

Collaborative PhD projects: together towards innovation

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INTRODUCTION

The Delft Infrastructures & Mobility Initiative (DIMI) and Delft Energy Initiative (DEI) at the Delft University of Technology (TU Delft) have launched a pilot for collaborative PhD projects. A special group of PhD students not employed by the university, but at a company or a governmental organisation interested in the same research themes will defend their dissertation at TU Delft. These collaborative industry-university PhD projects strengthen the cooperation between the university and industry and this interaction increases the potential for innovation.

Another type of collaborative PhD project involves PhD students employed at universities of applied sciences. These universities have a limited number of promotional vouchers for their employees. PhD students, mostly teachers, are usually affiliated with a research group ('lectoraat') within their institute and require a supervisor with similar research interests at a university like TU Delft. In some cases there is also a company or governmental institution affiliated with the team, which generally consists of the PhD student and director of a research group ('lector'), both from a university of applied sciences, in addition to a university professor.

From the university perspective, PhD students from industry, governmental organisations or universities of applied sciences are called 'contract PhDs'. The contract PhD is defined as not employed at the university. He/she receives some form of funding for the PhD or is allowed to pursue the PhD during office hours, irrespective of the amount of time allocated for this purpose [1].

The goal of these collaborative PhD projects is to jointly develop knowledge that is useful for transforming practice and at a sufficient level for a PhD defence. The goal to increase Europe's competitiveness by innovating faster based on sound research could become a reality. An important condition, however, is that these collaborative PhD projects run smoothly. The question therefore is: What does doctoral engineering education for collaborative PhD projects look like?

WHY COLLABORATIVE PROJECTS?

Joint PhD projects are a promising form of research collaboration, connecting universities to firms, governmental organisations and/or universities of applied sciences. One organisation alone cannot achieve the goal to develop critical knowledge for the challenges of our time. For example, to accomplish integral design and management for resilient, durable infrastructures or system integration in the energy sector universities, companies and other institutions need to collaborate for a longer period of time. Technological change and economic success no longer depend solely on capital and labour, but on knowledge and other intangible entities like the interaction between (public and private) organisations and their ability to refresh: 'renewal capital' are equally important drivers for national growth [2]. A PhD project in this context therefore not only entails the training of an individual to become a scientific researcher, but a collaborative PhD project in which new knowledge is developed that should lead to innovation. In sum, these collaborative PhD projects are a way to implement the knowledge triangle [3] [4].

THE INTERESTS OF ALL PARTIES INVOLVED

As Pronk et al [5] showed, one of the success factors of a collaborative research project is clarity regarding everyone's objectives, benefits and risks. For every collaborative PhD project, matters like intellectual property rights and publications should be on the agenda and agreed on by all parties. This paper briefly discusses the interests of the parties to a collaborative PhD project as described in the introduction.

University

The benefits to the university can be found in various policy documents. Contract PhD students and their employers are addressing research themes that are relevant to business and society. They are constantly looking for solutions that are applicable for companies. Thus, by initiating these joint projects the university is satisfying both their research and knowledge valorisation efforts in developing, implementing and commercialising their knowledge [6]. The Dutch government also encourages cooperation between universities and industry. The government wants to increase the number of PhDs in business since they contribute to increasing the competitiveness of the country [7].

The interests of academic staff regarding contract PhDs differ. I interviewed four TU Delft professors supervising several contract PhDs for approximately one hour each. The semi-structured interviews were conducted using an interview template, recorded and transcribed. All transcripts were then analysed. In this paper, I focus on the interests of the professors to start with a contract PhD and the problems they encounter during the various phases of the PhD project. I leave out of consideration the (various) ways they supervise these PhDs.

The manner in which university supervisors get involved in these collaborative PhD projects differs. A professor and PhD candidate may know each other for a longer time: 'it's someone from my network' or 'it is a former student'. It also happens that an organisation, for example the tax authorities, asks a university professor to conduct research together on innovative ICT applications. The university professor may then select several PhD candidates from his or her organisation. At a university of applied sciences, the PhD candidate and professor from the university already know each other, or there is a programme in place that connects a candidate from a university of applied sciences with a university professor on the basis of a research proposal (such as Leiden University Dual PhD Centre The Hague).

