PROJECTS AS AN ATTEMPT TO MAKE SCIENCE INTO BUSINESS

- EMBEDDING COMMERCIALIZATION PROJECTS IN BUSINESS NETWORKS

Work in progress

ABSTRACT

The purpose of this paper is to investigate how science is transformed into business by means of commercialization projects, and especially the *interfaces* these projects create with the surrounding network. We also aim specifically at identifying which different types of interfaces can be pivotal from project to project. Our methodology relies on four comparative case studies, centered each on a specific project selected from the commercialization efforts of Karolinska Institute (Sweden). Our findings stress that, except in one case, interfaces with users/potential buyers do not play a major role in setting the commercial direction (target markets) of these projects. Instead, in the absence of a strong interface to users, the most decisive interface for setting the commercial direction is the one with financiers, which further binds all projects to Karolinska's innovation-supporting system. Moreover, we find that the interface with the project team is never pivotal for the four analyzed project, as the human resources directly employed in the project are kept to a minimum in all of Karolinska Institute's commercialization projects. This makes commercialization projects extremely dependent on external resources and largely unable to control their long-term development.

Keywords: *commercialization of science, embedding, resource interfaces, projects, networks, Karolinska Institute.*

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INTRODUCTION

In this paper we address the use of science in the forming of new business projects. Since the 1990s science has in various political initiatives and policy documents all the more been treated as a suitable base for achieving innovation and economic progress on both a national and transnational level (e.g. Eklund, 2007; Elzinga, 2004). The university, and the science it produces, is viewed as a crucial component in the national innovation system to which it should contribute knowledge that is to be directly applied in society and industry (e.g. Arnold et al., 1999, Etzkowitz & Leydesdorff, 2000, Etzkowitz, 2004;). Several Swedish universities have also answered to this type of view with initiatives of forming their own holding companies and other organizations which are to assist in the commercialization of new scientific research results. One of these universities is the Karolinska Institute (KI), famous for its many Nobel Prize winning scientists and focus on medical discovery. Under its holding company (KIHAB) a number of other organizations have been formed, one of them Karolinska Development (KD) which works as an investment company ultimately deciding which research results that are suitable for investment and the forming of business projects within the KI 'innovation-supporting system'. KD's goal is to sell these projects to pharmaceutical firms only after they reach phase II of clinical trials. Another organization is Karolinska Innovation AB (KIAB) which usually is the first organization which the researchers get in touch with when presenting their ideas. KIAB also selects which of these ideas that are presented to KD as potential investments. Today, around 30 start-up companies have been formed within the KD sphere as a result of such investments and they are run as time-bound projects, meaning that these ventures are constantly evaluated at certain milestones, after which there is no certainty that the venture can continue.

By studying four such companies we have investigated what this type of commercialization endeavor means in terms of making business out of science by forming new business *projects*. Projects are by definition *time-constrained* efforts aiming at clear goals (Packendorff, 1995: 320; Turner & Müller, 2003: 1). They are a typical managerial tool applied to achieve innovation and change (Kreiner, 1992; Packendorff, 1995: 319) that operates by keeping a group of people and resources *separate* from the mother organization or the broader inter-organizational context (Hobday, 2000). Projects are also considered as adequate tools as they focus attention, resources and efforts as a way to *increase coordination and control* (Söderlund, 2004: 187). Not surprisingly projects have therefore assumed a central role in product development and other innovation-oriented tasks (Eisenhardt & Tabrizi, 1995)

However, at the same time innovation processes are described in the literature as long-term (i.e. not time-constrained), boundary-less, chaotic, hardly controllable and filled with unexpected outcomes (Van de Ven, Polley, Garud & Venkataraman, 1999; Anderson, De Dreu & Nijstad, 2004: 152). This process unfolds moreover in complex inter-organizational contexts under the simultaneous influence of several organizations (Håkansson, 1987; von Hippel, 1988; Rothwell, 1992; Powell, Koput & Smith-Doerr, 1996; Håkansson & Waluszewski, 2002). Thus, there seems to be a clear dichotomy between projects, viewed as tools to "manage" innovations (see Tidd, Pavitt & Bessant, 2001) and characterized by *clear boundaries*, *order* and *control*, and the actual innovation process, characterized by *no or blurred boundaries, chaos* and *unexpected events*.

If science is to be turned into innovation through the creation of a great number of separate business projects then a key question is: what happens not only *within* the single project, but also in the *interaction* between a project and the wider inter-organizational context? This context can be envisaged as a heterogeneous *network* (Håkansson & Snehota, 1995;

Håkansson & Waluszewski, 2002), populated by other organizations such as customers, suppliers, venture capitalists, universities, research groups, complementary and competing technologies, etc. More precisely, the research question of this paper is dual: (1) how do the analyzed commercialization projects transform science into business, namely which types of inter-organizational *interfaces* embedding these project are pivotal for transforming science into business? And (2) which differences do these projects present in the key interfaces involved to transform science into business? The remainder of the paper is organized as follows: the next section provides our theoretical considerations, then comes our methodology, followed by four cases of commercialization projects. The next section analyzes and discusses the cases. The paper concludes relating back to our research question and providing practical implications.

THEORETICAL CONSIDERATIONS

Our theoretical review starts from the issue of commercialization of academic science, or more in general its utilization in the broader society, as viewed from the STS perspective. Then, we consider the literature on projects and project management. Finally, we relate commercialization projects with the inter-organizational context by considering the IMP network perspective.

Transferring science to business

A vast amount of empirical studies within the field of STS (Science and Technology Studies) suggest that science is both a technical and a social practice; scientific knowledge is created through the use of particular physical methods, equipment and materials, and also through the compliance to particular social norms and forming of alliances (e.g. Latour, 1987; Knorr-Cetina, 1995). It has also been shown that scientific knowledge often finds its use in technology and remaining society in unimagined and tortuous ways (Dasgupta & David, 1994; Basalla, 1988; Rosenberg, 1994; Grandin, Wormbs & Widmalm, 2004,). The commercialization and diffusion of science to industry and society is accordingly a process that can take several decades (see Waluszewski, 2004a; 2004b) and does not follow a predefined and linear sequence as the one posited by the original “linear model” (see for a review Balconi, Brusoni & Orsenigo, 2010:5).

But even though this simplified model has been criticized (Ibid; Grandin et al., 2004), the expectations by policy makers and university administrators that universities and their science will contribute to industrial development and economic growth are still very high (Gibbons, Limoges, Nowotny, Schwartzman, Scott & Trow, 1994; Lundvall, Johnson, Andersen, & Dalum, 2002; Etzkowitz, 2004). Even if the literature recognizes several patterns through which science can be made useful to society, such as skilled graduates, new scientific instrumentation and methods, networks that stimulate social interaction (Salter & Martin, 2001: 520), much energy by university management and attention by policy makers and the media is dedicated to the creation of new firms, known as “university spin-offs”. A particular commercialization mechanism known as the “spin-out funnel” (Clarysse, Wright, Lockett, Van de Velde & Vohora, 2005; Clarysse & Moray, 2004) is applied by most Technology Transfer Offices at universities (Mowery, 2005). Moreover, much research focus has been dedicated to tracing the diffusion of academic science to society by means of this funnel-like mechanism, whose effects are measured in terms of patents, licenses and start-ups (see e.g., Powell & Owen-Smith 1998; Zucker, Darby & Armstrong 2002). This “spin-out funnel” mechanism relies in fact on the following process: selecting the most commercially promising discoveries, patenting them, searching for licensees and/or starting a new company to further develop the discovery and bring it to market (Clarysse et al., 2005).

