Linköping University Post Print

The Interaction of Academic and Industrial Supervisors in Graduate Education: An Investigation of Industrial Research Schools

Minna Salminen-Karlsson and Lillemor Wallgren

N.B.: When citing this work, cite the original article.

The original publication is available at www.springerlink.com:

Minna Salminen-Karlsson and Lillemor Wallgren, The Interaction of Academic and Industrial Supervisors in Graduate Education: An Investigation of Industrial Research Schools, 2008, Higher Education, (56), 1, 77-93.

<http://dx.doi.org/10.1007/s10734-007-9090-4>

Copyright: Springer Science Business Media

<http://www.springerlink.com/>

Postprint available at: Linköping University Electronic Press

<http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-15959>

The Interaction of Academic and Industrial Supervisors in Graduate Education

An Investigation of Industrial Research Schools

Minna Salminen-Karlsson
Department of Sociology
Uppsala University
Minna.Salminen@soc.uu.se

Lillemor Wallgren
Department of Behavioural Sciences
Department of Computer and Information Science
Linköping University
lew@ida.liu.se

Abstract

In this study we explore the work and the cooperation of academic and industrial supervisors concerning single graduate students in so called industrial research schools, which are financially supported by a national research foundation and involve universities and industrial enterprises. Academic and industrial supervisors of totally eleven graduate students have been interviewed with focus on their cooperation. This cooperation entails negotiating the contract and monitoring the progress of the research project and the student. When students have problems this cooperation is particularly important. The places new demands on both the academic and industrial supervisors. In our study these demands were dealt with differently by different academic supervisors, depending whether their main orientation was towards industrial projects or traditional academic research. The way the industrial supervisors dealt with the new demands depended on their previous acquaintance with academic research, basically whether they had a doctoral degree or not. Another important finding was that academic knowledge had a strong position while the supervisors from the industry accepted a minor role. The main findings of the study are that industrial graduate students often require joint engagement in a way that differs from other forms of knowledge transfer between the academy and the industry. To explain the features of this type of knowledge transfer, we use the analytical concepts *boundary subject* and *phronesis*.

Keywords: Partnerships, doctoral programmes, funding, graduate study, graduate school faculty, institutional cooperation, technology transfer.

The Interaction of Academic and Industrial Supervisors in Graduate Education

An Investigation of Industrial Research Schools

1 Introduction

This paper deals with knowledge transfer between the academy and the industry. We study the phenomenon of industrial research schools, which are hosted by universities and financed by a national research foundation and the industrial partners. Thus, the industrial research schools are an example of a ‘triple helix initiative’ to promote innovation and growth (Etzkowitz, 2002). The ideology behind the creation of industrial research schools can be related to Gibbons et al (1994), who focus on the ‘new production of knowledge’ and the blurring of boundaries between academic and industrial research. The new producers of knowledge, for example, representatives of the academy and the industry cooperating within the framework of industrial research schools, are expected to change the landscape of scientific research by exchanging features from their respective research culture. Our question in this study is not whether this collaboration produces new kind of scientists, but how the setting of an industrial research school and the task of educating new researchers shapes the cooperation.

Wallgren & Dahlgren (2005) found that the complex context of industrial research schools results in new situations, not only for the graduate students, but also for their supervisors. Our aim in this study is to scrutinize the cooperation of supervisors to get to the core of the practical ‘doing’ of knowledge transfer. Knowledge transfer begins with individuals and it is therefore important to look at the interaction between individual academic and industrial researchers to understand the process of knowledge transfer in a triple helix initiative.

This article is based on an exploratory study of industrial and academic supervisors in two research schools. When analyzing the interviews made with them, we found out that the graduate students can be looked upon as *boundary objects*, fulfilling different needs in academia, on the one hand, and in the

industry, on the other hand. In our data the cooperation concerning industrial graduate students was not only about knowledge creation and knowledge transfer in an instrumental sense. Graduate education implied also educating a person, and we came to use the Aristotelian concept of *phronesis* as a reminder of the importance of this educational process.

This article addresses two particular issues. First, how do representatives from the academy and the industry, with their different backgrounds, cooperate when educating a person who is to benefit both sides? Second, how can we describe the type of knowledge transfer between the academy and the industry that is actualized in the case of supervision of industrial graduate students?

1.1 Research on the cooperation between the academy and the industry in graduate education

Research on graduate students with financing from and obligations towards the industry (hereafter: industrial graduate students) is sparse. Harman's (2002, 2004) descriptions of Cooperative Research Centers in Australia correspond best with what we term industrial research schools. From a methodological point of view, Gemme & Gingras (2004) and Behrens & Gray (2001) survey industrial graduate students, Wallgren (2004, 2005) interviews students and Harman (2002, 2004) combines a student survey with interviews with both students and supervisors. These studies describe a new kind of post-graduate students who aim at working in the industry rather than in the academy. The differences concerning their academic work, in comparison with more traditional graduate students, seem to be marginal. However, the closeness to various industrial environments appears to affect their overall experiences and opinions of graduate studies.

