

**WASP INDUSTRIAL PhD  
REPORT 2019**

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## 1. Introduction

Collaboration between industry and academia is of crucial importance for the dissemination of knowledge from research and development to industry and society at large. The purpose of the industrial PhD student instrument is to contribute to needs-driven research and to foster in-depth cross-fertilization between academia and industry both in terms of relevant research results and availability of competence. This also leads to greater knowledge and appreciation of the different conditions under which people work in academia and industry.

At the WASP Industry Day in May 2018 a request to shed light on different aspects of the industrial PhD student concept was expressed. In a discussion session several questions and issues regarding industrial PhDs were addressed. A main overall question is how to set up and execute an industrial PhD project so that chances of success is maximized. Another main question is how to explain and motivate high industry engagement in the instrument and the PhD students both internally and externally. Based on these issues raised by industry, WASP organized a one-day workshop to discuss these issues on January 31, 2019.

### 1.1. Highlighting industrial PhD students as a strategic instrument

As an overall and initial comment, it is worthwhile to highlight possibilities for industry to think of industrial PhD students as a strategic instrument. There are two main types of results for participating industry:

- Concrete result in the form of a doctoral degree, research results such as papers, contributions to technical meetings, and sometimes patents.
- As shown in recent research participating industries improve their innovation capabilities.

The latter item is elaborated on in the last chapter and it is clear that when an industrial partner selects and forms an industrial PhD project, inclusion of a strategic dimension regarding the individuals or groups involved can significantly enhance innovation capabilities.

## 2. Industrial PhD Students

All PhD students generate new knowledge, contributing to a dissertation project, but also take courses to become experts in their field and develop a general academic knowledge base in their field. Within this general framework, the industrial PHD has an added focus upon needs based on business challenges expressed by companies. This latter aspect needs to be handled with care but can lead to added value and advantages also in the academic perspective.

An industrial PhD student (or Industry Doctoral Student) is a PhD student who performs his or her PhD studies while employed by a company in the private sector or by an organization in the public sector. The PhD student is enrolled in a program at an academic faculty and follows PhD courses and authors a PhD thesis following the same procedure as a university-employed PhD student. In some cases significant, or even the majority of, time is spent at the company rather than at the university while the opposite situation is also common. A balance between time spent in the hosting environments is thus desirable but can vary. The student has one academic advisor and one industrial mentor named industrial PhD advisor. In many cases the latter also has a PhD degree.

The salary for a PhD student is covered by the company. Sometimes the company also covers the cost for the academic supervision time. In most cases, the company receives compensation, for parts or for all of, these costs from a research funding agency in the form of an industrial PhD student grant. In Sweden the funding agencies that currently have calls for industrial PhD student projects include the Swedish Foundation for Strategic Research (SSF) and Knut and Alice Wallenberg's Foundation (KAW) through the Wallenberg AI, Autonomous Systems and Software Program (WASP). Until 2014 the Swedish Research Council (VR) also had calls based on this instrument.

## 2.1. Industrial PhD Students in WASP

Wallenberg Artificial Intelligence, Autonomous Systems and Software Program (WASP) is Sweden's largest ever individual research program. A key element of the program is a graduate school with industrial PhD students, which is operated in collaboration with industry. The graduate school in WASP is dimensioned for at least 400 PhD students out of which 100 are to be industrial PhD students. By August 2019, 184 PhD students have started and 49 more have been accepted but not yet started. Regarding industrial PhD students 59 PhD students have started their studies and 21 more have been accepted. In total 34 different companies are represented. Larger companies such as Ericsson, Saab, Zenuity and ABB have several PhD students each, with Ericsson in the lead with 12 PhD students. On the other hand, the majority of the companies only have one PhD student and in several cases, this is their first industrial PhD student project ever.

A company hosting a WASP industrial PhD student receives 600k SEK/year from WASP if the student performs his or her studies at full time which corresponds to four years of studies. The normal case, though, is that the studies are performed at 80% of a full time equivalent for five years which means that the total annual funding will be 480k SEK per year during five years. This includes a travel budget of 30k SEK per year at the 100% level. In addition to this the university gets reimbursed by WASP with 15% of the university advisor's salary costs per year for four years. This may also be changed to 80% over five years. A WASP industrial PhD student must spend at least 20% of his/her time at the company and at least 20% at the university.

