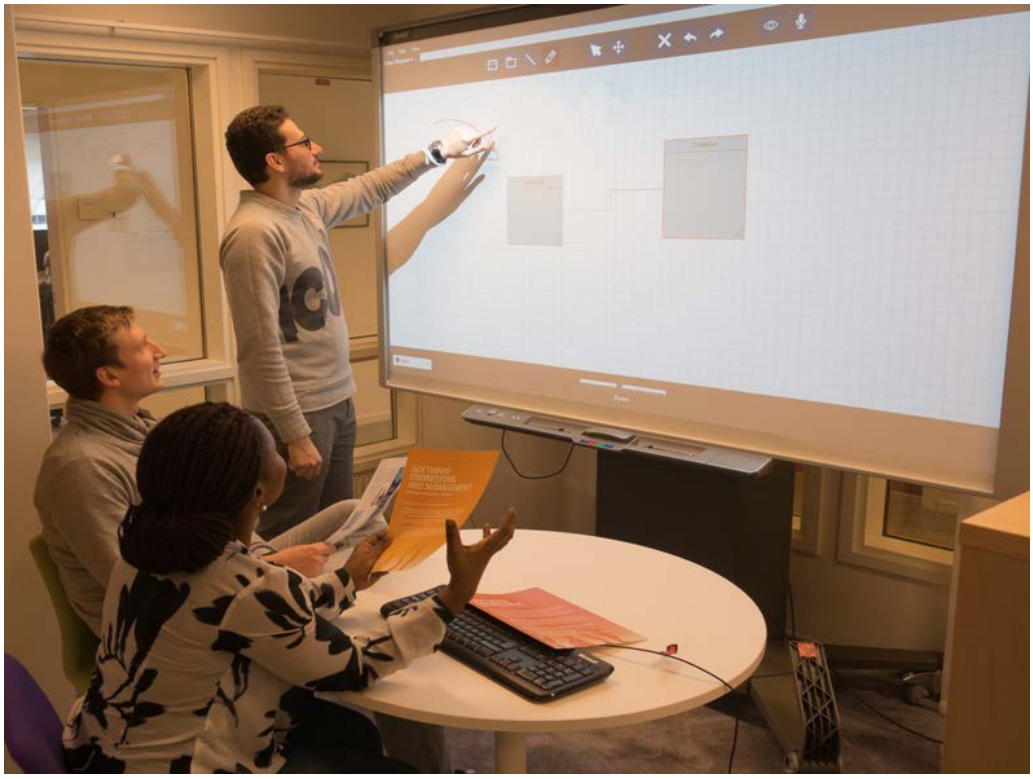
CHALMERS | GÖTEBORGS UNIVERSITET

Universitetskanslersämbetets utvärdering av utbildning på forskarnivå 2017

Självvärdering

Lärosäte: Chalmers och Göteborgs universitet
Forskarutbildningsämne: 10201 Datavetenskap
Licentiatexamen: ja
Doktorsexamen: ja



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1. Aspektområde: område, miljö och resurser

1.1 Aspekt: Forskarutbildningsämne

Bedömningsgrund:
Avgränsningen av forskarutbildningsämnet och dess koppling till den vetenskapliga/ konstnärliga grunden och beprövad erfarenhet är välmotiverad och adekvat. (Forskarutbildningsämnets relation till området för forskarutbildning är adekvat (för de lärosäten som har examensrätt för område för forskarutbildning)).

1.1.1 Computer Science

The Department of Computer Science and Engineering achieves internationally recognised research excellence in a broad spread of topics, ranging from VLSI design and parallel computer architecture, through software technology and empirical software engineering to programming logic and its application to the formalisation of mathematics. Thus, we have good coverage of all of the abstraction levels and a broad range of research methodologies considered in research in Computer Science and Engineering at large.

At our department, the subject Computer Science includes research areas in Algorithms and Optimization, Machine Learning, Programming Logic, Functional Programming, Formal Methods, Information and System Security, and Distributed Computing and Systems. Three important themes that reappear in many of our research groups are logically based methods, programming languages, and practical algorithms. For example, the Information Security group has a strong emphasis on programming language based security, with associated logical program analyses and the Distributed Computing and Systems group has developed a library of non-blocking shared data structures (NOBLE) that bridges the gap between theoretical work (including proofs) on these data structures and their practical use.

Having been created through the merger of the computer engineering and computer science departments, our department has world leading research groups in its historically strong core areas of computer engineering (e.g. parallel computer architecture) and of computer science (e.g. functional programming and programming logic). However, the merged department has also provided an environment in which new research groups in key topics such as software engineering, machine learning, and distributed systems can thrive. As a result, PhD students in computer science not only belong to a strong, specialised research group, but also have access to researchers with expertise in all major areas of computer science. In particular, our research groups in computer science provide good coverage of the Knowledge Areas described in the 2013 ACM Curriculum for Computer Science[1], including those that were newly added to that curriculum in 2013.