Turning to the role of supervisors, we are inspired by the one study, so far, really investigating industrial graduate students from this perspective, namely Slaughter et al (2002). This study is based on interviews with supervisors in the US and describes industrial graduate students as 'gifts' from the academy to the industry. They are part of a gift exchange in which the academy receives research resources in return and which builds a relationship of "trust, solidarity and mutual aid" (Lévi-Strauss, quoted in Slaughter et al, 2002, p.284). The view taken by Slaughter et al (2002) is that industrial graduate students are 'objects' exploited by so called "big men" (p. 284). The main part of the article deals with dilemmas of the faculty when accommodating the needs and claims of the industry to the academic tradition in the graduate education process. According to Slaughter et al (2002), in the US context, conflicts of interest between the academic and the industrial supervisors are likely to occur, leaving

graduate students in-between, bound between, or torn apart, by two supervisors.

When industrial graduate students are concerned, the main issues discussed are quite similar across different national systems: Does industry involvement direct the research too much, is academic freedom at risk? Are academic standards at risk? Are the students at risk, in responding to different demands and not knowing whether they are academics or industrial employees? However, the dilemmas of industry-academy cooperation can be expected to show some variation in the different national contexts. In particular, different systems of financing the higher education and research sector contribute to different power relations between industry and academy.

2 Analytic concepts: Boundary subjects and phronesis

2.2 Boundary objects and boundary subjects

Educating a human being is, naturally, different from solving a research problem. In industrial research schools there is a concrete physical entity which is in focus for the cooperation between the academy and the industry: the graduate student. Hackett (2001) states that graduate students to an increasing extent are seen as utilities, not ends in themselves. This implies that students often are regarded as objects rather than subjects. An object which satisfies various needs for different groups, thus functioning as a physical link between the groups involved, is termed *boundary object* by Star & Griesemer (1989). From our analytic stance and empirical material, industrial graduate students fit the notion of boundary object well. They are boundary objects between the industry and the academy, both sides having different interests in investing in their research and educational process. Looking at industrial graduate students as gifts, as Slaughter et al (2002) do, implies something that changes owners. We prefer to regard industrial graduate students as something that is shared. The notion of boundary object does not in itself necessarily demand more cooperation than that of gifts; two communities may share a boundary object but never meet physically. But boundary objects do have some significance in the ongoing activities of each domain, whereas gifts necessarily do not. The notion of boundary object also helps to understand the situation industrial graduate students find themselves in. Just like boundary objects are malleable and embody the aims and power relations of those working with them, industrial graduate students also have different, sometimes even conflicting, claims to consider (Wallgren & Dahlgren, 2005; Slaughter et al, 2002).

Thus, we find the notion of boundary object helpful in our analysis. However, though we are conscious of Hackett's (2001) observations, we wish to stress the fact that these boundary objects actually are humans, who already have, and who are expected to get more and more, agency among the cooperating supervisors. We want to explore how we can understand the cooperation between the academy and the industry if these students are understood not only as boundary objects but also as *boundary subjects*.

2.3 Phronesis

When regarding industrial graduate students as boundary subjects, that is, human beings which both industrial and academic representatives have an interest in and to whom they relate as future colleagues, we find the ordinary discourse of knowledge transfer insufficient. The complex concept of knowledge is in this discourse often reduced to denote something instrumental which creates economic growth. This view does not take into account the whole purport of the concept, significantly not the intrinsic value knowledge has to its bearers. To integrate our view on graduate students in a more complex discourse of knowledge, we therefore apply the Aristotelian terms of knowledge: *episteme*, *techne* and *phronesis*.

The terms *episteme* and *techne* correspond roughly to the concepts which are generally used when relationships between the academy and the industry are discussed. *Episteme* denotes, according to Aristotle, scientific knowledge, that is, knowledge of the common and general laws of nature. *Techne* is the 'know-how' used when man tries to influence his environment. Thus, *episteme* can be used to refer to basic academic knowledge and research, whereas *techne* can be used to refer to applied, industrial research and development. These two forms of knowledge dominate the scientific, political, professional and even educational discourse of today (Flaming, 2001; Gustavsson, 2004).

The third form of knowledge is *phronesis*, that is, "the ability to deal with what might be called the dynamics of practical situations" (Eisner, 2002, p. 381). According to Saugstad (2002, p. 381, quoting Aristotle), "The phronetic person reaches the right conclusion at the right time and on the basis of right arguments". Flaming (2001) emphasizes the difference Aristotle makes between 'making' and 'doing'. 'Making' has to do with *techne*; it is an accomplishment of a certain desired manipulation of the physical world. 'Doing' has to do with *phronesis* because it regards the consequences of the actions taken in a particular context at a particular time. *Phronesis* is thus concerned with judgment for a good end in a particular situation, whereas a more modern view on knowledge often liberates or separates knowledge from moral aspects.

Phronesis is, moreover, an embodied form of knowledge which cannot be codified into writing. Gustavsson (2000) and Eisner (2002) stress the fact that developing phronesis requires time. Phronesis cannot be acquired through instruction but through experience. According to Flaming (2001), knowing oneself is also a question of phronesis. Furthermore, phronesis has a social component; it is not knowledge for itself, but knowledge for a community.

Phronesis seems to be what a graduate education ideally is about. *The Handbook for postgraduate students* (2005), published by the National Agency for Higher Education, states that “The general goal of research is to gain knowledge so we may better understand the world we live in and if possible change it for the better”. A thesis is admittedly the end product of graduate education, but a socialisation into ‘academic thinking’ is an important part of the process, brought about by interaction with supervisors and peers. Thus, educating a graduate student is, we argue, both about episteme and about phronesis. A concern for industrial financing affecting academic values (Croissant & Restivo, 2001) can be understood not only as techne taking precedence over episteme, but also as techne taking precedence over what is regarded as phronesis in the academic setting.