Even if the "spin-out funnel", patents, licenses and start-ups are just *some* of the most visible and direct effects of universities' efforts to commercialize and diffuse science (cf. Pavitt, 2004; Nilsson, Rickne & Bengtsson, 2010), they are nonetheless pivotal for this paper for two reasons: (1) KI applies predominantly this mechanism to commercialize its science (Baraldi & Waluszewski, 2011), and (2) it is in the very nature of the "spin-out funnel" to utilize *projects* as tools for commercializing the selected scientific ideas.

The literature on projects and project management

The forming of projects in business is a way to temporarily organize resources and activities in order to tackle a specific task (Packendorff, 1995: 320; Turner & Müller, 2003: 1). Often projects are referred to as "temporary organizations", as they bring together particular people and resources into a tightly linked organization which will later dissolve once the project task is completed (Söderlund, 2004). Projects are also viewed as a more efficient type of organization when high coordination in performing a number of complex tasks or activities is needed (Ibid). The project literature has until the early 2000s focused mostly on prescriptions on how to efficiently manage projects (Packendorff, 1995: 321-5; Söderlund, 2004), including specific planning techniques and other managerial and control devices, such as Gantt diagrams and "SMART" principle in project goal setting (Pinto & Prescott, 1988; 1990). This rational view on projects focused specifically on the issue of project planning, implementation and evaluation (Packendorff, 1995: 322), stressing clearly the boundaries between the project and the mother organization for the sake of making project autonomous, manageable and measurable.

Also, until the early 2000s theories on project management were predominantly taking the perspective on singular projects, detached from their context (Engwall, 2003). To fill this gap, more recent research on project has recognized the importance of both the historical background and the organizational context of projects (Ibid). The historical and organizational embeddedness of a project can accordingly account more for its failure or success than the competence and power of the project manager or the project management tools applied (Ibid: 805). However, considering that innovation or commercialization-related projects operate within the context of broader and tortuous "innovation journeys" (Van de Ven et al., 1999), under the influence of several organizations (Håkansson & Waluszewski, 2002; 2007), a project's *inter-organizational embeddedness* deserves equal attention, as discussed in the next section.

Viewing projects from an industrial network perspective

If innovation and commercialization expose projects to several external organizations and interactions, then the industrial network approach (Ford & Håkansson, 2006; Mattsson & Johanson, 2006, Håkansson et al., 2009) can provide a useful way of framing projects in their inter-organizational setting. This approach suggests that organizations are defined and influenced by their inter-organizational interfaces (Håkansson & Snehota, 1995), which means that particular resources of theirs will become activated and specific activities will be performed as an effect of these external interfaces. A commercialization project may well rely on a company's internal resources, but these will be related and influenced by the resource controlled by other organizations.

Therefore, we can add to Engwall's saying that "No project is an island" (2003), stressing that projects are not separated from history and the organizational context, the expression by Håkansson and Snehota that "No business is an island" (1989), stressing how firms are themselves connected to each other. Projects are thus part of an inter-organizational network which will influence and be influenced by the single project.

Projects can clearly be inter-organizational per se, in the sense that they are conducted as cooperation projects jointly by two or more organizations (see Bresnen & Marshall, 2002): here the project, especially its formal mechanisms, is directly influenced by the informal relationships connecting the involved organizations. But also purely internal projects, conducted by and within a single organization, have important interfaces not only to the internal organizational context (Engwall, 2003), but also to the external inter-organizational one. The relevant interfaces embedding science commercialization projects are for instance those with *financiers* (providing financial resources to the project), with *supplying units* (providing materials or knowledge to the project), *downstream units* (receiving materials from or using the results of the project), *facilities* used by the project (e.g., equipment and instrumentation), *other products/projects* related via organizational connections, and the very *organizational unit* in charge of and performing the project (cf. Waluszewski, Baraldi, Linné & Shih, 2009). Analyzing these types of interfaces in four of KI's projects will help us answer our two research questions, as explained in our method section.

METHOD

This study is part of a larger research project scrutinizing the innovation strategies and structures of two major Swedish universities, Uppsala University and the Karolinska Institute (Baraldi & Waluszewski, 2011). The larger project comprises around 100 interviews with key people within the respective universities involved in the "innovation supporting systems" as well as examples of commercialization efforts. Data for this paper was collected through personal interviews and meetings involving 25 people between 2009 and 2012, as well as secondary sources (see the Appendix for details). Our research design is an embedded case study (Yin, 1994), which is particularly adequate to investigate complex interactions within inter-organizational contexts (Easton, 1995: 480): in fact, within the larger organization of Karolinska Institute and its "innovation supporting system" we selected four particular cases of commercialisation projects with the specific purpose of capturing variation (Creswell, 2007) in the inter-organizational interfaces involved in them, as they emerged from a preliminary analysis.

To perform the case studies presented in this paper we have in 2011 and 2012 conducted interviews with (at least) the CEO and the focal researcher within each of the four projects. The interview guide was based on the 4R model which classifies resources and helps identifies relevant interfaces (Håkansson & Waluszewski, 2002; Baraldi, Gressetvold & Harrison, 2012). This is a research tool that allows for the study of the technical and organisational resources assumed as being involved in the interaction processes of different actors relating and adapting to each other, for instance in innovation processes (Håkansson & Waluszewski, 2002; Baraldi, 2003). It divides the resources represented by any particular organisation into four resource categories; two are mainly physical/technical: (a) the *products* of any particular organisation, which are treated as the result of an interactive process with other organisations, and (b) the *facilities* or equipment used to produce these products, often in combination with external facilities. The other two are mainly organisational: (c) *organisational units* which implies the involved people in the organisation in terms of their knowledge, working routines, and their ability to cooperate with other organisations, and (d) *organisational relationships*, which represents the relationships between the focal organisation and other organisations as well as between other organisations that can be used to create more efficient resource combinations over time (for a detailed discussion see

Håkansson & Waluszewski, 2002). By using this model these basic resources of any organisation can be analysed in terms of the interfaces that exist between any focal resource and its internal and external environment. In this case this means that we have used the model to analyse the resources of the focal projects and how they interact with both internal and external resources. In doing so the data collected was meant to (a) trace the history of the scientific discovery being commercialized in terms of the people, research facilities and types of research results involved; (b) investigate the initiation period (cf. Van de Ven et al., 1999) of the commercialization project in terms of its early interfaces with business organizations (as a way to trace the first interactions between science and business); and (c) map the interfaces between the start-up project/company involving the focal product/discovery, the people and facilities as well as both academic and business organizations.

As the entity of analysis in this study is the organisaitonal unit of *the project* we took this as our explicit standpoint in identifying which particular resource interfaces to investigate. Firstly, as the transformation of science to business is at the heart of this study we started with the interface between the project and *the founding researcher/research group* (1). Here we primarily wanted to understand what type of scientific product/discovery that was being transferred from the research environment to the commercialization project, which equipment that was used, and through which types of relationships. Another central aspect here was which other interfaces (internal and external in reference to the project) that were essential for this process. Thus secondly, we also wanted to investigate the interface between the focal project and other *commercial projects run within KI* (2), as to see whether the resources used in the KI innovation supporting structure were being shared across projects boundaries, or if specific projects perhaps were interconnected in other ways. Thirdly, as none of these projects would exist would they not have received investment capital, another interface of the project which we identified as central was that between the project and *its financiers* (3). The financiers have central positions in the company boards and thus have a direct influence of what happens within the projects and which external interfaces they have. By looking into this interface we wanted to understand which types of resources (besides capital) that were being exchanged and which degree of influence that the financiers were having on the technical and financial development of the focal project. Fourthly, a central internal resource of the project is that of the team running the daily operations which also made us investigate the interface between the project and *the project management team* (4). Here central aspects were which type of competence that this team represents and how it cooperates with organizations both within and outside the KI structure. Lastly, as these projects have been initiated to induce innovation the users of the final product are of central importance (e.g. von Hippel, 1988), and also the potential buyers of the company which will then produce this final product. Producer-user interaction is according to the industrial network perspective central to achieve innovation which makes the interface between the project and *its actual or potential users/buyers* (5) (cf. Waluszewski et al., 2009) central also to this study of attempting making business out of science. We searched explicitly for all five types of interfaces in all four cases, but we could not find them all in all cases: especially the fifth interface (to users/buyers) appeared only in two of the four cases. Understanding the impact on each project of these interfaces enables us to answer our research question on *how* science is turned into business: in fact which features of scientific knowledge that become useful (or useless) in our studied projects can be viewed as an effect of which interfaces the project has with for instance its major investors/owners, with the founding research group, with the internal staff, etc.