## 2.2 Thematic day January 31, 2019

On January 31, 2019 WASP organized a seminar day at IVA in Stockholm where different aspects of an industrial PhD student project were discussed. The aim was to try to help companies that were new to the industrial PhD student instrument to understand how to best make use of it, i.e., how to best organize and execute the project so that the chances for success are maximized. The program was as follows:

10:00-10:20 Introduction WASP och WASP's industrial PhD student program – Karl-Erik Årzén, Chair of the WASP Program Management Group

10:20-11:05 Claes Lundström, Sectra – Experienced industrial supervisor and himself a former industrial PhD student

11:05-11:50 Karl Henrik Johansson, Royal Institute of Technology, KTH – Experienced academic supervisor

12:00-13:00 Lunch

13:00-13:45 Lars Hultman, SSF – CEO for the Swedish Foundation for Strategic Research

13:45-14:30 Maureen McKelvey, Gothenburg University – Researcher on innovation and industry – academia collaborations

14:30-15:00 Discussion

The objective of this report is to document parts of the presentations and the discussions that were held.

## 3. Common Questions and Issues

When one discusses the industrial PhD instrument there are a number of frequently asked questions and issues raised. The following summary is an attempt of addressing them.

### How does an industrial PhD thesis differ from an academic PhD thesis?

An industrial PhD thesis is often more application-oriented than an academic PhD thesis. However, this is not a necessity and not always the case.

### What is the objective for the company?

There are many examples of objectives, e.g.,

- To become more involved with an interesting research program, e.g., WASP, or with a university research group that is doing research that is of interest to the company.
- To increase the knowledge within an area that is of vital importance to the company.
- To solve a challenging problem.

- To provide competence buildup for a promising employee who the company wants to invest in.
- To hire a person with sufficient skills who will be prepared to take on a leading role in R&D after 4-5 years.
- .....

Added to these objectives is of course the strategic dimension mentioned in Section 1.1.

#### How should the research topic be defined?

It is important to define a research topic that is not too narrow. The reasons are that a PhD thesis must meet the degree requirements of novel research, so the topic must be of academic interest and researchable. The topic should also be broad enough so that it is still relevant to the company in the long-term future. It is also important to consider that a research project can change over time, so that it allows for initial uncertainty and new results should lead to next steps. The likelihood that the topic will still be relevant to the company after five years must, however, be very high.

Also, the problem should not be so simple that it is easily solved, nor so difficult that it is unlikely that a solution will be found within the scope of a single PhD thesis. The topic must also be of a nature that enables publication of the results in scientific journals and conferences. The definition of the research topics requires close interaction and discussion between the academic supervisor and the industrial supervisor, so that an appropriate thesis project can be defined that suits both partners.

#### What does a good industrial PhD student candidate look like?

In the standard case the ideal candidate is a person that has been employed by the company so long that he or she is well established at the company and has obtained solid knowledge about the company and its products and services, but still has a university education relatively up-to-date. Typically, this means 2-5 years after completion of the degree.

However, also persons who have been at the company longer can be very suitable. The most important aspect is that the person has a good analytic competence, excels at problem solving, and has good oral and written communication skills. Normally this is associated with high grades from the previous university education. The importance of grades should not be underestimated.

A PhD education, in most subjects, includes taking around 1.5 year full-time of courses. These courses are often at a very advanced level and require high theoretical maturity of the student. Hiring a newly graduated person with, typically, very little industrial experience for an industrial PhD position is normally not a good idea, even if the person is very qualified. The reason for this is that this person has to spend significant time to both become integrated with the new company and with the research group at the university.

#### Be prepared for deviations

Very few PhD student projects end up with a thesis that corresponds exactly to the

problem that was initially formulated. Research is all about generating new knowledge, and thus may/should take new directions based on discoveries and decisions along the way. Deviations of different types do thus occur and the company must be aware of and accept that this is the case.

#### The company must be aware of the realities of PhD studies

The company must be aware of the realities of PhD studies already from the beginning. For example, a PhD education at most Swedish universities includes taking 90 ECRTS credits of PhD courses. This corresponds to 1.5-year full time. Some of these courses may be of slightly less interest to the company and relevance to the particular research project, but they still must be taken to provide the PhD student with the opportunity to learn additional areas of knowledge, and thereby meet the requirement of having the necessary breath of knowledge required to obtain a PhD degree.

An important part of the PhD studies is travel to conferences, summer schools, and meetings of different kinds. These are important for the student to discuss and present the research results and to learn. Other examples of travel that are important are international study trips.

#### How to guarantee that the PhD student remains relevant to the company also after 4-5 years?

To prevent the company from losing the interest of the PhD student and what she/he is working on it is important with a continuous knowledge transfer from the PhD student to the company, e.g., in the form of regular presentations and meetings. Another way of ensuring that the intermediary results are relevant can be to set up a research-related shadow project at the company where the results can be evaluated and where new research questions can be generated.