However, industry, too, values the form of knowledge we refer to as phronesis, even if phronesis in the industrial context has a different outlook and the ways of reaching it are organized differently. A trainee programme, for example, is not merely a question of learning the techne used by different departments in an industrial organization. It is also a socialisation process through which trainees should acquire insight in far reaching consequences of their future actions, and also learn what is regarded as common good in an organization.

Thus, as long as we laborate with episteme and techne only, industrial graduate students can be described as boundary objects which are to be provided with these two forms of knowledge so that they may transport knowledge between the academy and the industry, and the academy and the industry may benefit from both knowledge forms. However, when phronesis is considered too, industrial doctoral students cannot be regarded as empty vessels to be filled with knowledge, but as human beings who are to be accepted and socialized in two different cultural contexts where they subsequently are to make their judgments. This implies that these students, at least to some degree, become ‘one of us’, that is boundary subjects.

3 The setting for the study

Two Swedish industrial research schools within the Swedish educational framework were involved in this study. Doctoral education in Sweden is

currently regulated to four years of full-time studies, which equals four years of full-time employment at a university. The doctoral process consists of doctoral courses and thesis work. Full-time employment of graduate students can include a maximum of 20% department service such as teaching. If students do teach, they are allowed to spend totally five years for their doctoral education.

In the 1990's, training of post-graduate students for a career outside universities became a new interest. Accordingly, doctoral education in cooperation with the industry became a promoted issue. One of the initiatives in Sweden for this cooperation was taken by the Foundation for Advancement of Knowledge and Competence Development (KK Foundation) in the mid-nineties, as they established a programme supporting industrial research schools. The aim was to promote research and knowledge exchange for the mutual benefit for involved parties. These research schools were organized by universities and provided graduate education in cooperation with the industry, with financial sponsoring from industrial companies and thesis work with a connection to company interests. The graduate students were supposed to share their time between an university department and a company, for example, by spending their 20% department service doing company tasks instead of teaching. Hence, knowledge transfer was supposed to take place continuously during the doctoral process and knowledge from industry was to be exploited. Financially, the contribution from the KK foundation was dependent on the contribution from the company.

4 Sample and methodology

Our research design is based on semi-structures interviews with a limited number of graduate students and their supervisors to be able to illuminate a number of doctoral processes from three different angles.

Originally, we interviewed 17 industrial graduate students and most of their supervisors in two research schools supported by the KK Foundation. These research schools represented two very different areas of research: bioinformatics and building & indoor environment. The data for this paper consists of those 11 cases – or triads – where we were able to interview both the academic and the industrial supervisor of a graduate student. All in all, this paper is based on 30 interviews: 11 with students, 9 with academic supervisors and 10 with industrial supervisors. (Two academic supervisors and one industrial supervisor supervised two students each.). Three students came from bioinformatics and eight came from building and indoor environment.

Our interviews are semi-structured and for the purpose here we have mainly analyzed questions and answers focusing the relationship between the super-

visors and the supervisors' relationship to the student. Analyzing the interviews, we attempted to find the answers to why the different parties were involved, how the cooperation was initiated and conducted, and the overall satisfaction and dissatisfaction with the process for every participant. Some of our questions, posed to all supervisors, were particularly informative. Questions like 'How do you think the student will use his degree?', or 'What are the most important milestones in the student's career?', or 'How do you think the student experiences her situation between the university and the company?', gave us the opportunity to find out whether the supervisors were talking about an object or a subject and whether they were talking about phronesis or not.

Each of us read and re-read the interviews individually several times before we jointly drew of table on the features of every triad. (a) what every member was hoping to gain from the process, (b) whether every member was satisfied or dissatisfied with the process, (c) who had formulated the project, (d) the background of the student, (e) the progress of the student in the graduate education, (f) the background of the industrial supervisor (graduate education or not), (g) who was taking the main responsibility for the student's well-being, (h) whether each of the supervisors regarded the student as a 'person' or a 'product' (subject or object), and (i) whether the supervisors were talking about phronesis or only about episteme and/or techne. After our separate analyses we easily agreed on most of the cases. The few disagreements were mainly due to one of us neglecting some statement discovered by the other, and were easily solved.

4.4 Boundary subjects in the material

We judged that the supervisors talked about a boundary subject and not a boundary object when they described the graduate student as a person in at least one of the following ways: (a) describing the student, the supervisors also used expressions that were not directly related to the student's professional performance, (b) in regard to any student problems, the supervisors showed empathy (instead of only discussing problems for the educational timetable), (c) the supervisors showed some knowledge of the student's private life, or (d) the supervisors referred to the student as an equal part in a dialogue (for example by referring to a certain dialogue with the student or remarking that questions about the student actually should be answered by him or her). For example, in the following cases the supervisors were categorized as talking about subjects rather than objects:

I was a kind of a builder with a project that should be done and it was my task to take it to the end with everybody staying healthy on the way...She

was working on quite a large study and I was petrified that it would be too old to publish before she could publish, because it would have been so hard for her to start all over from the beginning again. (Industrial supervisor)

I think that he has some difficulties, because it's hard to really get into a company when you are there only now and then. Even if you want to and even if you try, it's difficult. And you can't really require that of him. His workplace is at the university and he works there with his professor and his workmates and it's their way of thinking that influences him. So, I think it's difficult. He can feel that he hangs somewhere in between and that it's hard. (Industrial supervisor)