Research education is strongly linked to research carried out by senior researchers at the department. PhD students belong to the research group of their main supervisor, and the research group plays a major role in providing a supportive research environment. We strive to break down borders between research groups, and it is not unusual for both senior researchers and PhD students to have a strong link to a second research group. For example, we have students and senior researchers who work on the border between functional programming and language technology, and between information security and formal methods. These students will typically have a co-supervisor from the other research group.

[1] https://www.acm.org/education/CS2013-final-report.pdf

1.1.2 Graduate Studies

PhD students at licentiate and doctoral level are enrolled within the graduate studies in Computer Science and Engineering, which is led by a Vice Head of Department for Graduate Studies, and three Directors of Graduate Studies (hereafter called *the CSE-team*). We have three directors to better meet the needs of the students that are enrolled. Graduate studies in Computer Science and Engineering cover not only computer science, but also computer engineering, software engineering, bioinformatics and language technology. We do not currently distinguish in enrolment between these five topics. Even though it is clear for most of our students to which of these five topics they belong, this is not true for all students, as some work, for instance, on the border between computer science and computer engineering. We have chosen this open design to encourage collaboration between research groups at the department. However, a weakness is that the field becomes broad and challenging to cover for the individual PhD student as well as the individual faculty. We have reflected on this and will review the structure and possibly redesign it to maintain the desired strengths, while addressing the challenge of becoming too broad.

Of the 105 students enrolled at the time of writing, we have selected 52 PhD students (14 national/38 international) in the topic of computer science (48 at Chalmers and four at the University of Gothenburg - table 1a). Seven of these are female PhD students (13.5%), and three are industrially funded. Of the 48 PhD students who took a degree during the period 2012-2016, 44 are male students (table 1b). While the selection could include other students, due to unclear borders between the subjects, we regard this group as an adequate representation of our graduate studies in Computer Science.

1.2 Aspekt: Personal

Bedömningsgrunder:
A. Antalet handledare och lärare och deras sammantagna kompetens är adekvat och står i proportion till utbildningens innehåll och genomförande.

B. Handledarnas och lärarnas sammantagna kompetens och kompetensutveckling följs systematisk upp i syfte att främja hög kvalitet i utbildningen. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

1.2.1 The Department of Computer Science and Engineering

The Department of Computer Science and Engineering is an integrated department between Chalmers and the University of Gothenburg. Employees are affiliated either at Chalmers or the University of Gothenburg, and there are separate research educations with separate general syllabuses (ASP), and separate administrative systems, e.g. for individual study plans. In practice, we are one shared environment. Our policy at the department is that day-to-day activities in teaching and research should not be strongly affected by the different affiliations of employees, and in fact this works very smoothly.

1.2.2 Supervisor Resources

There are 70 supervisors available in Computer Science, 45 listed in Table 2 and 25 listed in Table 3. Of the 70 supervisors, 31 are registered as possible main supervisors, and 39 are available as co-supervisors. Of the 45 active supervisors at the time of writing, 25 are main supervisors, and 20 are co-supervisors. The average number of PhD students per main supervisor is two, the maximum six and the median one. 11 of the 25 active main supervisors are also co-supervisors. Every main supervisor is Docent or Professor; promotion to Docent or Professor demands 15 credits of pedagogical training, including training as a PhD

supervisor, 5 credits at the University of Gothenburg and 3 credits at Chalmers. Eight of the 20 currently active co-supervisors are junior faculty, who thus prepare for a later role as main supervisor; the remainder are Docent or Professor.

More than 70% of our supervisors in the area of computer science have an international background, and a doctorate from outside Sweden. Our international faculty make for a dynamic research environment with strong external influences and contacts, and many visitors. We have long been one of the most international departments at both universities, and this allows us to recruit highly qualified faculty.

Of the 45 active supervisors in Table 2, five are women and 40 men. All five women are registered as main supervisor. Of the 25 additional researchers in Table 3, 24 are men. We are aware of the gender imbalance, and how this is a challenge to the research area at large, both nationally and internationally. This is addressed centrally from both Chalmers and University of Gothenburg in gender mainstreaming work, with a particular focus on recruitment (see Section 8.1).

1.2.3 Supervisor Qualifications

Chalmers has been running a comprehensive project aimed at improving the quality of supervision of PhD students since 2008. Mandatory supervisor development has been introduced for all main supervisors every three years (Chalmers decision C2015-1272). This is done by creating meeting and development platforms for supervisors. Three different types of support activities have been developed: “Supervisor forum” is a meeting place for supervisors to share experiences and support each other, “Coaching supervisor” focuses on the ability lead doctoral students and offers concrete communication tools and training, and “I as (supervisor) leader” focuses on becoming more aware of and lead yourself to obtain feedback on how you are perceived by others, as well as through a personality questionnaire.

These activities are offered to and used by all faculty at the department, independent of their employment at Chalmers or the University of Gothenburg. In addition, University of Gothenburg offer courses in supervision for PhD students.

