considered positive by the researchers.

*Collaboration champions* have been put forth as important in general, but more when there are potential issues that might be a hindrance (e.g. IPR, university policies). The champions can then mitigate such problem (Bstieler et al., 2015). It is important to stress that within almost all the UICs in this thesis much of the work was driven by exploration and/or curiosity. The collaborations with Peter Bergsten as a boundary spanner (in UIC 3) and Lars Magnusson as a broker (in UIC 1) and in some manner also Mikael Schröder as the project manager (in UIC 4) are examples of this. The set of practices that they brought to the collaboration was important for what was done and how it was done.

*Good communication* between parties in university industry-collaborations has been portrayed as important for productive work (Ankrah & AL-Tabbaa, 2015). Like any social relationship communication is essential. In the studied UICs, communication between actors in the collaborations was described by all respondents as unproblematic and productive. It was a great deal of communication most often through emails or phone calls. The positive experience and ease of communication was often ascribed to personal characteristics of the collaboration partner. Understanding of industry/university cultural differences was also mentioned as something that eased communication. In such a way this was also a facilitating factor for the practices in the studied UICs.

*Mutual trust and commitment (and personal relationships)* have been said to be of great importance in all UICs (e.g. Santoro & Saparito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Mora-Valentin et al., 2004; Davenport et al., 1999). This seemed to be very important in all cases. The companies did not think that their signed NDA would really protect their business. Both instead pointed to the need to dare to trust their researcher partners. The companies reasoned that within these kinds of explorative projects, there needs to be trust because the researcher(s) needs to have the freedom to explore new topics. The researchers, on the other hand, all expressed similar thoughts when asked about trust, publishing or IPR issues. Individuals are at the centre of practices and trust between them could be of importance if their respective practices are to be carried out in a closely connected way.

*Capacity constraints of SMEs* as a hindrance: in the literature this group of companies is said to have low resources in general and thus have more constraints than larger companies (Ankrah & AL-Tabbaa, 2015; Klofsten & Jones-Evans, 1996). In such a way size did truly matter in the collaborations I followed. All company representatives expressed that having a personal commitment to the researcher were very beneficial. It was also clear that having so little resources (both funding and materials) was a hindrance for their business in general just as much as within the collaborations. Less so

for Mercodia, which had more resources at their disposal, certainly in relation to Metahyd who had almost none. Still, one of the managers in Mercodia pointed to that this sort of work (working with academics) often comes with a lot of negotiations, uncertainties and on occasion unclear value for the company. For this reason it can be very beneficial in being a small company, because there is not a corporate head far away that decides on what to do. In smaller organisations you have much more freedom to make your own decision on how (or if) to proceed with a collaboration. Much of the UIC-literature talks about these constraints of being a small company, but in fact the four cases show also varying benefits of this “smallness”.

The *difference in organisation culture* between academia and industry is often pointed to as one of the barriers for UICs and has been claimed to be one of the major obstacle for UICs. However, it can also have positive effect if both parties are accustomed to or understands the “other side” (Bruneel et al., 2010). All respondents in the four collaborations investigated recognised that there are clear differences between a university and a company. In recognising this, they also seemed to adapt and adjust to their partners’ needs (see a more through discussion above). However, this notion takes its start on how human actors viewed this separation. From a practice theory perspective this separation is much more fluid and also less of a demarcation.

According to the UIC-literature *the skill and role of both university and industry boundary spanners* (I have instead used broker as the main concept for the individual) could affect the outcomes of a UIC. These are persons that are able to move across the different communities in companies and university taking knowledge with them across boundaries (Gertner et al. 2011). In UIC 1, 2 and UIC 3 it is clear that there are persons that are able to manage work as a broker (Brown and Duguid, 1998; Etienne Wenger, 1998; Haas, 2015; Burgess & Currie, 2013). They had a great effect on how the collaborations progressed over the years. It would seem as their roles, on many instances, were important for the collaborations.

A large part of the body of knowledge on UICs comes from studies that in some form involve technology or knowledge transfer. The UIC literature *found that the type of technology that is meant to be transferred* (tacit or explicit; generic or specialized; academic rigor or industrial relevance) can affect the collaboration (Ankrah & AL-Tabbaa, 2015). The four studied collaborations were all exploring aspects of a technology and they all experienced difficulties in the technology they were working on. In general, it was the technology/product that was a hindrance, because they were exploring something new or unknown and through the years this was the cause of a number of problems, but technical complexities were the very reason why the academic researcher and the company worked together.

*Policy/legislation/regulation to guide/support/encourage UICs* and how that affects UIC is common topic in the UIC literature (Howells et al., 1998). The SMURF-project was the result of policy just as much as UII and SLU-



Holding exists because of governmental policies. Without that funding, all of the actors stressed that they would probably not have started to work together. The matchmaking function and funding provided by UII and SLU-Holding made these actors come together and initiate collaborations. Linked to such notion are also the *use of intermediary (third party)* and what effects this might have on UICs (Ankrah & AL-Tabbaa, 2015). All of the collaborations in this thesis were in some way connected to a third party, the SMURF-project (and indirectly UII Innovation and SLU-Holding). After their start, it was a broker or brokering practice that acted at the connection and held together the four UICs.

*Enhancement in reputation/prestige.* This can be important for both the university and the company partner (Siegel, Waldman, & Link, 2003; Hong & Su, 2013; Mian, 1997). For SLU-Holding and UII it is essential that they can point to companies being connected to the universities and how they can gain something from collaborating with a researcher. That gain can concern material effects (e.g. new patents), new knowledge, but also reputational effects. In UIC 2, for Metahyd (Sven-Olov Holm) being connected to a researcher was one of the strongest reasons for him to engaging in the collaboration. It gave him legitimacy for his invention in trying to create an innovation. Similarly, but to a lesser extent, the other companies also expressed the importance of being connected to a university. Instead, the researchers did not specifically see any clear enhancement of reputation in connection with a company. They took part in the collaboration out of interest for company specific research questions or general curiosity in the topic.