The four different cases illustrate the influence of different types of interfaces for the individual projects. Our preliminary analysis points that, besides being extremely dependent on and influenced by the interface to the financiers: 1) *Clanotech* is also highly influenced by interfaces with the organizations inside KI's innovation supporting system; 2) *Aprea* mostly by interfaces with the international research community; 3) *Dilafor* mostly by interfaces with clinical organizations; and 4) *Lipopeptide* is influenced by interfaces with two other projects/companies through joint ownership. The cases reveal that the projects are highly influenced by their interfaces to external resources but that these resources are mainly connected, directly or indirectly, to the research environments or the internal KI innovation supporting structure (i.e. upstream units), and not to external organizations involved in production or use (i.e. downstream units). We now present the four cases in detail and discuss them.

THE CASES

1. Clanotech - The focal project

Clanotech is a company with two employees; a CEO and a biologist working in a laboratory. The rest of the organization is "virtual" in terms of externally hired consultants and CROs (contract research organizations), both Swedish and foreign. The potential product, which is still in a preclinical phase, is a treatment for *macular degeneration* through intravitrael injections (via the eye). This is an eye disorder where the macula (the yellow spot) is degenerated through uninhibited growth of blood vessels which can cause blindness. The company's major owners are KD and Professor Cao, the founder of the company.

1.1 Interface to the research group

The commercialization project was initiated in 2004 when KIAB, KI's own innovation scouting unit, was contacted by Professor Yihai Cao at the Department of Microbiology, Tumor and Cell Biology at KI. He presented a new screening method designed to find specific types of 'targets' (biological components that are present in sick tissue) from which corresponding substances then could be found to work as inhibitors. Cao has since the mid-1990s mainly been involved in research connecting cancer to angiogenesis (new growth of blood vessels), and when approaching KIAB he had found a possible target for cancer by the use of an own designed screening method. It was a specific group of enzymes which is connected to angiogenesis, called tyrosine kinases. They were found to work as important signaling molecules regulating new growth of blood vessels in tumors, among other things. The initial idea for the commercialization project was thus that a substance could be found to regulate these signaling molecules and stop tumor growth by inhibiting the growth of new blood vessels. This focus remained until 2009 when the project became a company, and was then abandoned for treating an eye disorder instead (this process is described below). In sum, there are two scientific research results that are supplied to the project by the research team: a new screening method and a target (for tyrosine kinases).

During this process Cao and his research group have had an advising function in the project and have supplied the project team with information when needed. Also, as he has a position in the company board Cao has been involved in the project from the beginning, but there has not been active research collaboration between the research team and the project team, in any direction. As an example, as it is of little research value the screening method has not been the focus of the research group but has been left for the commercialization project to handle. The research focus has instead been to further understand the basic mechanisms behind angiogenesis and its connection to different diseases such as diabetes, cancer, obesity etc.

1.2 Interface to other projects

One important reason for why the project was initiated was that KD, KI's investment company, wanted to restart a research facility within its innovation supporting system called ACTAR (Academic Targets) that had been shut down two years earlier due to lack of financial resources. The patented screening method that could trace down targets for different diseases was deemed an appropriate start-up project for this facility and together with another project (Novasaid) Clanotech became the basis of ACTARs activities during the next few years. All resources (e.g. laboratory facilities, knowledge and external consultants) and activities (e.g. research, screening etc) around the project were thus supplied by ACTAR until 2009. Initially the plan was that ACTAR would run the project up until phase I of a clinical trial and then find an industrial partner that would take over, but as there was no external interest in the project at this point the new plan was to finalize phase II before approaching a partner.[1] Clanotech remained a project within ACTAR until 2009 when it was transformed into a company and formally became a more independent unit than before.

1.3 Interface to the financiers

The interest which KIAB initially showed for the project was primarily connected to the screening method and a possible target for cancer. It was seen as a good way to get ACTAR started again, and especially with a project involving a screening method that could be used for identifying different targets and consequently different drug candidates. The KD funds and later KD (formed in 2007) has been involved in all major decisions made concerning the future of the project and its direction. KD is one of two owners of the company, it is also the major owner of ACTAR and had members in the board of ACTAR, which also was directly involved in steering the project. The board of ACTAR met with the project management every two months and KD every six months. At these meetings KD requires a budget presentation and an action plan for how the next milestones will be achieved.

As an example of their influence, the decision to shift market focus from cancer to macular degeneration was made by the investment managers at KD. The market for cancer treatment (by regulating tyrosine kinases) was considered too crowded in terms of competitors being involved in the same type of treatment and having come even further on the market. Also, the preclinical studies were not showing encouraging results in terms of anticancer effect. The market for macular degeneration was however completely different; here there were not many companies with a satisfactory treatment method, the currently used treatment was very expensive and there were some patient groups which couldn't use it, such as patients with diabetes. Therefore, this seemed a more appropriate direction of the company, and has remained so.

1.4 Interface to the project management team

The team around the project has constantly been very small. First it consisted of one project leader, one chemist (for 10%) and one laboratory assistant (for 50%), and later grew with one CEO, one chemist in Uppsala and two chemists in India. The project leader and the small project team initially involved in Clanotech were hired by ACTAR and worked systematically with finding substances for a possible cancer treatment, testing these substances both in preclinical and initial clinical trials, and also investigating the patenting situation. The project leader had a PhD in molecular biology and also had industrial experience from working at

[1] Bringing projects to phase II and then selling them off is the current strategy applied by KD on all the projects in its portfolio.

Astra Zeneca in Mölndal. The CEO which entered the project as it became a company had extensive experience from working within industrial development projects in large companies. The project team, now under a new CEO, however initially remained the same and thus ACTAR in this sense remained involved even when the project became a company. Even though the decision to go for an eye disorder instead of cancer was taken by the owners of the company it was not self-evident from the project management team's point of view that the cancer track should be completely abandoned. The lack of resources however made it impossible to pursue both directions.