The above activities are continuously evaluated and further developed. The evaluations provide overall good results and many respondents state that they try out new tools and approaches in their daily work. Examples would be to give and receive feedback, clarify expectations between supervisor and student, use various communication techniques in counselling, test a new method of recruitment of graduate student, or to discuss supervisor issues among the colleagues, to name a few.

All main supervisors have undergone one development activity until 2014 and the overall experience is positive among the participants. The main challenge today is to reach out with information and to get all the supervisors to prioritize participation in these activities in the often pressured work situations. During the years 2009-2014, participation was followed up centrally, but since September 2015, planning and follow up is done through line managers in appraisal meetings.

It is difficult to measure benefits brought by the project. However, the negative results for PhD students in a 2005 survey on harassment have now greatly improved; PhD students are the group least exposed to harassment, according to Chalmers’ employee survey in 2016.

Chalmers encourages excellence in supervision by offering a prize for Research Supervisor of the Year. Andrei Sabelfeld from our Information Security group won this in 2010. Following the award, Prof. Sabelfeld has been asked to speak about supervision and research team management, most recently at the all-Scandinavian ERCEA Summit for ERC Principal Investigators, in Stockholm in 2015. He has also given this talk for our PhD students, and will give it for our faculty this spring.

1.3 Aspekt: Forskarutbildningsmiljö

Bedömningsgrunder:
A. Utbildningen och forskningen/den konstnärliga forskningen vid lärosätet har en sådan kvalitet och omfattning att utbildning på forskarnivå kan bedrivas på en hög vetenskaplig/konstnärlig nivå och med goda utbildningsmässiga förutsättningar i övrigt. Relevant samverkan sker med det omgivande samhället.

B. Forskarutbildningsmiljön följs systematiskt upp för att säkerställa hög kvalitet. Resultatet av uppföljningen omsätts vid behov i kvalitetsutvecklande åtgärder och återkoppling sker till relevanta intressenter.

1.3.1 Quality of research and teaching environment

PhD students in computer science join a research environment staffed by leading researchers. The environment is well resourced, with a high level of external research funding, including several frame grants from The Swedish Research Council and Swedish Foundation for Strategic Research. Our Master's programmes in *Computer Science: Algorithms, Language and Logic* and in *Networks and Systems* attract well qualified local and international students, some of whom go on to become doctoral students. Courses in the programmes are taught by research experts in the topics, and are available to PhD students. Examples of advanced Masters courses taken by doctoral students are *Topics in Advanced Algorithms* and *Language-Based Security*. A new Master's programme in *Applied Data Science* will begin in 2017. The Master's programmes provide breadth and depth not only in the courses that PhD students take, but also in those on which they teach.

Our research groups foster strong links to industry. Volvo Car Corporation, located in Gothenburg, is an important research partner, for example in a recently announced VR Research Environment Grant on *Testing of Cyberphysical Systems*. Recent Research Faculty awards from Google and Facebook show that we also have international industrial collaborations. Several of our faculty work part of their time in start-ups that commercialise their research. This gives new perspectives in research student supervision, as well as opportunities for students to work with industrial problems.

1.3.2 Recruiting PhD Students

The recruitment process for PhD students at Chalmers or the University of Gothenburg is supported by Human Resources (HR) and the Vice Head of Department for research education. Each announcement of a PhD position receives around 40 applicants on average. The majority of our graduate students (49 of 52) are employed in graduate student positions (doktorandanställning). The remaining three students are industrially funded, and employed by the funding company. To attract future PhD students, the CSE-team organizes annual *PhD Mingles*, where interested master students can meet with PhD students and supervisors and listen to talks about graduate studies and life as a PhD student.

1.3.3 Setting up the Supervision for PhD Students

In line with central rules at both universities, each PhD student has a main supervisor, a co-supervisor, and an examiner, who is different from the supervisors. The examiner must be a Professor and must have supervised at least three PhD students to completion. At the University of Gothenburg, the examiner is approved by the Dean of Faculty, and at Chalmers by the Vice Head of Department. The CSE-team maintains a formal list of approved examiners.

1.3.4 Supervising a PhD Student's Research Education

Our supervisors arrange a broad variety of activities with and for their PhD students starting with individual meetings to discuss the status of their current research, publication planning, current and upcoming challenges, and career planning. In addition, individual reading courses are used to deepen a PhD student's knowledge in a particular field.

On a research group's level, the collaboration between the PhD students, PostDocs, and senior researchers is strengthened using weekly research seminars to discuss selected research topics at the forefront of research. This includes discussions about own work, talk rehearsals, and the direction of research in general. Visiting researchers giving talks are announced to a wider audience at our department to engage subsequent discussions.