#### How can the company be sure that the PhD student stays with the company?

The short answer to this is that there is no way of ensuring this. The finished PhD can of course decide to leave the company for another company or for academia as soon as she/he has obtained the PhD degree. The only thing that the company can do is to ensure that the PhD student feels appreciated during the studies and is engaged in the company. This can be done in several ways, e.g., by setting up a well-defined career plan for the student and discussing possibilities to use their new knowledge in new ways after obtaining the PhD degree.

## Interview with Sectra: “A Long-Term Engagement”



### **Claes Lundström**

Center for Medical Image Science and Visualization (CMIV), Linköping University. He received his PhD degree in 2007 and Docent degree in 2014.

He has since 2012 led the technical side of the digital pathology research at CMIV, being the PI for large national-scale grants. From 2017 he is the Arena Director for the Analytic Imaging Diagnostics Arena (AIDA).

Since 2010 Lundström holds the position as Research Director at Sectra AB.

*Claes Lundström is the Research Director at Sectra, a medical company that for several years has been collaborating with Linköping University in different industrial PhD student projects. Claes Lundström has vast experience as a researcher, PhD supervisor and he has also been an industrial PhD student himself. Below he gives some views from Sectra on hosting an industrial PhD student.*

A PhD student is a huge investment; it is a long-term decision. Claes Lundström stresses that having an industrial PhD student is a collaboration of long-term engagement between the company and academia.

“The PhD student has to feel that company and academia have a joint view and good communication. For the industrial PhD student, the relationship with both academia and the industrial supervisor is important,” Claes Lundström says.

### **Get the right person onboard**

He emphasizes that the PhD student needs to be passionate about taking research from the academia out to real use in a company.

“First thing is to get the right person onboard in terms of self-management skills. It is good to have a couple of years’ experience from the industry before you become an industrial PhD student,” Claes Lundström says and stresses that it is important that the company helps the industrial PhD student to have full focus on the project that he or she is working with.

“We want industrial PhD students who previously have been working at the company. This make it even more important that we as a company separate them from what they have done before, so that they will not be distracted,” Claes Lundström says.

One advice from Claes Lundström is that the company should have a separate research department, so the PhD student do not have any firefighting responsibility. However, at the same time it is also good to have the research department close to product development, so the agenda is aligned.



## Questions and answers

At the meeting, Claes Lundström was given the opportunity to answer a large number of questions about the program with industrial doctoral students. Below is a selection of these questions:

### Q. What is important to obtain a good result?

A. It is important that the PhD student is independent and has a higher ability. It is good if the PhD student can both write scientific papers with high quality, but also be able to demonstrate results and create prototypes. You need people with talents at several levels.

### Q. Why is it important to find a PhD candidate with experience from the industry?

A: If we have students fresh out from university they know a lot about academia, but if they do not have any industrial experience we have to train them before we put them to work.

### Q. If you don't have anyone to disengage from their daily business at the company, have you tried to hire somebody with the intent right from the start to provide an opportunity to conduct PhD studies?

A. We regularly bring that possibility into recruitment discussions. In some cases, this has indeed materialized, but in other cases, after a couple of years, other assignments in the company have been seen as more interesting. So, the company must be open to move people around from one department to another.

### Q. How do you setup a PhD student project internally at the company? You have a supervisor, but do you also have a group around the student?

A. We are very much interleaved and the staff in the group have many connections. It makes things easier if the industrial supervisor has a PhD.

### Q. Do you have any special training program for the PhD student to be an industrial leader?

A. No, it is not in the program. Nevertheless, they can be responsible for their respective research groups, but it is not formalized.

### Q. How about the end of the program, where have the people gone?

A. All of our PhD students have stayed with the company for a long time. We must make sure that they feel appreciated and that there is an interesting future for them, and that afterwards their engagement is shown in the paycheck.

## Interview with KTH: “A Fantastic Possibility”



### **Karl H. Johansson**

Electrical Engineering and Computer Science, KTH Royal Institute of Technology. Visiting positions at UC Berkeley, Caltech, NTU Singapore, Hong Kong UST, NTNU, Zhejiang U, etc.

Advised or co-advised 22 PhD students and 35 postdocs. Currently 14 PhD students and 11 postdocs.

Published 650 papers and 6 patents.

*Having a PhD industrial student is a project that runs for several years. For the student it will be a life changer, for academia an opportunity to show that basic research has an impact, and for the company to obtain knowledge, Karl H Johansson, Professor at KTH, stresses.*

“A PhD is really a life changer for the student. It is not just a research contribution. It changes the way you are and the way you reflect and think,” Karl H Johansson says.

It gives the PhD student an ability to formulate problems and to understand challenges in a different way than he or she did before. Being an industrial PhD student adds even more to this as the student gains knowledge of how a company is developing projects.