Facilitating factors/barriers for successful collaborations found in the literature	Conclusions from the cases in relation to the literature on facilitators/barriers	Difference between the cases and the UIC literature
Availability of adequate resources (Ankrah & AL-Tabbaa, 2015).	The four collaborations had varying degree of adequate resources but external funding was essential.	Any collaboration would be dependent on adequate resources. A difference in the cases is the strong dependence on external funding.
Incentive structures for university researchers. (Ankrah & AL-Tabbaa, 2015).	Not a hindrance for the collaborating parties.	External party (the SMURF-project) assisted in drawing up the contractual agreements.
Inflexible university policies including intellectual property rights (IPR), patents, and licenses and contractual mechanisms (Bruneel et al., 2010).	Same as above.	Same as above.

Treatment of confidential and proprietary information (Bruneel et al., 2010)	In UIC 1, 2 and 4 (where it mattered for the respondents) they trusted that their collaboration partner would not disclose sensitive information.	Small companies seem to allow for a greater possibility to form close personal relationships and trust between parties.
Leadership/top management commitment and support. (Ankrah & AL-Tabbaa, 2015).	The SMURF-project and the interaction leaders provided support. Positive view on the support from all actors.	No clear difference
Collaboration champions (Bstieler et al., 2015).	Important within the UICs and in particular Peter Bergsten as a broker (in UIC 3) and Mikael Schröder (in UIC 4)	No clear difference
Communication (Ankrah & AL-Tabbaa, 2015).	Productive and positive	No clear difference, communication is always important regardless of social setting. In any social relation communication is a key aspect. Lack of it could cause problems.
Mutual trust and commitment (and personal relationships) (Santoro & Saporito, 2003; Bstieler et al., 2015; Barnes et al., 2002; Mora-Valentin et al., 2004; Davenport et. al., 1999)	Very important in the cases as a facilitator for productive work.	Small companies seem to allow for a greater possibility to form close personal relationships and trust between parties.
Capacity constraints of SMEs. (Klofsten & Jones-Evans, 1996)	Had a clear effect on the collaborations. Not all negative. Some notions were even positive.	A general lack of this discussion in UIC-literature.
Organisation culture differences between academia and industry is a major problem(Bruneel et al., 2010).	Said to be present by the respondents, but seem to have caused very little problem in the collaborations.	This issue did not surface as a problem that needed to be dealt with compared to its importance in the literature.
Skill and role of both university and industry boundary spanners. (Gertner et al. 2011).	Peter Bergsten in his collaboration with Mercodia acted as a boundary spanner. It had a major impact on that UIC. Also Christer	No clear difference

	Sjöström had that role, but to a lesser extent.	
Nature of the technology/knowledge to be transferred (Ankrah & AL-Tabbaa, 2015).	Did effect the collaborations, because for most of them technical issues were very reason to collaborate.	No clear difference
Policy/legislation/regulation to guide/support/encourage UIC (Howells, 1998)	The SMURF-project was the result of policy just as much as UII and SLU-Holding exist because of governmental policies.	The studies confirm the clear effect of policy on the four UICs as it created the SMURF-project.
Use of intermediary (third party) (Ankrah & AL-Tabbaa, 2015).	These factors were facilitators rather than a hindrance.	Described in general terms as positive and similar notions can be seen in this study
Enhancement in reputation/prestige (Siegel, Waldman, & Link, 2003; Hong & Su, 2013; Mian, 1997).	Can be said to have been important, but mostly for the participating companies, specifically Metahyd.	The literature points to this being important, but this study highlights how a small company might want to collaborate to enhance its reputation more than “industry” in general does.

Table 4. Summary of the existing literature’s facilitators and barriers of UICs in relation to the four cases

## 6. Outcomes

We can separate between short term and long term. The former concerns the immediate results of the collaborating practices. The latter has to do with practices involved as such and their inherent drive towards excellency, which does not always conform to institutional valorisation. The outcomes in both these sections are based on the interactions I had with the companies and the researchers and it is perhaps possible that other outcomes have surfaced since our last contact.

### 6.1. Short-term outcomes

With short-term outcomes I mean quantifiable measurements either talked about by the interviewees or written down in documents. Talking about outcomes in this way is a small step away from addressing the outcomes from a

practice theory perspective. These outcomes are, first of all, important to mention and contrast to the practices, whose outcomes can be talked about in a slightly different way. Secondly, the short-term outcomes are also of interest for policy (governmental bodies that provide funding for collaborations like the ones described in the case studies), who viewed them as imperative measurement that can (or cannot) be linked to economic growth.

It is hard to point to a clear link to the funding provided by the SMURF project on the four case studies described in this thesis. Those types of outcomes appeared later, making it increasingly difficult to determine if those can be attributed to the SMURF funding or something else related to the company performance and changes in its environment. The most pronounced result from the SMURF funding could be said to have been “potential for creation”, as it provided a chance for the parties to work together, to establish contact or to try out an idea together. Even though they had to point towards a possible tangible outcome from the SMURF-funded project, the interviews revealed that this was not the main reason for working with the researcher/company. It was a “test-bed” to try out a collaboration that then, hopefully, could lead towards something in the future. On some occasions, this was clear to the parties involved and in others was more of a hope rather than a structured plan. It was later, in some instances years, after the SMURF-funded projects ended, that measurable results appeared from the collaborations. So in one way, looking at these four case studies, the SMURF project did create some of the outcomes they set out to do. It would seem that the project manager of SMURF was right when asked about the effects of the SMURF project: “*SMURF will be like ripples on water*”.

Below is then a list of the outcomes from the collaborations as described by the actors and or/written down in project documents:

#### UIC 1

- For the company: New knowledge on the material that was the focus for the collaboration (Quartzene).
- For the researcher/research group: Development of new electron microscopy methods. No scientific paper was published during the time I followed this case.
- The employment of a shared PhD student.

#### UIC 2:

- For the company: Increased knowledge about its innovation in a larger system (knowledge about the obstacles to making it commercially viable), the legitimacy of being tied to a university.
- For the researcher: A literature study and a system study. An abstract was produced but no published article.

### UIC 3

- For the company: A new product (a new ELISA-assay) was launched on the market.
- For the researcher/research group: New knowledge on the mechanism of type-2 diabetes. 2 articles published.