1.3.5 Broadening and Deepening a PhD Student's Knowledge

PhD students are also advised to participate in courses from neighbouring departments in their education. One example is the course "Transdisciplinary Research Methods", which was developed and conducted between two neighbouring departments to help broaden a PhD student's view of their own research in inter-/cross-disciplinary settings. In addition, PhD courses, offered by senior researchers at the department, as well as courses from other universities and departments, help the PhD students to specialize in their fields.

A broad selection of Generic and Transferable Skills courses[2] are offered, including 15 mandatory credits in all doctoral studies at Chalmers (see sections 2.2.2, 2.3.2, and 3.1). Of these, 3 credits in Research Ethics and Sustainable Development are mandatory for our PhD students at the University of Gothenburg. A course in pedagogical training is mandatory for all our PhD students, and supports them in their teaching activities in courses or as supervisors of bachelor and master theses (see Sections 2.1.2 and 2.2.2).

Supervisors encourage their students to improve skills besides a PhD student's research work, for example improving oral presentation skills in front of a small audience, giving presentations for the general public, diary writing, note-taking, or pre-writing to improve writing skills, and applying for scholarships to practice application-writing and thereby, have some freedom to travel at their own will. This topic is elaborated in detail in Section 2.2.2.

1.3.6 Supporting a PhD Student to Build Academic and Industrial Networks

Academic networks help PhD students to get in touch with more and different academic settings to enrich the own research with methods and equipment that is not easily accessible on-site, or to find potential future collaborations. Industrial networks help students to find relevant and realistic settings to try methods or transfer ideas from theory into practice; such industrial networks also help PhD students to identify potential future employers.

[2] cf. https://student.portal.chalmers.se/doctoralportal/gts/courses/Pages/default.aspx

Our supervisors arrange, for example, tutorial sessions, workshops, or research visits, where speakers and guests were brought in based on the research topics of the PhD students. Chalmers Initiative Seminars are one example for successful outreaching activities, where topics of interest for the network of academic and industrial partners are presented and discussed by also inviting distinguished speakers[3].

Some research groups arrange group retreats, locally and in connection with major conferences to identify talks of interest. These activities are completed with annual division meetings, where groups meet to discuss topics of common interest, and our annual department day, where all colleagues meet to exchange ideas.

Activities at an international level include students' participation in summer and winter schools. Supervisors either let their PhD students travel abroad (for example participating in the renowned Marktoberdorf Summer Schools), or successfully attract funding to arrange summer and winter schools locally[4], see Section 2.1.2.

Conferences help to initiate, deepen, and extend a researcher's academic network. Sometimes, PhD students are even encouraged to participate at the beginning of their graduate studies without having work to present, to help them understand various research trends. Additionally, our research groups are also frequently involved in arranging important conferences. The role of presentation is discussed in greater detail in Section 2.2.2.

Supervisors also organize research visits to sites from their academic network. Some groups have established the tradition to arrange such visits after a Licentiate seminar: "Almost all of my students have done an internship during their PhD studies - at Microsoft Research, Google, IBM Research - This gives excellent experience, leads to publications and new networks, as well as to job offers, which is important in the late stage of PhD studies." Some supervisors also provide active career planning: "In the last years of their PhDs, we have an explicit focus on what would be their 'dream job' after finishing, and we strive to get them to a level where they can get a job they wish." The impact of research visits is discussed in Section 2.2.2.

1.3.7 Systematic Follow-Up on Quality in Graduate Studies

In line with the central rules at Chalmers and at the University of Gothenburg, each PhD student has a follow-up group consisting of the main and co-supervisor, the examiner, and someone from the CSE-team as chairman of the meeting, that systematically follow-up a PhD student's individual research education.

As a minimum, each PhD student shall have one annual follow-up meeting, more frequently if needed. The PhD student provides his or her updated individual study plan (ISP) before the meeting, which forms the basis and agenda at these meetings. We follow up on how supervision is functioning, how teaching or department duties are functioning, completed and planned courses, completed, ongoing and planned publications, planned research visits, and we specifically ask how the work environment is perceived with the aim to identify as early as possible if anything is not functioning well. As a standard format for the meeting, the member of the CSE-team always talks separately with the follow-up group without the PhD

[3] For example, Chalmers Initiative Seminar on BigData (https://goo.gl/uClcnY) or Chalmers Initiative Seminar on Green, Safe, and Efficient Transports (https://goo.gl/HYjZYe).

[4] For example, the DIVA Summer School (cf. https://goo.gl/kpJ8ka)

student, and separately with the PhD student without the follow-up group, to enable confidential communication if needed.

There are jointly developed guidelines[5] between Directors of Doctoral Studies from all doctoral studies at Chalmers that specifically guides what to focus on for year one through four in these meetings to support progression. For example, bring up the planning of the Licentiate seminar well in time during the meeting year one, to provide ample time to plan and prepare. The member from the CSE-team is involved in the discussions regarding suitable discussion leaders for Licentiate seminars, as well as committee members and opponents for the PhD seminars to monitor quality and avoid risk of conflict-of-interests. The CSE-team also strives for gender balance, to the extent feasible in each field, in these roles. Suggested candidates for these roles are approved by the CSE-team at Chalmers, and by the Dean of Faculty at the University of Gothenburg.