4.5 Phronesis in the material

As to phronesis, we looked for expressions where the supervisors talked about the aim of the doctoral process being maturity, judgment, personal development, or such. Thus, if the supervisor used one or more such expressions in relation to the doctoral process we coded this as a case of phronesis. For example, the following supervisors talked about phronesis:

(About what the student will have learnt while writing the thesis.) In addition to the process itself, to develop as a person, he will know better what he can and what he can't, he will be surer about himself. (Academic supervisor)

The negative side of graduate students is that it takes so long before they produce anything. This person does normally not have very much routine, so it takes a year or two before you get any results. But you get the positive aspect in the end, you have this person who has gone through trials and tribulations and who has a good education. You don't get that if you just want to solve a problem. (Industrial supervisor)

5 Findings

5.6 Negotiating the contract

A successful implementation of the idea of an industrial doctorate, that is cooperation between an academic and an industrial supervisor, normally required a preceding and ongoing cooperation also in other matters between the supervisors or at least some personal acquaintance between the two supervisors. Notably, in only three of the eleven triads the doctoral process itself initiated a first contact between the academic and the industrial supervisor. In the other cases, the supervisors had a background of previous research cooperation or they had the experience of having worked at the same depart-

ment. In a couple of cases the industrial supervisor was a consulting professor at the department of the academic supervisor.

We already had some cooperation with this department and then this KK-thing came up and made it possible to support a research project around it. [The academic supervisor] had this project, and then [the student] came up as a suitable person to do it. They found her at the university. (Industrial supervisor)

Our group in the company started cooperating with the research group of [the academic supervisor], and it had actually nothing to do with these graduate students. Then it was quite natural that I got this role as a supervisor when [two graduate students], they are working with [the academic supervisor], needed to have this construction to be able to get their financing from the research school. (Industrial supervisor)

This implies that our findings are in agreement with those of Schild & Hanberger (2000), who in their evaluation discovered that most of the doctoral processes in industrial research schools supported by the KK foundation did not initiate new relationships, but consolidated already existing ones.

As the research schools were located at universities, it was normally the academic supervisor's responsibility to initiate and formulate the contract. Some of the industrial supervisors in our material were presented with more or less ready project plans; in some cases, time-consuming negotiations were made. Regardless of how much negotiation actually did take place in every actual case, both parties regarded it the academic supervisor's task to formulate the doctoral project so that it met academic qualifications, while the task of the industrial supervisor was to assure that the scope of the project would be of interest for the company. This is in accordance with Rynes' (2001) finding that most successful projects appear to have been formulated by academic supervisors who, so to say, 'use reality' to solve them. So while industrial supervisors did have the last say on whether their companies would support a student or not, the formulation of the project itself was largely in the hands of the academic supervisor, thus affected by his ideas of episteme and academic phronesis.

This means that our results do not fully certify the concerns of the research reported by Croissant & Restivo (2001) on industry funding distorting academic values. Conflicting interests between the academy and the industry did exist, but the industrial supervisors accepted the precedence of academic knowledge interests. It seems reasonable to assume that the financial support of the KK foundation, which was channelled through universities, worked to strengthen the position of the academics.

5.7 Meetings between the supervisors

Gemme & Gingras (2004) report that the cooperation concerning a graduate student is not a homogenous experience. All our 11 triads did have distinctive features. Not only the backgrounds, expectations and previous relationships among the supervising pairs differed; also graduate students and projects varied. It is obvious that the students were not docile boundary objects, but that they were subjects who sometimes brought in a great degree of insecurity. The supervisors had to cooperate, apart from education and doctoral training, on general human issues like resistance, hostility, illness and lack of interest. At the same time, however, they were in the position of seeing new valuable members of their respective communities getting started on promising careers.

The frequency of cooperation and encounters between supervisors varied. When the industrial supervisor was a consulting professor at a department, meetings were not always arranged, and the parties had therefore difficulties reporting how often they discussed the graduate student, among other common issues. Supervisors who otherwise did not have an ongoing cooperation had meetings from once every two months to less than once a year, and normally this was a meeting with the whole triad, the student included. Some of the industrial supervisors also had additional meetings together with the students only, even when the students were not working on the company premises. These supervisors saw their role as active yet different from the role of the academic supervisors.

The academic supervisor has the responsibility. It is extremely important that they take that responsibility. But I don't think we can just let these graduate students go with the wind, like we do now. It is a poor investment, there is less hope of getting them back if you don't have somebody who does some pushing and pep-talking, talking with them. (Industrial supervisor)

My task as to his research is to check that it is professionally conducted and being driven towards the common goal. And then my task is to acclimatize him into this company. (Industrial supervisor)

On the agenda for the meetings between the supervisors were progress reports, discussions on the work the student was expected to carry out at the company, discussions of using the results of the thesis work at a company, and financial matters. The aim of the industrial supervisors appeared to be to keep an eye on the interests of the company in the continuous project planning, and to ensure that the student in question made progress. Some of the supervisors also mentioned the importance of showing the student their interest in his or her work.

5.8 New demands and new roles for academic supervisors

Once initiated, regular meetings formed one type of cooperation in our material. Frequently, cooperation was intensified when a student encountered some kind of problems. The industrial graduate students may be subjected to double socialisation dilemmas and they easily get a heavy workload as they have responsibilities towards both the university and the industrial company (Schild & Hanberger, 2000; Wallgren & Dahlgren, 2005). Consequently, the supervisors have to negotiate on issues which are generally not brought about in projects carried out in more traditional ways.