1.5 Interface to users/buyers

KD was approached by a large Chinese pharmaceutical firm showing interest in buying into the Clanotech project and company. However, KD refused this offer and preferred to pursue its own way looking for a different buyer when the drug will hopefully have completed clinical phase II. The resource and interfaces reviewed above are presented in figure 1 below:

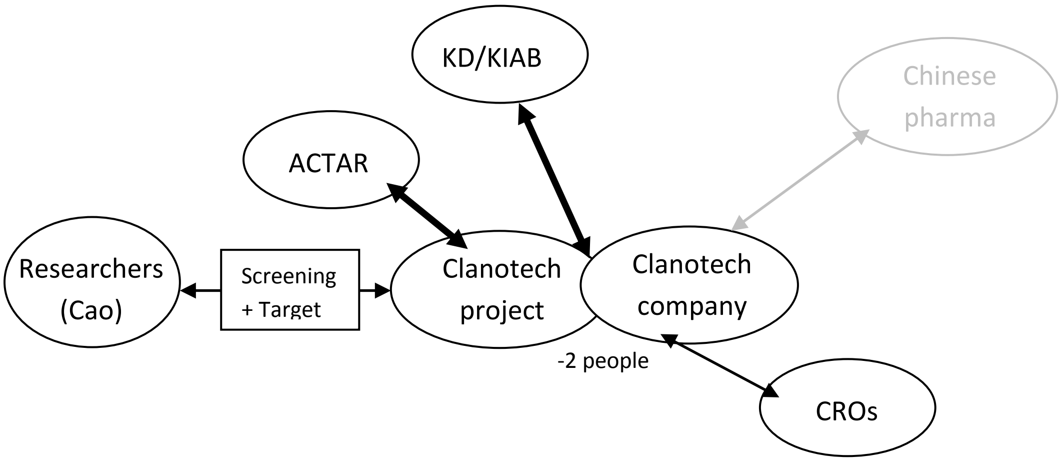

Figure 1: The interfaces embedding the Clanotech project.

2. Aprea – The focal project

Aprea is a company with five employees; a CEO, a Vice President Discovery, and three laboratory scientists. In addition, a number of consultants from companies and CROs, both Swedish and foreign, is connected to the company. The potential product, which during the last months has entered phase I/II in clinical trials, is a treatment for solid tumors. The major owner is KD along with The Foundation for Baltic and East European Studies (Östersjöstiftelsen) and Praktikerinvest.

2.1 Interface to the research group

The project was initiated in the early 2000s when KIAB was approached by Professor Klas Wiman at the Department of Oncology-Pathology at KI who had discovered a peptide (a protein) which could take out cancer cells caused by a mutation in a specific gene, p53. KIAB assisted in getting the first patent and even though it was far from clear what this discovery could lead to in terms of a therapeutic treatment for cancer, KIAB showed great interest and a company was formed in 2003. The scientific research preceding the commercialization project is based on research performed during the early 1990s concerning the role of the gene p53 in tumors. It was found that in 50% of all tumors this gene was mutated which caused the forming of cancer cells. This meant that p53 was a suppressor gene; in its absence cancer cells would form. Wiman and his group then started working specifically with the protein which was formed due to the mutated gene and tried to find a way to restore it so that it would function properly even though the gene was mutated. They succeeded in finding a peptide which could achieve this, which resulted in a highly prestigious publication in 2002 (in Nature Medicine). The scientific research result supplied to the project was thus a substance which could influence defected protein (causing cancer) from the gene p53.

The reason why the project became a company was that Wiman and his group put together an EU application together with an international group of researchers (25 different research groups) all focusing on the p53 gene. The application required the involvement of an SME which meant that the project around Wiman's idea needed to be formed into a company. So in connection to the application the company was formed in 2003. The five year long EU project turned out to be very beneficial both for Wiman's research group and the company. The group became part of an international research network containing many different types of knowledge and competences. Annual meetings were held and the group needed to deliver "work packages" and achieve specific goals. One of these goals was to start a clinical trial, which was also achieved during the very last year of the project, in 2009.

About half of Wiman's group, five people, has worked specifically with p53. In the very beginning of forming the company the group was asked by the project management team to do routine tasks, such as screening for possible substances, but this was never something which the researchers found interesting to engage in. Instead their work has been focused on gaining knowledge about the basic mechanisms around the function of p53 and the mutated protein. There are also two other groups at KI working with this specific gene, one led by a former doctoral student of Wiman. Even though the research leaders of these two groups have been involved in the knowledge produced around the gene and are co-founders of the company, they have not been directly involved in the company activities. Unlike Wiman who has a position in the board.

2.2 Interface to other projects

As Wiman and his group approached KIAB the first time in 2001 the initial idea was to merge the project with two other projects involved in cancer research in order to form a joint "cancer company". One of them was connected to an Uppsala based company called Personal Chemistry which is now part of a larger company called Biotage. However, few actual initiatives were taken in this direction and as it never happened, Wiman and the other researchers decided to form their own company.

2.3 Interface to the financiers

KD is the major owner of the company after taking over shares from Industrifonden who before also was one of the majority owners. KD has had a strong impact on the project and company in terms of being highly involved in all major decisions around not only its financial situation but also what should be the direction of the preclinical and clinical trials. The project team has constantly needed to convince KD that Aprea is a solid project which needs further financing at continuous "milestone meetings", but the financial resources have been scarce and it has been difficult to make progress on the limited resources at hand. A direct consequence of the limited budget has been that the project team has not been able to try parallel directions of how to proceed. One such issue has been whether the candidate drug is more suitable for solid tumors or hematological malignity, of which it has been difficult to fully investigate both options. However, as mutations in p53 are more strongly connected to solid tumors this path was chosen. Another example is finding different ways of applying the drug, where a project of applying it orally couldn't be completed, therefore an intravenous type of application has been the only option tried.

2.4 Interface to the project management team

Since the start of the company there has been a change of the CEO three times. The present CEO has a background both within academic research and industrial production. She is an assistant professor in pharmacology, and has worked in leading positions at both Astra Zeneca and Biovitrum. One of the major challenges for her and the team has been to make due with a very tight budget and scare resources mainly in terms of a small staff and lack of laboratory instruments. The focal team therefore has external connections to several companies and CROs. These external organizations include Uppsala University, Karolinska Hospital and companies from Italy, France and India. These organizations perform many of the tests and studies necessary to make progress both pre-clinically and clinically. These four types of interfaces are presented in figure 2 below.

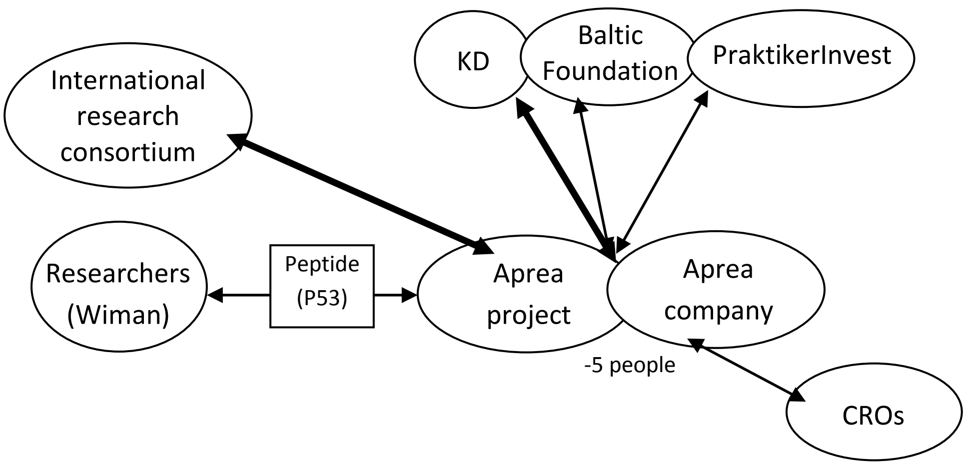

Figure 2: The interfaces embedding the Aprea project.

3. Dilafor – The focal project

Dilafor is a company with a CEO, three administrative staff and a part time hired chemist. The rest of the staff is hired as consultants. The potential product, which has completed phase I of a clinical trial and now has entered phase II, is based on low molecular weight (LMW) heparin used for shorter labor work and fewer labor complications. The drug is called Tafoxiparin. KD (through KIAB) is a majority owner and owns the company together with The Foundation for Baltic and East European Studies and Praktikertjänst.