When a PhD student wishes to change supervisor, whether due to conflict or by mutual agreement because of changed circumstances, established support and official guidelines are in place (and followed) at both universities. The students can turn to local and central Doctoral student representatives, their head of division, to a member of the CSE-team, or their own follow-up group. More generally speaking, students express a high appreciation for the established support structures. For example, one student said: “When asked by people from the outside, what is specific about doctoral studies here, then I say the support structure, that includes many options where to turn to for different issues.”

Furthermore, the CSE-team organizes monthly lunch meetings to provide a platform where PhD students and the CSE-team can meet in an informal setting to exchange ideas and discuss topics of general interest.

Chalmers monitors the quality of doctoral studies on a four-year cycle of self-evaluations. Our last self-evaluation took place in 2012 (with the 2016 one replaced by this review). While the overall conclusion was that our doctoral studies maintain high quality and have very good completion rates, an important area of improvement was the need to provide more doctoral courses. This has led to the introduction of several new courses, including the Chalmers Tech Talks, and courses on Theorem Proving and on Research Ethics. We have successfully sought new ways to fund doctoral courses, for example through the Area of Advance ICT, which calls for proposals for doctoral courses yearly[6], providing funding of up to 100kSEK. We received such a grant for a course on Formal Hardware Verification given in SP4 2017 by a senior visiting industrial researcher. The current self-evaluation has led to the introduction of a doctoral course in Research Methods in Computer Science.

1.3.8 Systematic Follow-Up on Quality of Work Environment

In an effort to constantly improve quality, we make use of the annual Chalmers-wide employee survey, which allows the responses of doctoral students to be separated from those of other employees. In response to high stress levels in both doctoral students and faculty, we have initiated a project, to run during 2017, aimed at providing comprehensive information

[5] Vägledning för uppföljningssamtal i forskarutbildningen - framtagen genom diskussioner i Studierektorsgruppen augusti 2015 - augusti 2016

[6] http://www.chalmers.se/en/areas-of-advance/ict/news/Pages/Call-for-proposals-of-course-development-support.aspx

about chronic stress, its warning signs and effects. The project, which has strong input from an external expert in stress and organisation culture, aims to analyse our working processes with the intention of reducing stress. It will also develop activities that help individuals to increase their resilience, for example through meditation. There will be a strong emphasis on group activities, and on the development of a more supportive, collegiate environment. We are firmly convinced that this initiative will benefit research students. The initiative will be run in the form of a research project with an evaluation at the end of 2017.

2. Aspektområde: Utformning, genomförande, resultat

2.1 Aspekt: Måluppfyllelse – kunskap och förståelse

Bedömningsgrunder:
A. Utbildningen säkerställer genom utformning, genomförande och examination att doktoranderna, när examen utfärdas, visar bred kunskap och förståelse både inom forskarutbildningsämnet och för vetenskaplig metodik/konstnärliga forskningsmetoder inom forskarutbildningsämnet.

B. Systematisk uppföljning görs av utbildningens utformning och genomförande i syfte att säkerställa måluppfyllelsen. Resultaten av uppföljning omsätts i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

2.1.1 Scientific methodology

The supervisor, with the help of the research group, supports the student in developing mastery of scientific methodology. Follow-up and assessment of this mastery is done by the follow-up group (see Section 2.2.1), the student's individual examiner, and finally by the grading committee of the PhD defence. Writing and publishing papers is central to the training. The process of publishing at high quality venues (producing publishable research results, writing them up, providing sufficient discussion and evidence, discussing methodology and related work) requires the gradual development of knowledge and understanding of the research field and of scientific research methodology. External peer reviewing, as part of the publication process, serves two important purposes. Through their feedback, reviews contribute greatly to competence development. But also, the acceptance decisions at high quality venues (which we guide our students to target) serve as the major, independent quality control for the student's level of knowledge and understanding of the research field at hand. A typical demand from reviewers is to expand on related work discussions, and to make a stronger case for why the contribution advances the state of the art. This leads to a broadening of the student's competence in Computer Science.

However, the one thing external reviewers cannot judge is the individual contribution of the student to a publication with co-authors. A student's competence and skills cannot be judged by only looking at his/her publications. What has to be judged in addition is the level and scope of the individual contributions, and the level of independence in achieving those. Therefore, the progression in individual contributions and in the level of independence is focus topic in the student's follow-up group meetings, where decisions are made about how far a student is from the licentiate or PhD level. This is further described in Section 2.1.3.