Another role I have is to protect the students a little towards the companies. The 80%-20% relation. You have to check that it doesn't become 80%-80%. Because it easily does, I have seen students who have been on their knees because they have had so much to do. It's easier if you work 100% with your theses, 80%-20% is more difficult. And I have had countless discussions with the companies where I have reminded them of this. You asked me in what ways I have become tougher and this is one of them. For if you get problems, you have to go to the company with the student and sit down and talk, this is how we see the situation and this is what we want in the future. It's all for the best of the student. (Academic supervisor)

[Being an industrial supervisor] takes about three or four days a year. But when we have supervised intensively we have had one day every other week. It is when the student is not independent. It is insecure. Often the professor falls short, and the industrial supervisor falls short and the student is lost and does not know how he should proceed. But you can usually solve it when you get the right signals. (Industrial supervisor)

Regarding attitudes to industrial financing, we could discern two types of academic supervisors. Both were interested in the financing that industry could offer, and both were well aware that they were producing researchers for industry. However, in relation to developing academic phronesis, they created different conditions for their students.

The 'researcher' supervisors were primarily interested in the activity of research itself and/or doctoral training, and saw the industrial financing as a possibility to further their academic research area. They often took a genuine interest in their students' welfare and were of the opinion that the students were to be given what research education possibly could offer as regards the ways of creating knowledge. This would also enable the students to make informed judgments in their future positions within the industry. These supervisors were highly appreciated by their students.

The ‘entrepreneur’ supervisors seemed primarily interested in the activity of producing a large number of doctors and actively sought contacts to enhance this. Interviews with the students indicated that these supervisors had found it easier to overlook problematic doctoral processes. These supervisors were regarded to have too little time and interest, and the students were well aware that negotiating new contracts and finding new industrial partners took a lot of the supervisors’ time.

It can be difficult to find the time [for a meeting], because the supervisors I have, they supervise a number of students and besides, when these projects come to an end, they must travel and meet people to apply for new funds. Right now my supervisor is out a lot and meets people to be able to apply for new funds. Now I have come so far in my education that I can manage by myself for long periods of time, and you can discuss some things by phone, but when you come in and are new to the place... (Graduate student)

5.9 Industrial supervisors and the academic way of creating phronesis

From the outset, the interests of academic and industrial supervisors were not equal. What seemed to be most important as regards the cooperation, from the industrial supervisors’ point of view, was their own experience of graduate studies. A couple of the academic supervisors also commented the relative difficulty of cooperating with supervisors who did not hold doctorates. Graduate education has its own ramifications and traditions, even when conducted in cooperation with industry, and these are difficult to influence or even comment on without a personal understanding.

The role of the industrial supervisor is to make the work related to the industry, so that it is relevant for that company. All industrial supervisors have not held PhDs themselves. And I think it is an interesting observation that those who have not gone through a graduate education themselves are generally much more difficult to work with. They do not understand what a doctoral project entails, they do not understand the process. While those who hold a doctorate know what it is all about, there is less need for explaining everything. (Academic supervisor)

When taking on supervision, the industrial supervisors had normally expected to help boundary subjects to grow into their companies, but not all of them had been prepared for the fact that these industrial graduate students at the same time were subjected to a strong academic socialization. Even if there had been previous cooperation in shorter projects, an understanding of the time span and the kind of knowledge that was expected from a graduate process had to be learned through experience. For the academic supervisor, publications were

the measurement of a student's career, whether he or she had benefited the industry or not. If the industrial supervisor had been engaged in the project with the prospect of getting access to practically applicable knowledge (techne), what he got in terms of episteme and hopefully a phronetic person was not always satisfying. However, more or less, the industrial supervisors accepted the terms of the academic knowledge production for the doctoral project.

We have a contract with the KK-foundation and the university, and the goal is described there.... And it is a bit structured, what the project includes. But it is in quite general terms, you cannot tick off what has been achieved and when. And as far as I understand goals in research can be changed under way, you find out something new that changes the goals. It's a different way of thinking. And maybe it should be, it's not sure that there is one right way. (Industrial supervisor)

The importance of the relationship between an academic supervisor and a graduate student is a traditional feature of academic knowledge production and does not apply to knowledge production in industry. When the industrial supervisor had no knowledge of this fundamental difference, frustration could easily build up on both sides. This can be seen as a problem caused by the fact that phronesis is created differently in the different environments of academy and industry. For example, graduate students who have difficulties in writing a thesis with the required academic standard might be even more of a problem in an academy-industry cooperation than if they only are taken care of by the academy. The academy has experiences of this kind of processes and a certain acceptance of the fact that some doctoral processes fail. For an industrial supervisor who is not socialized into the academic tradition and who, moreover, is dependent on an academic supervisor for the student's progress, the situation can be much more problematic.

When discussing their distinct roles relating to the doctoral process, academic supervisors were quite secure about their positions and often viewed the industrial contact as an enrichment, particularly for the student. The industrial supervisors were normally satisfied with what they perceived as a minor role. While some of the industrial supervisors stated that the doctoral process gave them a new understanding of how academic research is conducted and the very nature of academic knowledge, the academic supervisors did not tell about comparable learning experiences of knowledge creation and knowledge use in industry. Thus, the knowledge transfer between the supervisors seems to have been one-sided. In short, the industrial supervisors learned more about the academic way of creating knowledge than vice versa.