3.1 Interface to the research group

The commercialization project was initiated as the company Dilafor was formed in 2003 by 12 founders. The company is based on a discovery made mainly by Professor Gunvor Ekman-Oderberg during 30 years of clinical and scientific work around labor work. She found that pregnant women that were being treated with heparin for earlier illness, such as blood clots, often had easier and quicker deliveries than other women. Thus, heparin seemed to have a connection with how the cervix reacted during labor work, and if used right could ease the labor process. The research which Ekman-Oderberg has conducted is highly connected to clinical activities where she while working at the University Hospital in Lund/Malmö as well as at Karolinska Hospital combined practical work with experimentally investigating the uterus and cervix during pregnancies and both normal and non-normal deliveries. During the last 20 years the research has been directly connected to the Karolinska Hospital as Ekman-Oderberg and her group has collected biopsies from their patients, performed clinical studies there and also has worked at a specific research laboratory connected to the hospital where they have done many of the experimental studies. Ekman-Oderberg and her group have over the years worked closely with other research groups in Sweden, particularly with Professor Anders Malmström at The Department of Experimental Medical Biology at Lund University, who specializes in tissue biology. Ekman-Oderberg has been involved in the company activities, including clinical trials, and has a position in the board. She was one of the drivers of the clinical trial which has now entered phase II. This was a challenging process as it was the first clinical trial of its kind, which means that there were no references in terms of how and what to measure during the study. They have completed one part of the study successfully, even if there were several complications along the way, mainly connected to the measurements.

3.2 Interface to other projects

Initially the company also contained a project which involved using LMW heparin for finding a treatment for malaria. As Ekman-Oderberg approached KIAB it was suggested from KDs part that the two projects should merge, which also was carried out. The two projects remained in the same company until 2010 when they were separated into two different companies, the other one called Dilaforette. This company has now entered phase II as well. There were no real synergy effects of combining the two projects as they were completely separate in terms of research and clinical agenda. The two companies do however still share administrative staff and a chemist. According to Ekman-Oderberg, as Dilafor is about women's' health it is very separate from other types of projects both in terms of clinical trials and business opportunities; there are very few clinical trials within women's health and also very few therapeutic treatments directed specifically to women (besides birth control), in turn this means that there are few pharmaceutical companies that are willing to invest in women's health, except when it comes to pharmaceuticals for birth control or menopause.

In addition to Dilafor, in 2009 Ekman-Oderberg (together with three other founders) started another company based on her research, called Pharmanest where KD also is the majority owner (together with The Foundation for Baltic and East European Studies and Praktikertjänst). The potential product is related to pain relief in cervix and uterus during gynecological intervention. A sequential goal is to also be able to apply it for pain relief during deliveries. The company will soon enter a so called phase I/II in which clinical tests will be conducted on non-pregnant women.

3.3 Interface to the financiers

KIAB and KD were initially not interested in supporting the project as there at the time was a lack of financial resources within the KI innovation supporting system around 2002 and 2003. However, when the inventors founded their own company and got a patent for their discovery, and could also show through experimental studies that this was a clinical problem/need (those with prolonged deliveries could be helped by this type of treatment) KD wanted to invest. KDs suggestion then was to merge this project with another (Dilaforette) as this possibly could result in synergy effects and might help attract a potential buyer of the company in the end. However, due to their great differences in terms of clinical agenda as well as potential buyers, they were separated.

As a majority owner KD has had a great impact on what happens with the company and its continuous financial status. The project team has constantly needed to report their milestones, of which some has been achieved faster than expected and some slower than expected.

3.4 Interface to the project management team

Since the start of the company there has been a change of CEO three times. The present CEO entered the company in 2011 and has many years of experience of both bringing pharmaceutical products to market from working within the industry and the regulatory side from working at the Swedish Medical Agency. The project team has constantly remained small with only a few employees and an external group of consultants representing both companies and CROs.

3.5 Interface to users/buyers

Due to her connections and daily working at Lund and Karolinska hospitals, Ekman-Oderberg was one of the drivers of the clinical trials which have now entered phase II. The interface to the hospitals and their patients is very important as this is the only way to get access to pregnant women and follow their labor work. This means that the potential users of this potential drug have been included from the very beginning of the research as well as the commercialization project. Figure 3 below shows the interfaces involved in the Dilafor project.

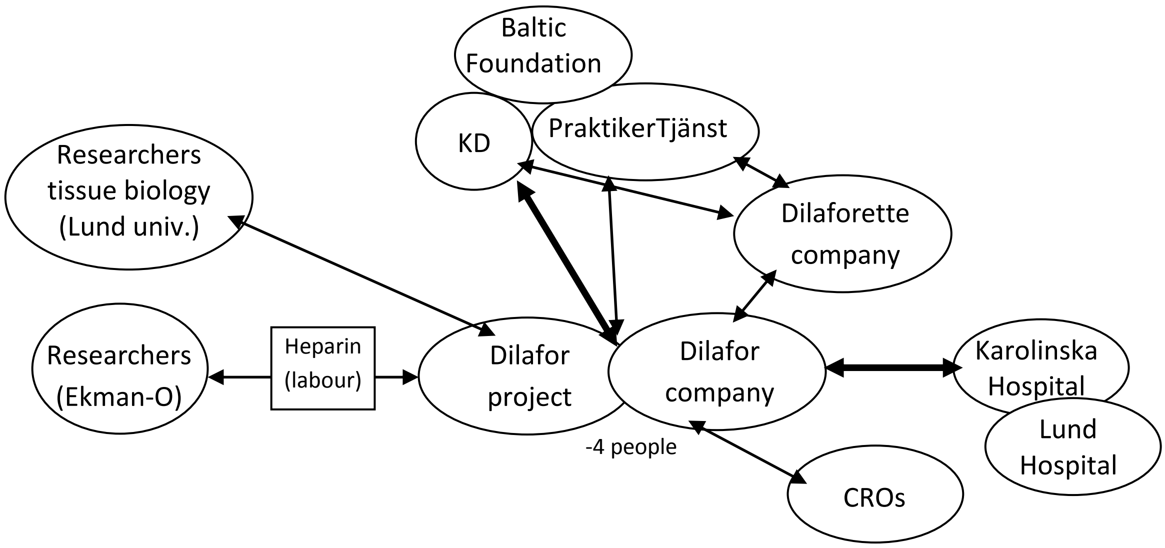

Figure 3: The interfaces embedding the Dilafor project.

4. Lipopeptide – The focal project

Lipopeptide is one subsidiary of the company Pergamum and has a small set of employees; a CEO, a director of Preclinical R&D, and a laboratory engineer. The rest of the organization is "virtual" in the shape of consultants from companies and CROs when it comes to regulatory competence, product development, clinical development etc. Up until very recently (late 2012) Pergamum consisted of three subsidiaries but now only holds one of them, Lipopeptide, after a divestment in the other two, Dermagen and Pharmasurgics. The potential product of Lipopeptide, which has entered phase I in a clinical trial, is a treatment for chronic wounds in the shape of a thin film containing a human peptide that is placed on the wound. Today, Pergamum's major owner is KD, followed by Midroc New Technology AB and The Foundation for Baltic and East European Studies. Together these three investors hold 95% of the company.