### UIC 4:

- For the company: A working product, *CMGIS*, which is sellable for the company and could generate resources and consultancy hours.
- For the researchers: the possibility to get relevant research data from the working product. Part of the collaboration described in this case had a direct influence on Kerstin finishing her PhD.

It seems that there were in general several positive outcomes for both the researcher and the companies from these collaborations: their practices got connected and their results clearly demonstrated that. The companies got access to a variety of resources and knowledge otherwise difficult to obtain. Although based on larger companies, Cohen et al. (1998) conclude that university and industry cooperation research can enhance a company's sales, R&D productivity, and patenting activity. This is somewhat in line with what can be seen in this study but no patent ever came out of the collaborations and it is unclear if there was any increase in sales directly linked to the collaboration. Something that undoubtedly resonates with this study is the claim of Perkmann & Walsh (2007) that firms often choose not to assess the value of these relationships via hard performance measures. In most of the cases it was the relationship as such that was important and there was never any talk of how to evaluate the collaboration through key performance indicators or similar measurements. The researchers also expressed in the interviews that they benefited from the collaborations: this is consistent with the findings of Cyert and Goodman (1997) and Meyer-Krahmer and Schmoch (1998) that researchers get access to funds, gain awareness and "real-life" applications of their research, secure funds for their students and access to lab equipment, supplement their own research and gain new insights from UICs.

Researchers engage in these activities because they want to secure funding for their research, put their research into practical use and/or gain private financial benefits (Nilsson et al., 2009). Perkmann et al. (2011) find that researchers in general want to further their research rather than to commercialise their knowledge. Furthermore researchers are said to benefit from collaboration with industry by getting access to funds otherwise hard to obtain, by gaining awareness and "real-life" application on the practical application of their research, by securing funds for their students and accessing lab equipment, by supplementing their own research and gaining new insights (Lee, 2000). This is only partly supported by the cases within the the-

sis: it does not seem like getting financial benefits was a major reason for engaging with the company, as the financial resources obtained by the researchers in the four UICs were quite modest. However, the researchers thought it was good to understand the practical use of their knowledge and get new insights.

Industry is motivated to engage in UICs as they might acquire access to technologies and research facilities with expertise otherwise difficult for them to obtain on their own (Bonarccorsi & Piccaluga, 1994). The lack of R&D and in-house capacity to carry out technological research and thus the need to seek out universities as a way to remedy this is also said to be a strong motivator and prevalent in the UIC literature (López-Martínez et al., 1994; Ankrah & AL-Tabbaa, 2015). This is supported by the cases within the thesis. In all of the collaborations, one clear motivating factor was, for the companies, to get hold of resources (knowledge, technology, expertise) that they did not have in some way or the other. The outcomes only partly reflect the value that the actors ascribed to working with a company/university partner. More than anything else, all the respondents highlighted the intangible value as very beneficial in gaining insights or legitimacy and increasing their knowledge. These issues were mentioned by all respondents, and the two quotes from Sven-Olov Holm (about legitimacy) and Christer Sjöström (about the importance of the relationship itself) I brought out in the UIC 1 and 2 underline this very well:

It is a matter of attaching yourself to the right people so you don't come off like some crazy nut. – Sven-Olov Holm

The most important, if I have to choose even though this is one thing that apparently goes together, it is undoubtedly the relationship in the collaboration, but that we also got those concrete results. – Christer Sjöström

## 6.2. Long-term outcomes

I call these outcomes “long term” as they concern outcomes from a wider perspective relating to how the practices in the UICs developed and were performed, something that does not easily conform to clear-cut tangible measurements. Practices are about the doings of human agent together with material(s) in that their outcomes are either more practices or practice elements that are continuously carried onwards by carriers. They strive towards their goal, their excellency, on their own accord, detached from institutional valorisation (Keat, 2000). Every practice involves a set of standards that serves to identify what counts as a good or bad way to perform them, a situated normativity. People generally perform practice for intrinsic reasons, the satisfaction of doing them and this might not conform to what a policy or other institutional actors seek to accomplish.

Institutions like universities or other policy funding agencies have a power to affect what goes on, what is and what is not funded. They can recruit people, build material infrastructure and provide the external goods that practices may depend on (Keat, 2000). Their method of doing this is to ask for measurable results, e.g. publish a paper from researchers and KPIs from companies (e.g. employees or sales). Institutions can provide a basic structure of available resources but have, from a practice point of view, very limited power to affect how practices are developed over time. The SMURF project tried to influence the practices in the UICs by creating a structure with the application procedure which all the aspiring UICs had to go through in order to get funding. These boundary objects and brokering material did initially establish an association between practices and had an influence on how the practices developed. However, this kind of boundary objects and brokering functions lost their function after the work in each UIC had begun and in such a way the SMURF-project lost its influence on how the practices developed inside each UIC.

Looking at these collaborations from a practice perspective provides an explanation as to why “intangible values” were so outspoken. The determination of the actors didn’t come from the external goods (e.g. money, power, prestige or status). Many of the practices were instead about achieving something of that particular situated normative value for those individuals involved, Metahyd’s founder wanted to solve the energy crisis, Svenska Aerogel’s founder tried to understand their material artefact, and all the researchers are seeking to gain new knowledge and were driven by curiosity. The inherent excellence in those practices was not directed towards a tangible output.

The point is that in many instances the organic development of practices is in conflict with the valorisation and measurements performed by institutions (Keat 2000). In one way, the SMURF project is an illustrative example of how difficult it is to influence the outcome of practices. SMURF’s main KPI – to create jobs over a set period of time from the initiated UICs – was never close to being achieved. Instead, the project created a structure that established long-lasting connection between practices between very different sites.

Another outcome, or conclusion, that can be drawn from the study concerns which practices contributed with the most work in the UICs. One of the reasons, in tandem with theory and convenience sampling, for choosing the four cases described in the thesis was the different possibility, or outspoken aim for the respondents, of commercialisation of their respective project output (see method chapter). If this is connected to the cases, the degree of commercialisation correlates with an increased number of, or focus on, the practice(s) on the company side rather than the research community. In UIC 1 and 2, the practices that generated the output from the collaboration had much more to do with what happened in the researcher’s laboratory than

within companies. In UIC 3, the company was more involved, but the researcher was still an active participant within the project. In UIC 4, most of the practices occurred in the company. It can thus be concluded, logically, that increased potential for commercialisation means more practices, or work, performed at the site of companies rather than academia.