“The technical skills are important for the industrial PhD student to learn. He or she becomes kind of a super engineer in the company,” Karl H Johansson says.

### **Finding the right student**

Karl H Johansson stresses that it is extremely important to find the right student. It is good if the student has been working in the industry for a while because then he or she realize that theory and practice is not always the same.

“Not everything is as the abstract models that we look at in the academia. But on the other hand, a PhD student can help with new views on industrial projects,” Karl H Johansson says.

### **80-20**

80 – 20 is the right split. 4 days a week at the university, and 1 day a week at the company. If you spend too much time in the industry you miss a bit of what research is, if you are not at all at the company you miss that other side.

“It is good to be flexible; it depends very much on what is happening in the project. But it is good if the student doesn’t stay at the company all the time, then you tend to lose a bit of the way we work in academia. It is also important that the industrial PhD student can learn from other students. You come into a group with several other PhD students, and that is good,” Karl H Johansson says.

## Belonging to a group

It is important that when you start as an industrial PhD student you have someone to discuss with, for example a senior industrial PhD student mentor. It can be someone who is in the same organization.

There are several challenges for the PhD industrial student. One thing is that management at the company can change more often than in academia, in that way it can sometimes be more uncertain at the company than in academia. However, you grow with that experience.

## Academia and industry

It is important to build up long-term relations to understand the different views in academia and industry.

The strength in academia is to formulate precise problem and to be able to abstract as you do in science. In industry, on the other hand, you know what problems is and what the details are. Discussions arising from these differences can be very useful.

“Having an industrial PhD student is a fantastic possibility for a company to influence academic research, for example as invited speakers in different PhD courses. I think that all companies should take part of that. It is a fantastic window to show what the company is doing, to brand the company and give the students a connection to industry,” Karl H Johansson says.

“For academia this is a fantastic way to show that basic research has an impact. It is also obvious that we at the universities can never afford to run such large testbeds that companies have. A close connection to the industry will expose all the PhD students to real problems in the companies,” Karl H Johansson says.

## Steer together

Karl H Johansson adds that you have to accept that you do not always know from the beginning where a project with an industrial PhD student will end up. It is not so easy to know what will appear along the way.

“But as long as we have good feedback and steer this together, industry and academia, that is the right way to handle it,” Karl H Johansson says.

## Interview with Maureen McKelvey: Social science explorations



### Maureen McKelvey

Professor in Innovation and Entrepreneurship at Department of Economy and Society, Gothenburg University. Her publications contain papers, book chapters and award winning books. She is recipient of large research grants, and an academic leader both locally and internationally.

*Social science research addresses innovation and entrepreneurship, and a paradigm is that innovation and entrepreneurship are closely related to processes of creating, accessing, and diffusing knowledge and opportunities.*

Research focuses on the development and use of knowledge at the interplay between innovation management and entrepreneurship with science and engineering. Such research and results will greatly impact the transformation of society through knowledge, innovation and entrepreneurship, says Maureen McKelvey, professor at Gothenburg University.

Recent research on industrial PhD students which unite universities and firms show two main types of benefits for firms active in engineering systems industries in Sweden<sup>12</sup>. Maureen McKelvey's previous research, which has been influential, demonstrated that universities contribute to society not only with commercialization - such as patents and start-up companies - but also by developing repeated

knowledge networks with firms, which is called "academic engagement with industry"<sup>3</sup>.

For specifically industrial PhD students engineering systems industries in Sweden, they have shown the need to think both about direct and immediate impacts as well as more long-term ones:

Industrial PhD students result in specific and more direct impacts on technological development in the form of a doctoral degree, research results such as papers, contributions to technical meetings, and sometimes patents. Very interestingly, we can show that the involved industries also improved their technical capabilities, which in turn improves their innovation capabilities in the long term, says professor Maureen McKelvey.

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<sup>1</sup> Berg, B. and McKelvey, M. (2018). "Exploring How Academic Engagement with Industry Can Influence Firm Innovation". Working paper at Institute of Innovation and Entrepreneurship, University of Gothenburg. Expected to be published in the book Diversity, Innovation and Clusters - Spatial Perspectives" Edward Elgar Publishers, UK.

<sup>2</sup> Berg, K. and McKelvey, M. (2019). "How academic engagement may affect firms' search capabilities for innovation: A micro-level analysis of firm employed PhD students in engineering". DRUID conference. www.druid.dk. Copenhagen. June 19-21, 2019.

<sup>3</sup> Perkmann, P. Tartari, V. McKelvey, M. et al (2013). "Academic engagement and commercialisation: A review of the literature on university-industry relations" Research Policy. 42:2, pp. 423-442.