4.1 Interface to the research group

The Lipopeptide project was initiated in 2003 after Professor and physician Mona Ståhle at the Dermatology Clinic at Karolinska Hospital had approached KIAB. Together with her PhD student Johan Heilborn, she had made the discovery that there was a human peptide (a protein which we produce ourselves) that was highly involved in healing skin wounds that was not present in chronic wounds. This meant that these types of difficult wounds could perhaps be healed by an addition of this peptide, which was the basic idea of starting the commercialization project. The research that led to the discovery of the peptide, called LL-37, was commenced by Ståhle during the mid-1990s as she entered a new research field of investigating anti-microbial peptides and their function in the skin, which had not really been done before. She had gotten a position as a Professor and physician at the Dermatology Clinic at Karolinska Hospital and was in charge of running both a clinical and a research facility. While other researchers had also discovered this peptide, Ståhle's contribution was to map its active function in healing wounds, and to conclude that it was formed in the skin during the influence of D-vitamin (and thus directly connected to the influence of sun light). It was around 2002 that she formed an actual research group around the peptide which worked in a laboratory connected to the dermatology clinic; two doctoral students, two post docs and one laboratory assistant. It was purely basic research in terms of taking skin samples from healthy persons, growing skin cells in the laboratory and experimentally investigating them. The insight that it might lead to a therapeutic treatment came when they discovered that the peptide was absent in chronic wounds, which made them contact KIAB. Ståhle founded the company together with one of her doctoral students, Heilborn.

As the company was formed Ståhle was asked by KIAB to "go on tour" with the project and present it on various conferences and business conventions in Sweden and the US. She has a position in the board and has acted advisor in specific issues or when something new has come up. As the project rather early on became an issue of regulatory aspects she found it difficult to assist as these were unfamiliar issues to her as a researcher. One of the biggest challenges for the projects has been to face the regulatory demands of developing the peptide into a pharmaceutical as the initial plan of developing it as a medical device was not approved by the Swedish Medical Products Agency. In terms of research there has however been some interactions as Ståhle from 2006 an onwards has had repeated contact and co-developed some ideas with the Director of Clinical R&D in the company. However, today all laboratory operations connected to the project are placed at the company facilities, and Ståhle and her group are mainly focusing their work on other types of skin-connected disorders, foremost psoriasis.

4.2 Interface to other projects

In 2011 Lipopeptide was merged with two other projects in KDs portfolio of commercialization projects which together formed Pergamum. One was Dermagen which was a project based in Lund focusing on skin infections connected to a particular peptide. The research results were achieved through a joint effort by the Department of Dermatology at Lund University and The Department of Pharmacy at Uppsala University. The other project was Pharmasurgics which was based in Gothenburg focusing on the prevention of skin infections and symphysis (the growing together of skin or bones) after surgery. Also this research was based on the use of a peptide which was discovered through work done at Gothenburg University at the Department of Medical Chemistry and Cell Biology and the Department of Clinical Bacteriology, in connection to Sahlgrenska University Hospital.

It was on the initiative of KD that discussions began in the mid-2010s of merging a total of five different projects in the KD portfolio involved in dermatology and the use of peptides as a basis for developing new pharmaceuticals. After several years of negotiations three of the company founders (the founding researchers) finally agreed on joining in. This formed Pergamum which then got three operating units in Stockholm, Lund and Gothenburg. While Lipopeptide was only about to enter phase I in a clinical trial at the time of the merger, the two other projects were entering different stages of phase II. Pergamum was thus a company with three projects in different clinical phases. They were however run as three subsidiaries with separate CEOs.

In late 2012 both Dermagen and Pharmasurgics got poor and indecisive results from their phase II trials, which resulted in a divestment from KD. This leaves Lipopeptide as the only running business activity within Pergamum.

4.3 Interface to the financiers

As Ståhle first approached KIAB they showed little interest as the peptide which the research was based on already had patents connected to it. However, when the situation was more thoroughly investigated at KIAB they realized that it would not be a problem as they could file for a patent directly connected to wound healing. This initiated the forming of the commercialization project and Ståhle was given assistance in the patent filing process. Several years later, the idea of merging several of the companies in the KD portfolio involved in dermatological applications was an initiative from KD in order to get economies of scale as well as reduce the risk of only having one product in each project or portfolio company.

As one of the oldest projects in the KD portfolio and with key people from KD in the company board (for instance, the CEO of KD is the chairman of the board and Conny Bogentoft who is one of the founders of KD is also on the board), Lipopeptide (together with Pergamum) has and is getting a lot of attention from KD. The final test if Lipopeptide will remain in the KD portfolio, as opposed to the other two subsidiaries of Pergamum, will be the clinical testing of the peptide in humans in a phase I//II trial. If it does not show a good effect here, it will be difficult for KD to keep supporting the project financially.

4.4 Interface to the project management team

While the parent company Pergamum has one CEO, the three subsidiaries have also had their separate CEOs. The last CEO of Lipopeptide (up until January 2013) was working halftime as CEO for Lipopeptide and 20% for Pergamum as a Chief Marketing Officer, which means that human resources have been shared over the company boarders. The three subsidiaries were however run as separate projects where the separate CEOs' mission was to "have the right resources at the right place and at the right time" (Interview Jan Nilsson, CEO Lipopeptide). Also, there has been repeated changes of CEOs and direction of the project.

The director of preclinical R&D has been in charge of and been one of two people in Lipopeptide working with the pre-clinical testing of the peptide. As he entered the company in 2006 there was not much data supporting the function of the peptide in wound healing which he then began collecting through preclinical testing and experiments. He also worked a lot on the application form of the treatment together with several CROs. Together with a particular company he developed a film that would contain the peptide and when being absorbed by the skin would help heal the wound. A major obstacle which then arose was a denial from the Swedish Medical Products Agency to develop and sell this treatment as a medical device. As there was an active substance on the film (the peptide) that would be absorbed internally by the body, from a regulatory point of view it had to be treated as a pharmaceutical. The clinical trial for a pharmaceutical is much more demanding than for a medical device, which has resulted in an even greater challenge for the company to overcome. Figure 4 below shows the four interfaces we identified around the Lipopeptide project.

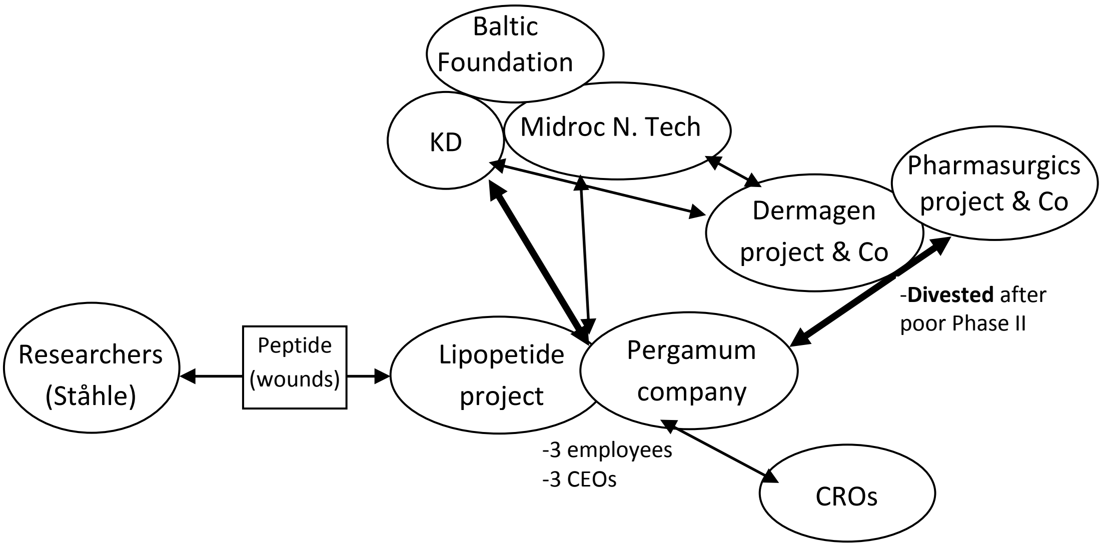

Figure 4: The interfaces embedding the Lipopeptide project.