Through the four UIC case studies a nuanced and complex picture emerges, which highlights the difficulty in evaluating such projects/collaborations. It becomes increasingly difficult to assume that these collaborations by definition will provide economic growth at least not according to the findings of previous studies (Perkmann & Walsh, 2008; Phan & Siegel, 2006; Rothaermel et al., 2007). It is a matter of looking over a longer time frame and clearly establish what the practices involved are striving towards.

## 7. The notion of a clear separation between university and industry

The theoretical chapter pointed out how the separation of university – industry from a practice perspective can be related to a difference in *sites*. It is the notion that social life is inherently tied to a context in which it transpires and that explaining these specific contexts is central to understanding the social (Schatzki, 2009). Human coexistence always transpires as part of a context of a particular sort. The different contexts shape the practices that are present at a given place and time and vice versa in a constant enacting process. This view still allows for an understanding of social practices as big nets of actions and activities, but would allow for an explanation of the reason for why practices differ depending on which type of site one looks at.

All respondents, in one way or the other, pointed to the differences between business and research. They pointed out that the goals of a business are not the same as a researcher in a university. It would then seem as there is something that would make collaborative work difficult, a hindrance of sort from the individual standpoint. The respondents talk about themselves “doing” science and “doing” business, as this illustrative quote points out:

“The researcher says that we are supposed to look at this question but most of the time we are interested in something very different’. it’s like sell vs. producing good science” – Annica Carlsson, Mercodia

It is not particularly surprising that such notion is so prevalent: from an individualistic perspective, the boundary between research and business is likely something very real. In a similar way, an organisational perspective also brings out a clear difference between a university and company. So in this way both an individualistic and a holistic perspective provide a picture of a clear separation between university and industry. If this thesis had applied a



more traditional approach the focus would likely have been on understanding the boundary (in the broad, non theoretical sense) between research and industry, like so many previous UIC-studies have already established. Having a practice approach has instead highlighted the similarities rather than the differences and how many connection points exist between these development oriented small companies and university researchers.

One conclusion that can be drawn in relation to the separation between university and industry is that practice theory has brought out a fluid picture of the connections between practices over a complicated web of activities between small companies and researchers. This study makes it more difficult to outline a clear divide and boundary between a university and a business, at least from a practice perspective. Connected to this is how the practices still tend to stay within their respective sites, i.e. individuals did not come together and form a joint practice (this is also the case in UIC 4 when a wider temporal perspective is included). A research practice was still present just as much as a development practice or a business practice. So rather than the formation of something in between involving human agents, i.e. “a joint practice” of sorts, the practices connected through a type of “node/linchpin”, facilitated by a brokering practice and/or a broker aided by boundary objects.

However, it is important to recognise that some practices in the collaborations shared many similarities, and in particular, how close the development and the research practices were in some of the UICs. The two practices did involve different materials, competence and meanings but they were also similar and could be carried out by the same individuals at the opposite sites in the collaboration (for example as in UIC 1). In three out of four UICs the individuals had experience of working with counterparts in the opposite field, industry or academia (only in UIC 2 Sven-Olov Holm had never before collaborated with a university in a structured way), and it seems like this had a positive effect on their collaboration’s success. They could build on those experiences in engaging with their new collaboration partner. This made these particular individuals either able to carry a brokering practice (as in UIC 3) or act as a connection between practices as a broker (as in UIC 1). In UIC 2 there was less experience from the company side in working together with university/researcher. The researcher on the other hand had plenty of experience. In this collaboration, an external broker carrying a brokering practice enabled a connection to be formed. This would imply that an inexperienced company or researcher is likely to benefit from having some intermediary help, just like the broker in UIC 2.

## Chapter XI: Conclusions

In this last chapter, I will briefly address the research questions that were outlined in the introduction of the thesis. I will also specify the theoretical contribution of the thesis, as well as its relevance and implications as regards policy. Lastly, I will discuss avenues for future research that could be conducted using this thesis as basic foundation.

This thesis has had one overarching purpose: to investigate *how small companies collaborate with university researchers*. The empirical narratives and practice theory analysis in the cases link in with the research purpose and provide an account and answer to *how* UICs between small (and even micro) companies are performed. The descriptions and elaboration from the cases also provided the scope to answer the more specific research questions put forth in the introduction:

The first research question was focused on using the theoretical framework to investigate which practices were present in each UIC. It was a way to guide the research process forward in a meaningful way. The question was: *What are the practices that appear in this kind UICs?*

As a general conclusion, all cases had some degree (some less and some more) of research and business practices connected to their collaboration: naturally so as these collaborations concerned both companies and researchers. Furthermore, each case had other types of practices than research and business. Each of the cases also had different practice elements that were used as resources to assemble the practices, making each practice specific to the context they originated from.

All four UICs included a *development practice* centred within a business/industry site. Each of the four development practices was also different in their respective practice elements. There were distinct dissimilarities in which type of competences and materials were part of these four practices. However, one thing that made them similar and the reason they were grouped together as “development” was the practice element of meaning. This element concerns the reason for engaging with a practice and the motivations for actors in their activities. Development within a business context will always be about making something that can be sold on an economic market (or is at least connected to it through other practices) and in this, all four UICs’ development practices were much the same.

In three of the UICs (UIC 1, 2 and 3), there was an *academic research practice*. In much the same way as within the development practices, these three academic research practices had clear and distinct variations between the elements of competence and material but similarities in the element of meaning. As a general inference, the element of meaning within this practice incorporated motivations towards the discovery of new knowledge and claiming recognition on this new knowledge. Surprisingly, there was not an academic research practice part of UIC 4. This was due to only one practice (a development practice) being active within that site during the time I followed the collaboration. The collaboration demonstrated the same dynamic as the others when a time scale over a longer period was added. An academic research practice had been active before the SMURF project and was meant to be active again after the development practice had resulted in a deliverable product.