Students gain knowledge and understanding of their discipline and its methodologies by taking an active part in the activities of their research group. All of our research groups have seminars, where the PhD students participate. Both senior researchers and PhD students give talks, and ongoing research is discussed. This trains skills and understanding both in the research area and in scientific methodology. Through the talks of others, and discussions, the

students are exposed to examples of research activities, and the discussion thereof. Through their own talks, and the resulting feedback, students train to expose and defend the used scientific methodology, and get feedback on how to develop it further. Often, research visitors play an important role in the discussions at these seminars, because they are seeing the work for the first time, and are not party to what might be implicit assumptions being made inside the research group. This helps doctoral students to broaden their understanding to include more of computer science, and to encompass a greater range of methodologies. Thus, we see our steady flow of active visitors as an important contribution to the quality of the research environment, and of our doctoral studies. Long-term visitors in recent years include Benjamin Pierce, Neil Jones, and Carl Seger. Whether the stay is short or long, we urge the PhD students to discuss their past, ongoing, and future work with visitors, in an organised manner.

Senior doctoral students regularly act as Bachelor's and Master's thesis supervisors, and this further deepens knowledge of scientific methodology. The PhD student acting as supervisor is supported by our guideline documents for thesis structure and assessment, and by the examiner of thesis (who is always a senior person).

2.1.2 Broad knowledge and understanding

Computer Science and Engineering is a large department with good coverage of Computer Science and related areas. We have open research groups and a broad range of courses to take and teach, facilitating the development of broad knowledge and understanding of the field. Doctoral students (and faculty) have access to expertise, seminars, thesis defences and visitors from all across this range. One result is that students can choose from a wide range of masters and doctoral courses, covering much of computer science. In addition, courses can be chosen at neighbouring departments (Signals and Systems, Mathematics etc.). Hence, breadth is easy to achieve given the courses we offer. Apart from local courses, attendance at international summer schools is strongly encouraged, bringing further breadth. Our students typically participate in about two summer schools during their PhD studies.

Our sheer size brings advantages as well as challenges. We have fewer department-wide research-related activities than we would like. An example of a successful initiative, aimed at the whole department, was the Chalmers Tech Talks[7], which also incorporated teaching about scientific writing to form a doctoral course. Encouraging greater communication across division and research group boundaries is a high priority even at the level of the departmental steering group. We have some success stories that have led to joint projects between research groups (e.g. REMU[8], DataBIN[9]), but would like to improve further. We will introduce a new doctoral course on Research Methods in Computer Science, by our senior researchers, which we believe will encourage greater communication across research group boundaries.

External collaborators can bring in specific expertise and experience that is not present in the local context. Collaboration with external researchers broadens and deepens a student's knowledge and understanding of his research area. The ultimate evidence of successful external collaborations is common publications with external co-authors. A recent questionnaire among the 52 active PhD students in Computer Science, which was answered by 23 students, gives evidence for a high involvement in successful external collaborations,

[7] complab.github.io/tech-talks-2015-01/
[8] remu.grammaticalframework.org
[9] https://research.chalmers.se/en/project/6221

with a clear progression over time. Of the students who started within the two years before the questionnaire, 27% have published with an external academic. Of the students who started before that, 67% have published with an external academic, and each student has on average 1.4 externally co-authored publications. (Note that this covers students with *ongoing*, not *finished* PhD studies, where we would have higher numbers.)

Our doctoral students spend 20% of their working time on departmental duties by default. Departmental duties can include tasks like developing software or web pages, but most students spend their 20% on teaching at Bachelors and Masters level; this amounts to assisting on three courses per year. Typically, one or two of those courses are close to the student's own area of research. Teaching in courses unrelated to a student's own research area contributes to a broadening of knowledge and skills in computer science in general. This breadth of knowledge and broad teaching experience must also make our graduating students more employable, both in academia and in industry.

For individual students, the follow-up meeting is one of the main means of systematically ensuring the required breadth of knowledge of the research field and associated scientific methodology. Current and planned teaching and courses are always discussed, and the examiner can, for example, advise on courses that lead to a greater breadth of knowledge. Current and planned publications are also discussed, giving the opportunity to discuss the work and its methodology in a group that includes the examiner and a member of the CSE-team.

One issue that we need to address better in the future is the common understanding, among both students and faculty, of the role of courses in guaranteeing breadth of the education. Students have access to a broad range of courses, but they do not always appreciate this breadth. They may complain that there are too few courses offered in their own sub-area, and that they are therefore ‘forced’ to take courses in other sub-areas of computing. It is unfortunate that this is sometimes perceived as a shortcoming, rather than a feature, of the education. As we know that motivation is a big factor in effective learning, we will address this issue by providing information to new students and to faculty, in discussions in our monthly lunch meetings where all PhD students are invited, and possibly by including a question about breadth in the ISP.

2.1.3 Systematic Follow-Up

A student’s progress in knowledge, understanding, and mastery of scientific methodology is systematically monitored (in addition to the continuous monitoring through the supervisor) by the annual meeting of the follow-up group. The findings of the meeting guide the student and supervisors. The fact that one member of the CSE-team is always present, and always sends a summary of the meeting to the other members, lifts the following-up of these learning outcomes from the individual to the departmental level. The members of the CSE-team meet regularly, discuss the observations and draw conclusions. This results in improved information for students and supervisors, and continuous cross-departmental calibration of which level of knowledge, understanding, and scientific methodology is required for the Licentiate and PhD.