DISCUSSION

We will now discuss our results in terms of similarities and differences between the interfaces which have played a role in the attempt of transforming science into business in these projects. There are several common aspects among the projects in how they are run but there are also significant differences in terms of which interfaces that have impacted which features of scientific research that are found relevant for the sake of business, and also the direction of the commercialization process (see Table 1 for a summary of the projects and their main interfaces).

First let us have a look at the similarities across the projects. A first observation is that, except for two of the projects, Clanotech and Dilafor, overall the projects have little interaction with actual users or potential industrial buyers or partners. This is related to the goal of Karolinska's innovation-supporting system (namely KIAB and KD) of *first* trying to reach or complete phase II of a clinical trial *before* approaching a partner or buyer. This is simply so because there are extremely few, if any, pharmaceutical companies who are willing to buy into such high-risk projects before seeing actual results from a clinical trial. Therefore, we have found few interfaces to users/buyers for these projects. Another commonality is that most financing is provided through a single common interface, KD, which is the majority owner for all the projects. In turn this means that the project management teams have to follow KD's routines for milestone reporting which occur every six to twelve months. If the team cannot report progress, KD has the option of dropping the project, which implies that this interface plays a very decisive role for all of the projects. However, as will be discussed below, this interface has also had more specific implications for two of the projects (Clanotech and Lipopeptide).

Another common trait is that the project management teams are very small and have to settle with limited resources available during extremely short financing periods (six to twelve months at a time): therefore these teams cannot hire more internal staff or acquire adequate laboratory facilities and research instruments. This also means, as several of the cases indicate (particularly Clanotech and Aprea), that the teams cannot pursue parallel development directions but have to choose only one way to proceed with the preclinical and clinical work and target a very restricted set of potential market/users. Another commonality among all projects is that the teams, and particularly the CEOs, are selected especially on the basis of their knowledge of *industrial production* and *commercialization of new products*. KI's innovation-supporting system, and especially KD, seems therefore to view this type of experience and knowledge as an important component for transforming scientific results into a potential pharmaceutical, that is, a business opportunity. This interface, and its implications, will be discussed in more detail below.

Now, to what separates these different projects in terms of which interfaces played *the key role* in transforming science into business, namely in *orienting scientific results, which might have taken very many possible directions, towards a specific commercial target*. Starting with *Clanotech*, an important interface is the one to ACTAR, that is, another project/organization within KI's innovation-supporting system. It was KD's interest in re-starting ACTAR which made Clanotech a particularly interesting commercialization project, and especially the screening method which lay the foundation of the project. The screening method could potentially be used for finding different types of targets for different diseases, which made it highly interesting for a "research-assisting facility", which ACTAR was supposed to be for KI's whole innovation-supporting system, namely all other KD's projects. It was also ACTAR which supplied the project with staff and laboratory facilities. In terms of what product could be commercialized by Clanotech as a company it was however the particular target for angiogenesis (tyrosine kinases) that was in focus at the origin of this project. However, the interface that played the decisive role in how this research result was to be transformed into a product, and for which market, was the one to KD: instead of continuing with the original scientific focus on hindering tumor growth, KD chose as commercial target a particular type of eye disorder, for which Clanotech's products seemed to have an easier way to market, with less competitors than in anticancer drugs and with comparatively better (pre)clinical results, which it did not achieve in relation to existing anticancer therapies.

In the case of *Aprea* the most important interface has instead been the one to the founding researchers as they connected it directly to a large international research collaboration funded by the EU. It was this joint research effort that pushed the researchers to turning the project into a company and to set specific goals with their research around the p53 gene and its resulting protein, as well as clinical goals in terms of initiating a clinical trial. This research collaboration also provided the researchers with extensive knowledge and competence around the p53 gene/protein through their direct connections with the other research groups involved, which included some of the most prominent researchers within the field.

For *Dilafor*, the interface of the utmost importance has been that to the clinical activities going on at the hospitals involving the founding researcher's work. This means that it was the researcher's and the interfaces she enabled the project to create with the very end-users, namely the patients, of the potential new drug which influenced both the identification of the new use of the "old" drug heparin, as well as the commercial direction of the project. It was the researcher's direct involvement in the clinical activities at the Karolinska Hospital which enabled the first phases of the clinical trial, which also involved actual patients. The common denominator of using heparin also made KD join this project with another KD-owned project (Dilaforette) in the hopes of gaining synergy effects, which however never were really realized: the two projects and their potential products (even though using the same substance, heparin) were simply too different in terms of target markets (malaria and women's health).

For *Lipopeptide*, two significant interfaces in transforming scientific results into business have been that to its financiers, mainly KD, and that to two other KD projects with which it was merged on initiative of KD. Lipopeptide's interface to KD was particularly strong from the very beginning: this project received a lot of attention from this main financier by having key people from KD on its board. This means that KD has been putting key human resources into making this a successful commercialization project. KD also played the main role in merging the Lipopeptide company with the two other companies, Pharmasurgics and Dermagen. The common denominator of the three companies was their focus on dermatology and the use of peptides. Even if the potential markets which these companies were approaching were different (open care for Lipopeptide and hospital patients for the other two), through their parent company Pergamum they represented three products at different stages of clinical trials all focusing on skin-related treatments: KD therefore tried to combine three of its projects into something which might be appealing for a potential industrial partner. However, before any industrial actor would be interested in Pergamum, the substances needed to pass phase II of a clinical trial, something which the other two companies failed to do. As Lipopeptide is now the only project within the Pergamum company, it has to show encouraging results in a phase II trial for KD to keep supporting it financially. Even if we have not explicitly focused our analytical grid on this type of interface, another interface which has played a pivotal role in this case is that to the authorities (the Swedish Medical Products Agency): they deemed Lipopeptide's product to be a *pharmaceutical* instead of a *medical device* (due to the fact that the peptide was to be absorbed inside the body), thereby obliging the peptide and the project to follow a very different, and more demanding, set of regulations than originally intended.

The cases illustrate how different interfaces have a determinant impact on how the different projects receive the original scientific results and then transform them into business opportunities, by connecting them in particular ways to other business resources. Put differently, the interaction between the features of the research results and specific interfaces ultimately decides the commercialization direction of the project, namely its type of product, therapeutic area and target market. For instance, in the case of Clanotech, the interface to the financiers and their interpretation of the potential market changed the commercial focus from one disease to another. For Dilafor, it was the users, the patients, who helped reveal how to use an old drug for a new purpose, as they were directly involved in the preclinical and clinical work of making it a reality.

The results also show that while the project management teams surely are important in terms of running the everyday activities of the companies, they seem to have very little influence on the directions of the commercialization processes. They have very limited resources and are completely dependent on their financier, mainly KD, for further financing granted only over very short periods of time. The projects therefore become very dependent on external interfaces, not only to financiers, but also to the external competence provided by other companies and CROs. As earlier stated, the project teams are selected on the basis of their research and especially commercialization and industrial competence, but what opportunity to optimize the use of this knowledge do they have under such time pressured and financially constrained conditions? Another observation is that this in turn creates very difficult conditions to establish and maintain any long-term relationships with those industrial partners eventually interested in buying into the potential products. Instead, the projects develop close connections inside KI's innovation-supporting system, typically with other KD-owned projects, and a few other external connections, mostly to CROs providing research services.