A *brokering practice* was present in two of the UICs (UIC 2 and 3). This practice created elements of meaning and transferred materials and also offered parts of a competence element to the other practices in the collaborations. It was essentially the same practice in both of the UICs, although with some small variations within the individual practice elements.

A *business practice* was less common to see included in the studied UICs, mostly because the collaborations did not involve sales or marketing activities as such. It was only in one project, in UIC 1, that activities that could be linked to a business practice appeared. This practice involved the selling and marketing of a product. However, in UIC 2 the development practice also connected to a type of business practice that looked very similar to the business practice in UIC 1 (the business practice was not directly part of the collaboration and thus not involved in this thesis).

Finally, UIC 3 presented the very specialised practice of a *clinical patient study practice*. In this collaboration there were isolated activities that were both spatially and temporally separate from the other three practices (development, research and brokering practices). The patient study practice added this.

In order to understand these UICs from a practice perspective it was essential to explore how the practices from an industry setting related to those from a research setting. Thus the second question was: *How do practices from different organisational contexts in the UICs connect with each other?*

The four case studies demonstrate a pluralistic way of both formation and handling work within the collaborations in overcoming the differences between academia and business. The practices from a university-based context and from an industry-based context connected through boundary objects (Nicolini et al., 2012) and/or brokers (individuals) (Haas, 2015) and/or a brokering practice.

A range of material and immaterial elements in the UICs connected the practices in the early days of the projects, before or just after work had begun, for instance in project documents, project plans and emails. These elements were part of the discourse and coordination within the collaborations. They were means to an end for the individuals in organising work. The interaction leaders within the SMURF project played a part in this because the UIC partners had to clearly specify how both the company and the researcher got something valuable out of the collaboration in order to get funding. SMURF acted in this way as an initial brokering function within all the UICs. This project application/project plan was, however, only a boundary object in the beginning of the collaboration. It was not stable in playing this role as time went by in each collaboration, and at some point ceased to be a bridge between practices. When work began and the development or research practices were either established or performed, other boundary objects sometimes replaced the project application/project plan.

Another way practices connected was through individuals, brokers, either directly or indirectly involved in the collaboration. This was an individual who was able to carry practices from different contexts and/or coordinate the flow of practice elements that were used to construct practices in different sites. There were two types of brokers in the cases: one carried a research and/or development practice but could be involved also in the other practice of development and/or research. The other type instead carried a brokering practice and on occasion also a business practice without being an active participant in the research and the development practice. Each case had its own distinctive way of connecting research and business:

In UIC 1, work was structured around two types of connected boundary objects, the electron microscopy and the Quartzene material. There were also two brokers that carried practice elements or practices between the university and the company sites.

In UIC 2, the practices connected through a broker carrying a brokering practice. He coordinated and managed work across the sites of academic research and business. In some instances this broker also carried a business practice acting as a connection between the research, the business and the development practices.

In UIC 3, connections occurred between multiple practices through a broker (individual) and a boundary object. There was also a brokering practice predominantly carried by the broker.

UIC 4 was special because it included only one practice, a development practice centred on an IT product. Connections between the academic research and the development practices instead took place before the project had begun and would be reinforced after a finalised product was launched on the market.

In summary, these four different ways of connecting practices demonstrate how diverse contexts/sites were able to connect with each other. The

case studies revealed how a node/linchpin between university and industry, a boundary object or a broker, enabled collaboration between “industry” and “academia”.

A practice theory approach was likely to bring out different notions along with questioning some of the assumptions in the UIC literature, and as much of the knowledge base concerns facilitation and outcomes of UICs the third and final question was: *What are the facilitating factors and outcomes connected to the analysed practices in comparison to existing literature?*

As summarised in Table 4 in the last chapter, many facilitating factors for a successful UIC were found in the literature and most of these factors could be confirmed to have had an impact on all four UICs in this thesis. These facilitating factors allowed practices from the company to connect with practices from the university (as explained in the second research question). One particular facilitator in terms of how practices connect was how each of the four UICs managed to create a “win-win-situation”. The actors within the UICs combined the possibility for interesting research with a potential for business.

Furthermore, the theoretical lens of practice demonstrated that one of the most important facilitating factors for the UICs was how they enabled movements of practice elements across sites in order to connect practices. This was managed by connecting a business/industry with research/university through boundary objects or brokers. This in turn can be thought of as the creation of a node/linchpin linking different contexts. Concerning the outcomes of these UICs, they can be separated into two closely related types: one part as a direct comparison to what the academic literature on UICs has put forth and another from a practice perspective, which is not present in the UIC literature.

Under the first type there was the connection with the SMURF project. That first funding provided a chance for the parties to work together, to establish contact and to try out an idea. From the interviews it was made clear that these UICs were mostly viewed as a type of “test bed” to try out a collaboration that then, hopefully, could lead towards something in the future. The result from this funding is labelled as “potential for creation”. Secondly, there are the specific different outcomes after the five years I followed the work in these collaborations in comparison with the UIC literature. A general conclusion is that there are positive and valuable outcomes for both the companies and the researchers, which confirms what other researchers have found. However, these benefits were often difficult to put into clear numbers or metrics for the respondents. Many of the outcomes that could be found in the four UICs also took many years to appear and when they did, the respondents still highlighted that the most important ones were of an “intangible nature”.

Through a practice theory analysis, an explanation emerged for why “intangible values” were so important for some of the respondents. In those cases, the practices that the individuals engaged in didn’t rely on the external goods (e.g. money, power, prestige or status). They often engaged in those activities because of that practice’s intrinsic value. Rather than being driven by a direct tangible output, it was instead about curiosity and solving something or gaining new knowledge. The nuanced and complex picture that emerges from this highlights the difficulty in evaluating such projects/collaborations. There were positive and valuable outcomes for both the researcher and the company, but it took a long time to reach them and analysing the practices in detail explains why.