Although several reasons for collaboration are mentioned, university professors tend to be mainly interested in PhD students who contribute to their own research. The goal is to publish jointly in the scientific journals in which they also publish themselves. The greatest advantage of contract PhD students is that they have direct access to cases and data. For more context-related research, the experience of the PhD students has been viewed as very important: 'The contract PhD candidate understands much better what is going on at major complex infrastructure projects than a recently graduated PhD student who has been at the university only'. The other side of the coin according to some scientists is that contract PhD students, due to their experience, do not always want to contribute to the core of their research. Furthermore, the supervision of a contract PhD can take a great deal of time. That also has to do with the fact that the quality of the PhD students - and thus the quality of the dissertations - varies significantly.

Contract PhD students may also contribute to education. They can give guest lectures in order to link theory and practice or supervise graduate students. In addition to these well-known forms of education, contract PhD students can also be an enabler of innovative teaching methods, for example through participation in living labs, MOOCS, writing competitions, hecatons and so on.

Private and public organisations

The best chance for success is if the parties already collaborate [8]. Pilots with collaborative PhD projects could therefore be set up with companies and organisations already involved with the university. The interests of public and private organisations to participate in collaborative PhD projects are not the same since they have different goals and responsibilities. In this section, I concentrate on companies. It was possible to provide an overview of the benefits for some companies by consulting several (mostly) managers from companies in various consortia.

Companies are currently experimenting with how they can shape and maintain their intellectual capital. It is important for companies to offer individual employees something in their career development. The company gets more motivated and better trained employees in return. A partnership with a university also means access to the academic world. The development of cutting-edge technology and the foresight knowledge of universities will make these companies able to strategically respond to future developments or, in other words, 'co-create the future'. They can take advantage of the good name and reputation of the university, contributing to the market value of the company. Furthermore, by participating in a PhD project, several regular students can also become involved, which can be of interest in attracting young talent.

The interests of universities of applied sciences are different from the companies. These universities want to increase their research capacity and better train their teachers and students. The professional practice calls for students with research skills, though the width and depth is still a subject of discussion. Until recently, universities of applied sciences had no research infrastructure. That is now changing, especially with the arrival of an increasing number of professors ('lectors') over the past ten years. A partnership with a university is needed because of the 'Ius Promovendus' [autonomy in the granting of doctoral degrees] of a university professor, but also interesting due to the well-organised research infrastructure that can be used by the PhD student and scientific perspective for more applied research. One of the requirements of many universities of applied sciences is that the results are implemented in practice. Universities of applied sciences therefore are increasingly recognised as knowledge partners for public and private organisations.

PhD students

I studied the problems faced by PhD students already employed from the start of their PhD study to the end [9]. Six PhD students were interviewed for approximately 90 minutes each (see table 1). The semi-structured interviews were conducted using an interview template with seven blocks of questions. Each interview started with general questions about the motivation, background and subject of the PhD study. The second block contained questions concerning the start of the PhD programme: why did you enrol in a PhD programme? Another question was: is there something formerly arranged at the start of your PhD? This was followed by blocks of questions about the problems they encounter during the first year, during the next phase, and during the final phase of the PhD project. Finally, there were questions relating to external partners: what kind of support do you receive from your company? There were also questions about the future: what do you want to do with the end result, both in terms of career development and implementation of the results? The interviews were recorded and transcribed. All transcripts were then analysed using the seven blocks of questions. In this paper, I focus on the motivation to start a PhD project and (some of) the problems encountered during the various phases of the PhD project.

Table 1. The background of the PhD students and their motivation to start a PhD project.

	Background (study)	Background (work)	Motivation
1	Information science, MBA	Employed at energy company	- Value for the enterprise - Personal development
2	Mechanical engineering, TWAIO: process technology in chemical engineering, executive MBA	Self-employed (formerly employed at (different) energy company)	- Academic career
3	Intermediate Technical School (MTS) Technical College (HTS)	Teacher at a university of applied sciences	- Achievement of highest level on this topic
4	Electrical engineering (alumnus TUD)	Teacher at (a different) university of applied sciences	- Interest in the topic
5	School for business administration and economics (in Dutch: HEAO), Master's in Information management, register accountant	Accountant at Dutch Tax and Customs Administration, and trainer at a university	- Tax Administration has opted for ICT research with the university - Own motivation: more freedom and appreciation, higher level of teaching
6	Civil engineering (alumnus TUD)	Staff position at a water supply company	- Expert training, possibly to find (new) job

The motivation to become a PhD holder varies significantly. All PhD students showed an interest in the topic and an effort to change something essential in the current situation through their research. However, their ultimate goals vary, from a future

academic career to innovation in their company or public organisation. In the case of two teachers at two different universities of applied sciences, it was less clear what they want to do with the PhD; it might be self-evident that they use it in their education, but it could also be that too little attention is paid to the career perspectives of teachers at universities of applied sciences with a PhD.