	Interface to researchers	Interface to other projects	Interface to financiers	Interface to project team	Interface to buyers/users
Clanotech	KI researcher developed new screening method and identified a target for angiogenesis Shareholder of the company and provides scientific advice	ACTAR played a **decisive role in starting up** the project, provided **various resources** for the project to move forward	KD's **decisive role** in shifting market focus from cancer to eye disorder KD **controls financing** and **continuous reporting** by project team	Team originally **hired by ACTAR** (small) Industrially experienced CEO Connections to external CROs Scarce resources	KD eventually decided not to sell Clanotech to a Chinese pharmaceutical firm
Aprea	KI researcher identified a peptide for restoring mutated protein in cancer development Started the company and connected it **to a large international research effort**	None	KD major owner (+Baltic Foundation and PraktikerInvest) KD **controls financing** and **continuous reporting** by project team	Small internal team Industrially experienced CEO Connections to external CROs Scarce resources	None
Dilafor	KI researcher identified the use of LMW heparin in preparing cervix for labor work Started the company and connected it **to potential users/clinical activities**	Joined with another project at start (Dilaforette): no synergy effects so now separated Founding researcher connects to KD-related company (Pharmanest)	KD major owner (+Baltic Foundation and Praktikertjänst) KD **controls financing** and **continuous reporting** by project team	Small internal team Industrially and regulatory experienced CEO Connections to external CROs Scarce resources	Users (patients/ hospital) **directly connected to both the research and the clinical trials**
Lipopeptide	KI researcher identified the role of a peptide in wound healing Board member and provides scientific advice, some research collaboration	**Merged with two other KD companies** (Pharmasurgics + Dermagen) under **the parent company Pergamum**. Later these companies are dropped.	KD major owner (+Baltic Foundation and Midroc NT) KD carries out **the merger** KD **controls financing** and **continuous reporting** by project team	Small internal team. KD people directly involved Industrially experienced CEO Connections to external CROs Scarce resources	None

Table 1: Summary of the four projects and their main interfaces

CONCLUSIONS

Our analysis of the four KI cases identified both commonalities and striking differences in the interfaces which influence the direction of commercialization of science within specific projects. Interfaces with financiers seem to play a determinant role in all analyzed projects, mostly at the expenses of the project team, whose role is restricted to daily and operational activities conducted with limited resources. However, single projects can also display a unique interface, which even more than financiers has influenced the commercial direction undertaken by single projects. More precisely, when users get *organized* within clinical trials or when researchers are *organized* within large collaborations, they represent pivotal interfaces that can determine the way science starts getting commercialized and embedded in the business context. In fact, differently from financiers, who exert a direct and formal control on a project irrespective of their number or size, users and researchers need to be organized and grouped together in order to constitute a strong enough interface to orient the commercialization of a given scientific result.

Our findings contribute to expand knowledge on project management by further stressing the limited control of project teams and managers on the very project they are accountable to execute. The reviewed projects are somehow extreme in terms of their limited “internal” resources, but most projects are likely not to control all necessary resources to achieve their goals, which make them more or less dependent on external resources. In this sense, all projects are embedded in inter-organizational networks of resources on which they depend in order to accomplish their goals. But at the same time, external dependence is not necessarily a negative issue: in fact, projects aim at eventually creating commercial products, which is only possible by creating several types of interfaces that firmly embeds products in a surrounding network, so that they become innovations (Baraldi, Gregori & Perna, 2011). Depending on and connecting with the inter-organizational context is therefore more or less of a requirement for a commercialization project. A more thorny issue is instead the situation in which a project is dependent on a *single external interface* that orients it unilaterally towards a single commercial direction, without the possibility of returning to previous interfaces if that direction should turn out to be a dead-end.

Our research can also suggest avenues for further research. First of all, it would be useful to extend the timeframe of analysis of the selected projects, making them more longitudinal, in order to verify whether interfaces to users/buyers (or other resources) become more relevant later on in the commercialization process. Secondly, the same analytical grid based on five interfaces can be applied to other projects as a way to reveal other possible patterns. Thirdly, projects could be analyzed in a more explorative fashion in order to identify other relevant interfaces (e.g., those to public agencies or suppliers). Finally, it is also possible to conduct a large-scale quantitative analysis (namely on dozens of projects) over a selected number of interfaces (ideally 5-10) as a way to identify broader pattern in whether, when and how the various interfaces intervene in commercialization projects.

Managerial implications can be formulated from our research. Even if we cannot provide any solutions for the highly risky and extremely complex endeavor of transforming a piece of science into a large selling drug, we formulate implications which are of more general character. In cases where financiers exert a very strong influence on setting the commercial direction of a science-based project, there is of course a caveat concerning whether they are in the best position, in terms of personal knowledge, connections and power, as to choose the "right" direction once and for all. Many decisions become irreversible if taken according to a strict funnel or even a Stage-Gate logic (Clarysse et al., 2005; Cooper, 2001) and would lead to terminate projects that might be given a second chance. The classical example is the story of Losec, one of the most famous block-buster drugs, which survived the commercialization process only thanks to the endurance of its project manager, who even had to hide the project from Astra's managers (corresponding to financiers) who had decided to terminate it. Therefore, two options can be identified to alleviate the problem: either (1) financiers accept to involve other actors and external interfaces in setting the commercial direction of a project, as a way to reduce their bias (which can hopefully balance their potential loss of some control over the project); or (2) they apply project steering methods which are less strict than a unidirectional funnel with staged financing and irreversible termination points, as a way to exploit the potential of "trials and errors" and "learning by doing", which goes lost if no possibility of retrying is given in a project.

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Appendix: Source of empirical data

Secondary sources:

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Interviews and meetings:

Meeting with Lena Hansson, Hanna Jansson and Jessica Norrbom, Bio-entrepreneurship Unit, KI, 1-10-2009
Interview with Rune Fransson, Chairman KIHAB, 28-10-2010
Meeting with Charlotta Dahlborg, Bio-entrepreneurship Unit, KI, 10-11-2010
Interview with Lilian Wikström, CEO KIAB, 29-11-2010
Interview with Conny Bogentoft, formerly CEO KIAB, formerly CEO KIF and formerly CEO and CSO Karolinska Development, 17-5-2011
Interview with Ola Flink, formerly CEO KIAB, VP Portfolio Management Karolinska Development, 20-5-2011
Interview with Folke Meijer, CEO KI Holding AB, 25-5-2011
Interview with Carl Johan Sundberg, Director Bio-entrepreneurship Unit, KI, 17-6-2011
Interview with Björn Kull, R&D Director, Actar AB, 06-09-2011
Witness seminar with Hans Wigzell, former vice-chancellor KI, Hugo Thelin, former consultant KI Holding AB/KIAB, Folke Meijer, CEO KI Holding AB, and Urban Ungerstedt, Prof. Emeritus, KI, 10-10-2011
Interview with Ulrika Backman, former project leader Clanotech at Actar AB, 24-10-2011
Interview with Gunvor Ekman-Oderberg, Professor at KI and co-founder of Dilafor, 24-11-2011
Interview with Jan Nilsson, CEO Lipopeptide, 11-25-2011
Interview with Alvar Grönberg, Director of Preclinical R&D Lipopeptide, 25-11-2011
Interview with Nina Mohell, CEO Aprea, 23-01-2012
Interview with Patrizia Caldirola, CEO Clanotech, 30-01-2012
Interview with Klas Wiman, Professor at KI and co-founder of Aprea, 07-03-2012
Interview with Mona Ståhle, Professor at KI and co-founder of Lipopeptide, 26-03-2012
Interview with Yihai Cao, Professor at KI and founder of Clanotech, 27-03-2012