## 1. Contribution to theory and literature

The theoretical framework I have constructed can be seen as a contribution to theory. The new wave of practice theorists have devoted a great deal of energy to developing and arguing for the benefits of using practice theory, but have not focused equally as much on providing clear analytical frameworks or methods usable in empirical investigations. There is a reason for this lack of a clear methodological and analytical approach, which has to do with the broad agreement that there is no such thing as a unified practice theory. Instead, this is a broad family of theoretical approaches connected through historical and conceptual similarities (Nicolini, 2012). This is one of the strengths of practice theory: the “umbrella of practice” encapsulates a rich theoretical world to explore and use. However, this way of approaching social phenomena is challenging because one has to construct theoretical and analytical tools from scattered and diverse thoughts on practices, often without consensus. I have leaned heavily on the thoughts of Shove et al. (2012) about practices, and on their deconstruction of a social practice into three practice elements (meaning, competence and materials). There is a pragmatic reason for this: they are one of the few authors who have tried to provide some theoretical tools that allow for a more nuanced empirical analysis of social practices. By adding other ideas on practices and the concepts of boundary objects (Star & Griesemer, 1989), brokers (Wenger, 1999) and sites (Schatzki, 2009), I constructed a framework which was useful for my research questions, but which I believe can be useful for other questions and empirical settings as well.

Another contribution of this thesis concerns the empirical setting I have focused on, which is broader than the classical focus of most practice-based studies. The type of study I have done is unusual within the “new wave” of practice theory, which tends to be centred on small local social phenomena, often with only one practice in focus (Hui et al. 2016). While I build on previous thoughts on how to understand the social world through practices, my

focus has been on the movement of practice elements and the collaboration between practices. I have focused on describing not only a group of practices, but also on how they connect with each other. In this way I have demonstrated that practice theory is not only useful for the study of small local social phenomena (e.g. cooking, playing football or driving), but that it can also be used to study larger social phenomena like collaboration between many actors involving a number of practices.

This thesis is also an extension of the discussion in Shove et al. (2012) about collaborating and connecting practices, something these authors discuss but do not further develop. I have provided a detailed account of how practices can collaborate in the production of either new practice elements or the performance of already existing practices and thus added to their reasoning. I have also outlined how practices can connect through materiality and individuals and particular practices themselves, i.e. brokering practices.

Flipping this argument around, this thesis has also provided a contribution to our understanding of collaboration. I have tried to go beyond the macro/micro or agency/structure dichotomy, which is the dominant form of explanation of social phenomena in social science today. I have in this way presented a different way of understanding collaboration from social practices and material arrangements rather than solely from the viewpoint of human actors or organisations.

Lastly, there is also a more general empirical contribution to the UIC literature in this thesis, because it has provided a detailed account of *how* collaborations between university researchers and small (and micro-) companies take place. These detailed accounts are something that has been identified as lacking in the literature on UICs.

## 2. Contribution to policy and practitioners

To a large degree this thesis has been empirically driven: the goal has been to understand *how* SMURF and the UICs I got involved with so many years ago worked. The theoretical lens I adopted has complemented our knowledge on UICs because it has brought out different features than what previous scholars have concluded. This provides a few implications for policy and how to best promote collaboration between small companies and university researchers. The body of knowledge on UICs is largely unreflective of if and how the size of a company affects collaboration with a researcher (some notable exceptions have been listed in the previous chapter). The case studies in this thesis are constructed with small and micro-companies and their results, in relation to the thesis' research questions and the literature study, suggest that there is indeed a difference compared to larger companies. Small companies are a sizable part of the economic sector and as this thesis has demonstrated, there are some key elements that differ-

entiate them from what has been the focus of university-industry collaboration research. The next step would be to think about these results and make informed decisions on how to best promote these collaborations, because they seem to come with benefits for both companies and researchers. My suggestions are as follows.

Through the UIC case studies, a nuanced and complex picture emerges that highlights the difficulty in evaluating such projects/collaborations and their link to public funding. It becomes increasingly problematic to assume that these collaborations by definition will provide economic short-term growth directly linked to public funding received. Instead, it's a matter of looking over a longer timescale. It took a few years for any of the UICs studied to generate some of the outcomes that seem to be important from a policy perspective. The connection between those results and the SMURF funding was always ambiguous. I believe that the reason for this lies within the very nature of academic research which (ideally) is focused on exploring new things, on trying to publish new knowledge that is produced under certain conditions. This knowledge is the output from university research and thus the focus for most university researchers. In general, this implies that projects/collaborations that are more or less explorative are by definition hard to plan, in detail, regarding when and what their result will be. In this way, they also have an aspect of serendipity built into them: exploring something new means a constant search for that interesting result. However, if we think that these types of collaborations can be useful for *both* companies and researchers, we should allow for researchers to stay explorative, to not become a type of consultancy service that solves immediate problems. In the four case studies, both the company and the researcher got something useful out of their collaborations precisely because they were explorative. The two parties were also motivated for this very reason to keep working together over many years and all but one (UIC 2) have continued to do so. It would in this regard make sense to distribute small amounts of funding over a long period of time instead of a large sum of money on one occasion. This would allow the actors to keep working in their constellation in an explorative manner over a much longer timescale. In this way a funding agency or those involved with commercialisation of research could create and foster long-term relationships.

The cases demonstrated a pluralistic way of forming and handling work. There were similarities just as much as differences and it would be very hard to abstract a simplistic model of how UICs are formed and performed from the practice perspective. Nevertheless, the results from the thesis reconceptualise how work in collaboration between researchers and companies is accomplished. The UICs in this thesis were at the outset structured to be valuable for both the research and the business sides: they were not a consultancy service delivered from one side to the other. This was in part due to the influence of the SMURF project, as it required both parties to clearly formu-



late their stake in the project in order to receive any funding. In such instances, instead of thinking about UICs as something that must be jointly performed by actors coming together under a single practice, the promotion of successful UICs should focus on establishing a connection that allows for work in both a research site and a company site. The focus from policy actors should thus be on making sure that there is something or someone to facilitate movements of and connections between practice elements across sites. Policy efforts should help establish a node/linchpin, a boundary object or a broker, between university and industry.