It was mentioned above that the progression in individual contributions and in the level of independence is monitored by the student’s follow-up group. If the group identifies the need for further progress, it formulates guidance and ambitions, to be documented in the ISP. Normally, this process leads to the desired result. But if it does not, and the group does not

see sufficient evidence for a very good level of independence in achieving published contributions, the group does not give the go-ahead for a thesis defence. For example, in a concrete case, a certain student had achieved a good number of publications at good venues, on the surface sufficient for a PhD. But a dialogue with everyone involved in the work showed that the student clearly lacked independence. (The problem had been anticipated in earlier meetings, but the resulting plan had not led to the desired result.) The group did not give the go-ahead for the PhD defence, but instead specified another research task and how it should be carried out independently by the student. This led to the desired result, and a go-ahead for the defence.

The individual follow-up groups (see Section 1.3.8) play a key role in supporting and monitoring the student's progression in knowledge, understanding, and scientific methodology. This issue of how to best monitor progression was discussed in the university wide regular meeting of Directors of graduate studies at Chalmers, and resulted in guidelines[10] that describe how to work to prevent lack of progression, and the role of the Director of graduate studies in such cases. The document contains guidelines for follow-up meetings, which are specific for year 1, 2, 3, and 4. This was a clear improvement over what we had before, as earlier guidelines for follow-up meetings did not distinguish the different years of study. The results of these discussions are equally relevant for students at the University of Gothenburg, and we now have a more uniform way to monitor and guide the progression of students.

2.2 Aspekt: Måluppfyllelse – färdighet och förmåga

Bedömningsgrunder:
A. Utbildningen säkerställer genom utformning, genomförande och examination att doktoranderna, när examen utfärdas, visar förmåga att planera och med adekvata metoder bedriva forskning och andra kvalificerade (konstnärliga) uppgifter inom givna tidsramar samt såväl i nationella som internationella sammanhang muntligt och skriftligt med auktoritet kan presentera och diskutera forskning och forskningsresultat i dialog med vetenskapssamhället och samhället i övrigt. Doktoranderna ska också visa förutsättningar för att såväl inom forskning och utbildning som i andra kvalificerade professionella sammanhang bidra till samhällets utveckling och stödja andras lärande.

B. Systematisk uppföljning görs av utbildningen för att säkerställa att utbildningens utformning och genomförande är av hög kvalitet och att doktoranderna uppnår målen. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

2.2.1 Planning of research: choice of methods and time planning

The student's ability to plan and carry out research using appropriate methods is developed in close collaboration with the supervisors, supported by the follow-up committee and by the activities of the student's research group. Weekly supervision meetings provide training in choosing and evaluating research methods and in research planning, with emphasis on preparing publications. Taking part in a research project also develops skills in evaluating research methods and results, often in a group that contains more researchers than just the supervisors. Research group seminars provide further training, typically covering a variety of research topics from local and visiting researchers. It is important to learn to question choices made in one's own research and those made by others. All of the research groups covered in this review have active research meetings. Research presentations in these meetings, and particularly talks by visitors, are advertised in the weekly newsletter for the whole

[10] Vägledning för uppföljningssamtal i forskarutbildningen. Framtagen genom diskussioner i Studierektorsgruppen augusti 2015 - augusti 2016.

department, which permits students to also attend talks in other research groups. Our ASP specifically states that a part of the education is attendance at seminars and guest lectures that are not necessarily directly related to the student's research topic. We encourage attendance by students at licentiate and PhD defences and this is recorded and followed up in the ISP.

Our research groups, with their international faculty recruited in strong competition, and with a steady stream of international visitors, provide a stimulating environment in which to develop the necessary skills in choosing, presenting and evaluating research methods. However, we note that both students and senior researchers would benefit from greater exposure to and analysis of the research methods of fields of computer science and engineering other than their own. We have identified this as a weakness that needs to be addressed, and as mentioned in section 2.1.2, we will introduce a doctoral course on Research Methods in Computer Science.

Writing and presenting conference papers plays a central role in the work carried out by our doctoral students. Note that conference papers are the most important publications in computer science, with the top conferences typically being much more highly ranked than the top journals. For this reason, all of our research groups publish extensively in top ranked conferences (see section on Research Environment above). Conferences have strict submission deadlines, and writing conference papers teaches the ability to plan research and writing in order to meet these deadlines. Final versions of accepted papers must also be finished to a strict deadline.