A large part of the interview was designed to create an overview of the problems encountered by PhDs or what they feel is lacking in the process. Some of these problems can be easily solved. Administrative problems and IT-related problems, for instance, can be solved through a proper intake process and by appointing someone who is responsible for organising an effective infrastructure. Many universities have put a lot of effort recently in getting PhDs up and running much faster. But this study revealed other problems that are less easy to solve since they arise from differences in the domain of practice and the domain of scientific research. These PhD students work in a company (domain of practice), often for many years, and are motivated by solving a practical problem. They want to make a difference in practice through their research, which is another starting point that differs from an internal PhD student carrying out a subsidised project with a proposal written by a scientist. The translation of a practical problem into a scientifically interesting research question is an issue for most contract PhD students. They use their own reference scheme to solve this issue, but that approach falls short. Some supervisors also speak a language different than what the PhD students are used to. In terms of the Model-Activity-Utility (MAU) framework, developed by Sjoer, Nørgaard and Goossens [4], universities and companies operate on the basis of different models, carrying out different activities. What is more, the incongruity regarding the production of satisfactory results poses problems for contract PhD students and universities [9].

Ingredients for a programme to overcome these problems will be discussed in the next chapter.

THE BEST WAY FOR ALL PARTIES INVOLVED

The collaborative PhD projects should be designed in such a way that they are consistent with the relationship and everyone's interest in it, as well as the needs and talents of the PhD student. This approach should lead to more successful PhD programmes. This may seem obvious, but I have looked into the part-time PhD programmes offered by universities in the Netherlands and they turn out to be highly diverse. Although the findings of this benchmark are beyond the scope of this paper, many universities offer an educational programme rather than a programme that involves both the training of an individual to become a scientific researcher and a collaborative project in which new knowledge is developed that should lead to innovation. Perhaps this model is more fitting for technical universities than other universities.

Design criteria PhD programme

Based on the results of this preliminary study and the existing literature, a tailor-made programme should be defined, which should include:

- Guidance team
- Subject research
- Doctoral education programme
- Performance assessment (including go/no go decisions)
- Agreements on results (patents, publications, confidentiality, etc.)

- Funding

A number of remarks are listed below, intended as a start for the discussion on the SEFI conference.

As regards guidance, all parties should be able to work together for a longer period of time. Continuity in the guidance team is a well-known success factor. A recommendation for all parties involved is to invest in the relationship and to pay attention to the selection criteria for (all) supervisors. For instance, selection criteria for the company supervisor might be someone who is able to contribute to the implementation of the results and who understands the scientific debate. In short, he/she is a good conversation partner for the university. In the future there will be many more PhDs working in companies, probably making the choice easier.

The subject of the research should be interesting for all parties involved. This sounds obvious, but all parties should be committed to a topic for a longer period of time. So the topic should be the core business of the organisations involved. For instance on Public Private partnership (PPS) in large complex infrastructural projects: How should the governance structure be organized to support the cooperation between public and private partners towards enhanced project performance? Furthermore, it is recommended to see if several collaborative PhD projects can reinforce each other. The projects contribute to the same body of knowledge and, although PhDs run their own project, they could meet and share insights. Thus, the lonely wolf syndrome is avoided.

Many universities have a doctoral education programme in place. TU Delft, for instance, offers courses on research skills, discipline-related skills and transferable skills. This preliminary research has made clear that a tailor-made programme should be adapted to the needs of a contract PhD. The delivery mode is also important, since the time of a contract PhD is limited and he or she may not live near the campus, as many regular PhD candidates do. Perhaps the extension school of TU Delft could provide several online modules, which will make the programme blended and more diverse.

Many graduate schools and doctoral education programmes have a form of performance assessment in place. There is often a sort of preliminary process in which a research proposal is written. Then there is a go/no decision point. For a collaborative PhD project, the extent to which the cooperation runs smoothly can be assessed too. Of course, every PhD must ultimately comply with the PhD requirements of the university of his/her preference. However, the incongruity of partners regarding the production of satisfactory results could also lead to a discussion about performance criteria.

Finally, a comment on the result agreements, such as patents, publications, confidentiality, etc. and funding. As stated by Salimi [8], the success of a collaborative PhD project is more likely if there is joint decision-making, which is more often the case when there are mutual dependencies. That means that not one party controls all critical resources.

Collaborative PhD projects are sure to become an interesting learning process for all parties involved.

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