In much the same way, this thesis can also be useful for practitioners, namely business people and academic researchers aspiring to collaborate with a researcher or a small company, respectively. It is important to shape the collaboration so that there are benefits to be gained in engaging in the UIC for both parties, and a successful way of managing the relationship is through clearly established “nodes” that connect practices.

### 3. Avenues for future research

This thesis has been centred on understanding how small companies collaborate with university researchers. A way forward could be to establish whether the conclusions made also hold for larger or medium-sized companies. This should be done by using the same theoretical lens on those collaborations as well. This, for one thing, could open up for a comparison on what effect size has on the practices in UICs.

This thesis has followed the collaborations over a period of time. All but one of the UICs (UIC 2) are likely to continue working together in different constellations and capacities. It would thus be interesting from a research point of view to keep following the remaining three collaborations in order to see how their practices develop over time and what outcomes emerge.

Lastly, I think that there is need to further develop theoretical and analytical tools in practice theory in order to understand and investigate empirically complex social phenomena that involve sets of practices that interact with each other. In particular, methodological tools for sorting out and differentiating practices from each other in empirical material would be very useful. All in all, more work should be carried out to test and establish methodological and analytical tools within practice theory.

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# Appendix I

<i>Lists of names and organisation of respondents</i>	
<b>SMURF-project group</b>	Number of interviews
Torbjörn Fängström, UUI	4
Andy browning, UUI	3
Lars-Eric Larsson, UUI	3
Anna Grönberg, UUI	3
Andreas Scheibenpflug, SLU-Holding	3
Björn Ingermansson, SLU-Holding	3
Martin Rogberg, UUI	3
Sara Jernberg, UUI	1
<b>Researchers</b>	
Karin Ågren, UU, Department of Economic History	2
Urban Lundin, UU, Division of Electricity	1
Erik Anerud, SLU, Division of Bioenergy	2
Raida Jirjis, SLU, Division of Bioenergy	1
Anders Tengholm, UU, Department of Medical Cell Biology	1
Nils Welsh, UU, Department of Medical Cell Biology	1
Stefan Roos, SLU, Department of Microbiology	1
Andreas Hedberg, UU, Department of Literature	1
Mikael Gidhagen, UU, Department of Business Studies	1
Stefan Hellstrand, SLU, Department of Energy and Technology	1
Tarja volotinen, UU, Department of Engineering Sciences	1
Per Sonnevik, SLU, Swedish Centre for Nature Interpretation	1
Maths isacson, UU, Department of Economic History	1
Joan Lyhagen, UU, Department of Statistics	1
Kerstin Nordin, SLU, Department of urban and rural development	3
Klaus Leifer, UU, Department of Engineering Sciences	3
Peter Bergsten, UU, Department of Medical Cell Biology	3
Åke Nordberg, SLU, Division of Agricultural Engineering	3

Company representative, Company	
Peter Kimpensky, Kontigo	
Leo Padakoviz, Entreprenörsfabriken	1
Per Nyman, Vasa Tech	1
Kiell Tofters, Tämnarens utvecklingsråd	2
Marih Jonsson, Skogsbackens ost	2
Rune ringom, Synartro	2
Jan Lundh, Eco ethanol	2
Sanna Rundling, Destination Älvkarleby	2
Nils Nilsson, Parans	2
Peter Nilsson, APRtech	2
Per-Olov Björk, Björks Rostfria	2
Kick Lidén, Vallonbruken I Uppland	1
Patric Springer, Sverigegepen	2
Torbjörn Lembke, Lembke mekaniska	2
Åsa Kallas, Cebix	1
Jörgen Andersson, Fjällbete	2
Erik Wallum, Gluxoc Biotech	3
Cleas Laegelius Upplands friskvårdshus,	1
Magnus Billgren, Tolpargoni	1
Ann-Sofie Andersson Mercodia	1
Annika Carlsson, Mercodia	4
Sven-Olov Holm, Metahyd	5
Mikael Schröder, Gisgruppen	4
Christer Sjöström, Svenska Aerogel	5

## Appendix II

#	Företag	Date for 1th contact	Institution & forskargrupp	UU / SUU	ärendet (mkt korfattat)	inkommet	Projektform	Projekt total (kr)	Åskad SMURF bidrag (kr)	Beslut	Beslut datum
1	Glucos Biotech	120110	Medical Cell Biology	UU	effect ofMOX-4 inhibitors on b-cell function	121031	Prestudy	80 000	50 000	Beviljat	120125
2	Glucos Biotech II	120110	Medical Cell Biology	UU	effect ofMOX-4 inhibitors on b-cell function	121031	Full study			Beviljat	121120
3	Mercodia / Cebix	120110	Medical Cell Biology	UU	<b>b-cell function &amp; biomarkers in juvenile obese patients</b>	120125	Full study	487 500	320 000	Beviljat	
4	Improvac AB	120131	?	?	adjuvanstillätsats för influensa vaccin					Avslag	
5	Genedoc	120217	Medical Cell Biology	UU						Avslag	
6	3H Biomedical	120110	Medical Cell Biology	UU						Ej realiserat	
7	Parans Solar Lighting	111220	Solid state physics	UU	Fiber som leder ljus	11-12-13	Full study	500000	250000	Beviljat	120207
8	Svenska Aerogel AB	111010	Applied material science	UU	<b>Studies of porous material</b>	11-12-20	Prestudy	39500	35000	Beviljat	120207
9	Svenska Aerogel AB II	111010	Applied material science	UU	<b>Studies of porous material</b>	12-12-20	Full study	410000	210000	Beviljat	121220
10	Ngeninc	110630	Systemteknik	UU	Reglering av värmesystem i byggnader	11-10-01	Full study	1288000	88000	Beviljat	110922