5.10 Examples of supervisor cooperation

In our small material it is impossible to say whether the differences in academic supervisors' orientation – researcher or entrepreneur – and industrial supervisors' background – graduate education or not – result in typologies in the forms of cooperation. Instead, we give examples of four processes, where these aspects played in. In two of our examples the supervisors were satisfied with the arrangement, and in two examples cooperation and the doctoral process, at least initially, failed.

In one of the triads with a researcher-oriented academic supervisor and an industrial supervisor with high academic credibility the supervisors had chosen to make a clear divide between the academic and the industrial work of the graduate student. This division was made in the contract and in the interviews the supervisors clearly stated that they had almost no idea of and no interest in what the student was doing on the other side of the divide. The common denominator of the two parallel processes was the method the student was using in her research.

We wanted to give [the student] freedom, so she and [the academic supervisor] could develop their work at the university without us interfering. At the same time we wanted to make use of their methods development in a certain activity here. That's how we have arranged it. She has been here part of the time and worked with applications of the methods she has developed at the university. [...] We try to make possible for her to write an article also from the industrial side. I have seen to it that the industrial part is designed as a graduate project should be. It's basic research, it's methods development, even if it's applied to our problem. (Industrial supervisor)

This arrangement appeared to work to satisfaction because both supervisors had a respect and a trust to each other and each took full responsibility for the student for his part. In addition, the student was very capable in her work and in handling the transfer between the two environments. She was seen and recognized as a subject in both milieus, and especially the academic supervising stressed her overall development of phronesis.

Another way of successfully managing a situation with a researcher type academic supervisor and an industrial supervisor was to let the student work on an academic research problem and at the same time socialize him into the company. This was the case with one of the students with a researcher type academic supervisor and an industrial supervisor without a PhD. While the student was working closely with his academic supervisor on a problem of interest to the company, the industrial supervisor showed continuing interest in his development by regular video meetings with him and his supervisor every

two or three months, by engaging him in company activities with the industrial trainees, and by having practical help from quite high up in the company easily accessible. The academic supervisor appreciated the meetings and the student was very satisfied with the company and clearly identified himself as belonging there, in spite of the fact that he did all his research in the academic environment.

My supervisor is good. I have video meetings with him regularly. Every two, three months. And I meet him sometimes, too. I have been to a number of activities arranged by the company, meetings of different kinds. [...] I have been to a number of courses, too, trainee courses, as they call them. [...] I get information in the meetings and on our intranet there's a lot of information about what we are doing and I can sometimes see that they look for some properties in a material, and that's something I can easily measure here. Maybe we have just the right equipment set up, and then it's not a big deal for me to do the measurement. [...] We get to meet different key people in the company and learn what the company is doing and we can present for the company what we are doing. (Graduate student)

While the supervisors in the previous case had divided their responsibilities, in this case they took a joint responsibility for the student. For the moment his academic work was in focus, but the company had also started to make him into a future employee. This student was a boundary object for both supervisors.

Both these students were very competent. However, when students had problems in their doctoral studies, the cooperation was put under a greater strain. In one of the cases the cooperation breakdown happened when the industrial supervisor, the manager of the student's department, changed positions in the company, and the new manager, without a PhD was not interested in putting in the effort required with this student. In another case the industrial supervisor had taken pains to support the student's work and continued to attend the arranged meetings twice a year, but did not feel that he really had very much influence on the process.

In the first case the company of the student finally put in a new supervisor with experience of doctoral studies and a task to see the student through a licentiate exam. This supervisor started a very intensive cooperation with the students' two academic supervisors (of the researcher type), which resulted in the student finally getting her exam. Even if the doctoral process had been troublesome, both supervisors expressed their satisfaction with their cooperation. They had had a problematic project, but it had been a common project around a boundary subject, whom they both were engaged in, and it had resulted in a continuing cooperation.

I still keep in contact with [the academic supervisors]. I had never met them before. Now they are two very good colleagues to me, and we can talk and help each other and we have good contact and we respect each other and what we are good at. (Industrial supervisor)

In the second case the industrial supervisor, who did not hold a PhD, more or less gave up his efforts after getting little response from the academic supervisor (of the entrepreneur type) and at the time of the interview none of them appeared to take a responsibility for the student. When the student fell short of the expectations, the differences in the way the supervisors related to the student and the process became obvious.

When we sit there, I can see that the professor knows what he wants, he has a vision, but how can he communicate it when we think so differently? Are we talking about the same issue at all? And the basics are, of course, that we always must think that we have to get some profit out of the project. [...] When we have a project, we have to get things done. It's not that way at the university, instead they try to get deep into it. But we live in a competitive situation, so we have to act in another way. Maybe we would need a person who would be a little more dynamic, a little more goal-oriented, while a person at the university does not need to be that way. [...] So, if I had that money and I should decide, should I take a graduate project or some other kind of project, I doubt that I would take another graduate project. It's a lot of work and it's risky. (Industrial supervisor)

The industrial supervisor did talk about the student as a person, as the future employee he once had expected to get and started socialising. However, neither the person, nor the research process had met his expectations. The academic supervisor did not say very much about the student at all. In general, he was talking about doctoral students in terms of production and in this case there was not very much production to talk about. The student was neither a boundary object nor a boundary subject.