11	Lembke Mekanska AB	110701	Electricity	UU	Magnetiska Lager	11-08-25	Full study	380000	250000	Beviljat	110920
12	VG Scientia	111230	Molekyl och kondenserade materiens fysik	UU	Analysutrustning test av biomarkör för Gliom	12-01-10	Prestudy	50000	50000	Beviljat	120207
13	Celluminova	120229	IGP	UU	Gliom					Avslag	
14	3H Biomedical	110614	IGP	UU	tillgång till endotelial cell från cancer vävnad	20110912	Full study	839000	139000	Beviljat	
15	Skogsbackens Ost		Inst för Mikrobiologi	SLU	ost med positiva hälsoeffekter	20120221	Prestudy	50000	50000	Beviljat	120223
16	Metahyd AB		Department of Energy and Technology	SLU	compression of biogas, process and system usage	20120323	Prestudy	50000	50000	Beviljat	
17	Synartro AB		Department of Clinical Sciences	SLU	Hyaluronsyrapre parat för effektiv behandling av artros	20110922	Full study	633000	250000	Beviljat	
18	Destination Tämnaren	11-11-01	Department of Economic History	UU	Story telling om byggnaden	20120307	Full study	494148	244148	Beviljat	120330

						Ta fram generisk metod och koncept för utveckling och användning av index för analys och lärande	20120313	Full study	500000	250000	Beviljat	120319
19	Kontigo AB	12-02-01	Business research	UU								
	European Community		Datorlingvistik, CSCW, Open Innovation	UU								
20	Networks AB	11-11-01	Business	UU			20120322	Full study	550000	250000	Avslag	
21	Tolpargoni	12-02-01	Business research	UU		Produktledning		Full study			Beviljat	
22	Kentor	12-02-01		UU							Avslag	
	Business network											
	Turism Forum (8 smaller guide - and booking companies in Uppland)	2012-08-25	Swedish centre for nature interpretation	SLU		Utveckling av guidningar för ökad lönsamhet i turismföretag.		Förstudie	50000	50000		130613
24	Noors slott	12-04-01		UU							Avslag	
25	Kon Kajak	11-11-01		UU							Avslag	
26	Friluftsförande	11-11-01	Business research	UU							Avslag	
27	Biskops Arnö	11-11-01		UU							Avslag	
28	Fototeknik	11-11-01		UU							Avslag	
29	Hotell C	11-11-01	Business research	UU								
32	Solelia	12-05-09		UU							Avslag	
33	Qloss	12-05-24		UU							Avslag	

	Ecoetanol@ 34 Sweden AB	12-02-21	Energi och teknik	SLU	Livscykelanalys för utvinning av foderprotein, fibrer och etanol ur ärtväxter	12-11-29	Full study	368000	250000	Beviljat	12-12-06
	Mälardalens 35 Gödsel-förädling	12-04-03	Mark och miljö	SLU						Avslag	
	36 Turismakademin	11-11-01	Department of Economic History	UU	analystjänster för besöksnäringen						
	Vallonbruk i Uppland (projekt 37 1)	11-04-01	Litteratur vet inst	UU	Utveckling av Vallonbrukens besöksmål genom identifiering och utveckling av storytelling baserad på skilda kulturarvsresurser	13-02-21	Full study	533 030	269 030	Beviljat	13-03-13
	Destination Älvkarleby, 38 Romantic Sweden	12-04-01	Department of Economic History	UU	Marknadsföring		Full study	600 051	300 051	Beviljat	12-01-23

39	Vasa Tech	12-01-01	Division of Solid state physics	UU	Förbättra korrosions och utmatningsegens- kaper i kombination med lågfriktion för t.ex. djuphavsborrar.	12-10-24	Full study	500000	250000	Beviljat	
40	Mercodia II	120110	Medical Cell Biology	UU	Utveckling av en ELISA-prototyp	12-09-18	Förstudie	217000	57000	Beviljat	12-11-20
41	Sverige Grepen	120415	Applied material science	UU	Undersöka anodiseringen av grepens handtag. Varför fås svärta ibland men inte alltid?		Förstudie	50000	50000	Beviljat	
42	Björks Rostfria	111227	Applied material science	UU	Studera skillnad i fog och opåverkat material i plasmavetsning	13-01-15	Förstudie	50000	50000	Beviljat	

43	Upplands Friskvårdshus AB	12-09-05	Företagsekono miska inst	UU	Utveckling av helhetskoncept för anläggning och drift av idrotts/friskvårds anläggningar som byggs och drivs av ideella och kommersiella aktörer tillsammans.	12-11-21	Full study	495 654	245 654	Beviljat	12-11-27
44	Fjällbete	31-04-23	Inst. Ekonomi	SLU	Betalningsmodell för lokala positiva externaliteter		Full study	312 500	250 000	Beviljat	12-12-21
45	Wildlife Sweden	12-09-06	Swedish centre for nature interpretation	SLU	Kvalitetssäkrad utbildning av natuguides (safariguider)	12-11-27	Förstudie	50000	50000	Beviljat	121206
46	Damasteel	13-02-05	Applied Mechanics	UU	Modulering av mönsterbildning i Damastål		Förstudie	50000	50000	Beviljat	130319



	Vallonbruk i Uppland (project II: Marketing 47 Vallonbruken)	11-04-01	Department of Economic History	UU	Studie av historiebruk och marknadsföring av Vallonbruken fram tills idag. Kopplat till marknadsföring av liknande besöksmål i andra länder. Inkl affärscoachning.	Full study			Beviljat	
					Värmesensorer för fasta biobränslen för övervakning och förhindrande av självantändning.				Beviljat	
48	APRTech	13-02-20		SLU					Beviljat	
49	Fullerö Park	12-09-01	?	UU					Avslag	
	Entreprenörsfabri 50 ken	13-02-07	Department of Law	UU	Ny finansieringsmod ell anpassad för mindre företag.	Full study			Beviljat	
51	Metahyd AB (II)		Department of Energy and Technology	SLU	Komprimering av biogas, process och systemanvändni ng	Full study	260 000	200 000	Beviljat	130402

Imagination 52 Studios	Department of Clinical Sciences	SLU	Animering av djurs rörelse		Full study	595 000	215 000	Beviljat	130815
53 GisGruppen	Stad och land	SLU	Hjälpmedel för stadsplanering		Full study	500 000	250 000	Beviljat	130830
54 Synartro AB (II)	Department of Clinical Sciences	SLU	Nytt preparat för behandling av torra ögon hos djur och människa		Full study	526 000	200 000	Beviljat	
						9 627 383	4 357 883		

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