To which extent the orientations and backgrounds of the supervisors affected the outcomes of these four (or the remaining seven) processes, and whether they are examples of more general patterns cannot be concluded from such a small material. What we could see, as a hypothesis for further study, is that the co-operation worked well and for the benefit of the student if both supervisors were good at what they were supposed to do – the academic supervisor in supervising academic work and the industrial supervisor in finding a meaningful space for the student in the company – and respected each other. It could be a disadvantage if the academic supervisor was very entrepreneurially oriented, because this could mean that he actually was not supervising the student very closely. It was an advantage if the industrial supervisor held a PhD, because it

made communication easier and allowed for more alternatives in combining the academic and industrial research of the student.

5.11 Episteme and phronesis as a goal for graduate education

When asked what they thought about the idea of modifying graduate education in industrial research schools to accommodate it to the special situation and needs of these students, industrial as well as academic supervisors were definitely of the opinion that the industrial graduate students should have exactly the same academic requirements as ordinary graduate students.

You want to benefit from the research project itself, but still, it is the person who will give you greater returns in the long run, employing that person. You want to have a person who can be a manager on some level and at the same time have a higher level of scientific knowledge, in that way you get as much as possible out of that person...He will get a specialist competence in a narrow area, that's true, but it would be impossible to give such a specialist competence in our ordinary competence development process for the newly employed...I don't have a doctor's degree myself, but I can imagine that when you have got your doctorate, you have learnt a kind of scientific thinking in another way, and I'm sure you can use that even in other areas... I think the most important thing is that the quality of the thesis is as good as possible. (Industrial supervisor)

A number of the industrial supervisors talked about the doctoral process in terms of phronesis, which would come about by having an extended, strenuous experience. This would make the students aware of their own capabilities and limitations, teach them to take in and evaluate information and to make sound decisions and communicate these to others. The academic graduate student experience was in itself regarded to produce a particular form of phronetic knowledge, which can not be acquired in industry alone, but which could be useful in some industrial positions.

6 Discussion

This study of the cooperation between academic and industrial supervisors was undertaken in a specific context, industrial research schools, within the special framework of Swedish higher education. The cooperation was furthered and supported financially by a research foundation through economic means administered by the universities. This construction made the academy a more powerful actor than in cases where the funding only comes from industry. Our sample is small. Because of these factors we regard our study as exploratory. However, our use of the concepts boundary subject and phronesis does direct

attention to some, so far, unexplored aspects of cooperation between the academy and the industry. These aspects, we argue, deserve further study.

Our study supports the idea that industrial graduate students can be looked upon as boundary subjects, that is, as something that representatives from both the academy and the industry – two different knowledge domains – are interested in and work with. The representatives of these two knowledge domains, the two supervisors, have to find a common denominator in order to make the cooperation rewarding. Our study indicates that the furthering of the intellectual and personal growth of a person can be precisely such a basis for interaction, when the different expectations regarding the nature of knowledge production itself does not make the cooperation valuable for one or both of the supervisors.

Our results do not necessarily contradict the metaphor of Slaughter et al. (2002), that is, looking at industrial graduate students as gifts exchanged between the academy and the industry; but we illuminate other aspects of this cooperation. We wish to stress the fact that this type of cooperation not only aims at production, but also at education. It does not only aim at the creation of scientific or applied knowledge, but also at promoting the growth of a human being. We agree with Rynes et al (2001) that knowledge transfer is about face-to-face experience and that this experience – per definition – involves a socialisation process. In the case of industrial graduate students this applies not only to the student, but also to some degree even to both supervisors.

Most of the supervisors in our study had cooperated before or were at least acquainted before starting the cooperation concerning the graduate student. Due to the long time span of the graduate education process, the graduate student stabilized the relationship according to several supervisors. This is in agreement with the function of gifts in terms of Slaughter et al (2002). However, we emphasize that these gifts for many of the supervisors in our study implied quite a few encounters with one another, that is, both time and engagement together. It appears that it was this cooperation, rather than the gift itself, that stabilised the relationship. For this reason, we argue that the notion of boundary subject, rather than that of gift, is more appropriate if we are to mirror the function of the graduate students in this cooperation.

Slaughter et al's (2002) picture of industrial graduate students being a work force exploited both by the academy and the industry does not apply to our data very well. The problems in some of the processes can rather be connected to Johnson's (2001) milder criticism of industrially financed graduate projects. According to her graduate education in cooperation between the academy and the industry can create "interests in professors that can affect their judgment on behalf of students" (p. 196), that is, professors attend to the interests of their

industrial sponsors on the expense of the interests of their graduate students. This did occur in our study, most commonly by the supervisor being more engaged in securing new contracts than supervising the graduate students working on the present projects. However, most often the education of the student to become a judicious person, either as a researcher or as a user or a manager of research at a company, was of great importance to one or both of the supervisors.

While knowledge transfer between the academy and the industry in general has distinctive sector specific features (Santoro & Chakrabarti, 2002), the type of supervision cooperation that we have studied did not show sector specificity. There were no aspects among those we were interested in where we could discern our three bioinformatics triads from the eight building and indoor climate triads. This might imply that while different disciplines and economic sectors have different balances between episteme and techne, furthering phronesis is a very general undertaking.

We found that working with three concepts of knowledge, instead of the two contrasting ones which are more common, enriched our analysis and made it possible for us to see aspects that easily are overlooked when looking at knowledge transfer in economic or political terms. The three concepts of knowledge are particularly suitable when dealing with an educational process, but they can be valuable also in other analyses of knowledge transfer. In the economic and political usage of the notion knowledge transfer, knowledge is often regarded as an end in itself, which fits the concepts of episteme and techne. However, if the ultimate aim of knowledge transfer is supposed to be furthering human welfare, phronesis, with its emphasis on the ethical aspects of knowledge, becomes a highly relevant concept.

Cooperation focusing an industrial graduate student as a boundary subject creates an arena where personal engagement in something less instrumental than exploitable knowledge also can create a common socialisation experience for the academic and the industrial supervisors. This socialisation experience might in itself be problematic, as it entails communication between different cultures on issues that might not be explicit in any of them. However, such experiences are of vital importance for achieving processes of knowledge creation according to Mode 2 (Gibbons et al, 1994), where the cultures of academic and industrial research merge for common knowledge production. Thus, more knowledge on this particular type of academy-industry cooperation, its practices and its results, will be valuable for our understanding of the possibilities of new forms of knowledge creation.

7 Acknowledgements

This research project was supported by a grant from The Bank of Sweden Tercentenary Foundation.

8 References

- Behrens, Teresa R. & Gray, Denis O. (2001) Unintended consequences of cooperative research: impact of industry sponsorship on climate for academic freedom and other graduate student outcome. *Research Policy*, 30, 179-199.
- Croissant, Jennifer & Restivo, Sal (eds) (2001) *Degrees of Compromise. Industrial Interests and Academic Values*. (New York: State University of New York Press.)
- Eisner, Elliott E. (2002) From episteme to phronesis to artistry in the study and improvement of teaching. *Teaching and Teacher Education*, 18, 375-385.
- Etzkowitz, Henry (2002) *MIT and the Rise of Entrepreneurial Science*. London: Routledge.)
- Flaming, Don (2001) Using phronesis instead of 'research-based practice' as the guiding light for nursing practice. *Nursing Philosophy*, 2, 251-258.
- Gemme, Brigitte & Gingras, Yves (2004) Training a new breed of researchers, inside and outside universities. Working paper. (Paper presented at Unesco: Colloquium on research and higher education policy, 'Knowledge, access and governance: strategies for change'.)
- Gibbons, M. et al (1994) *The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies*. (London: Sage)
- Gustavsson, Bernt (2004) Revisiting the philosophical roots of practical knowledge. (In J. Higgs, B. Richardson & M. Abrandt Dahlgren (Eds.) *Developing practice knowledge for health professionals* (pp 35-50). Edinburgh: Butterworth-Heinemann)
- Hackett, Edward J. (2001) Science as a vocation in the 1990's: The changing organizational culture of academic science. (In: J Croissant & S. Restivo (Eds.), *Degrees of Compromise. Industrial Interests and Academic Values*. (pp. 101-138). New York: State University of New York Press)
- Handbook for Postgraduate Students* (2005) (Stockholm: National Agency for Higher Education) Retrieved May 22, 2007 from <http://www.doktorand-handboken.nu/english/>
- Harman, Kay (2002) The research training experiences of doctoral students linked to Australian Cooperative Research Centers. *Higher Education*, 44, 469-492.

- Harman, Kay (2004) Producing 'industry-ready' doctorates: Australian Cooperative Research Center approaches to doctoral education. *Studies in Continuing Education*, 26 (3) 387-404.
- Johnson, Deborah G. (2001) Conflicts of interest and Industry-Funded Research: Chasing Norms for Professional Practice in the Academy. (In J. Croissant & S. Restivo, (Eds.), *Degrees of Compromise. Industrial Interests and Academic Values* (pp. 185-198) New York: State University of New York Press)
- Rynes, Sara I., Bartunek, Jean M. & Daft, Richard L. (2001) Across the great divide: knowledge creation and transfer between practitioners and academics. *Academy of Management Journal* 44 (2) 340-355.
- Santoro, Michael D. & Chakrabarti, Alok K. (2002) Firm size and technology centrality in industry-university interactions. *Research Policy*, 31, 1163-1180.
- Saugstad, Tone (2002) Educational theory and practice in an Aristotelian perspective. *Scandinavian Journal of Educational Research*, 46 (4) 373-390.
- Schild, Ingrid & Hanberger, Anders (2000) *Industrial research schools. A real-time evaluation of the Swedish Knowledge Foundations research school programme*. Evaluation Reports No 6. (Umeå: Umeå Centre for Evaluation Research)
- Slaughter, Sheila. et al (2002) The "traffic" in graduate students: Graduate students as tokens of exchange between academe and industry. *Science, Technology & Human Values*, 27 (2) 282-312.
- Star, S.L. & Griesemer, J. (1989) Institutional ecology, "translations" and boundary objects: amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-1939. *Social Studies of Science*, 19, 387-420.
- Wallgren, Lillemor & Hägglund, Sture. (2004) The Industry Doctoral Student – An educational challenge for academia and industry. In S. Hemlin & al (Eds.), *Creative Knowledge Environments*. (Cheltenham: Edward Elgar Publishing)
- Wallgren, Lillemor & Dahlgren, Lars-Owe (2005) Doctoral education as social practice for knowledge development: Conditions and demands encountered by industry PhD students. *Industry and Higher Education*, 19 (6) 433-443.