Longer term planning of the research is tracked in the ISP and the follow-up meetings. The ISP documents published papers and the research and publication plan for the coming year. Each meeting considers the extent to which the plan has been followed, suggests solutions to problems that may have arisen, and makes and documents a new plan for the coming year (or for PhD defence). The meeting includes a discussion of the research methods chosen and of the results achieved. In particular, the examiner provides important feedback. When problems arise, follow-up meetings are held more frequently than once a year. Working with publications keeps the research planning concrete and sets clear goals for the student. Both the licentiate thesis and the doctoral thesis usually consist of an introduction and a collection of the student's papers. Preparing the thesis also imposes strict deadlines and demands careful planning.

2.2.2 Development of the ability to present research

A major goal for every doctoral student is to develop skill and fluency in scientific writing. The education revolves around gaining writing skills through the production of publications. The supervisor teaches the student about the process of writing a paper by working closely together on the document, and by encouraging the reading and analysis of high quality papers in the field. As the student gains experience in paper planning and in writing, the student is gradually given greater responsibility in the process. The Chalmers Generic and Transferable Skills programme provides a sequence of three courses about different aspects of scientific writing.

Conference submissions in computer science receive detailed, well-argued reviews that provide useful feedback and quality control; they can provide views on the research and the choices made that may differ from those of the supervisors. Senior doctoral students may also get opportunities to themselves contribute to conference reviews being carried out by a

supervisor or a senior colleague, which develops the ability to judge a paper and provide constructive feedback.

Conferences provide a quick and direct way to communicate research results that includes the opportunity to present the work to other researchers, and to discuss its relationship to other work in the field directly with international colleagues. Learning to function well in professional research gatherings is an important part of the doctoral training. Having first trained through presentations to their own research group (or groups), students gradually hone their skills in presenting with fluency and authority for an international, academic audience. There is also a progression in the constellations in which students write papers. We often observe a pattern in which the first papers are written with the supervisor, the next with a larger group, including the co-supervisor, and finally, usually after licentiate and possibly a research visit elsewhere, the student co-authors with colleagues outside the original group. Thus, there should be a clear progression in the level of independence of the student, combined with a broadening of their network, documented in the publications, and this can easily be followed up in the follow-up meetings.

Considering the publications by the PhD students in table 1a, this expected pattern can be seen for most students who have reached the half-way point of their studies. We are pleased to see that many students publish with a wider group than just their supervisors. There are exceptions, of course. Some students do seem to have a strong preference for working alone or only with their supervisors. One way to help these students to develop their network of collaborators would be to offer an incentive of academic credits for a visit to another institution, with extra points given if a joint publication results. We will consider this as part of our departmental research visit programme mentioned earlier.

In line with Chalmers regulations, the PhD students take a licentiate degree before doctorate, so this is considered the norm. An exemption can be made but requires a mid-seminar instead, and the only difference is no printing of a Licentiate thesis. Following the licentiate, the student is expected to be more independent and to take a greater lead in proposing research directions, choosing conference venues for publications and building a research network. This is reflected in the shape of the discussion at the follow-up meeting. Both the examiner and the supervisor will be encouraging the student to take the driving role. All members of the group study and guide the expected changes in the student's role, including the ability to work with a greater variety of co-authors, and the ability to confidently lead the writing of a paper, even with senior co-authors.

In the follow-up meeting after licentiate, the building of the student’s research network becomes an important topic; the question of a longer research visit is raised, with such visits being strongly encouraged. We think that research visits play a very important role in the development of independence in the students. As an example, one of our students in Functional Programming spent an internship at Intel in the US. This led to a continued collaboration with a member of the group at Intel, who has since moved to be an associate professor in academia. In fact, the student became a postdoc with that professor after graduation, and continues to co-author with him after returning to Sweden. So the internship played a vital role in the building of this student’s international network. Research visits permit students to practice their skills in communicating about their research.

To encourage these visits, the department has provided central funds and a lightweight application process to allow doctoral students to make research visits of up to three months.

The aim is to encourage every student to make at least one research visit during their doctoral studies, without having to rely on the availability of suitable funding within their own research group. A pilot project was run during 2016, supporting one female and one male graduate student for visits, and the new support for visits will run for 2017 and be evaluated at the end of 2017. We note that we should be careful to monitor hindrances to visits. Is it easier for male students to travel? Are parents of young children less willing to travel?

In the computer science area, the department also welcomes visiting graduate students from other institutions. In Denmark, for instance, PhD students are required to make a longer visit abroad during their studies, which has led to productive visits by students from Copenhagen University (DIKU). Similarly, graduate students at elite institutions in France (such as ENS Paris) are required to conduct internships abroad, and this has given us the opportunity to host visiting students. These visits enrich our research environment, and help students and senior researchers to make new international contacts. Hosting international students also makes it easier to arrange international visits by our students.

Top conferences and workshops in computer science often provide videos of presentations permanently afterwards, so there is strong pressure to prepare professional presentations (see for example a presentation by one of our PhD students at the Haskell symposium last September, already with over 1250 views on YouTube[11]). These videos provide a way to bring a student's research to a broader audience, including advanced developers or programmers who are not academics, and often the number of views greatly exceeds the typical number of downloads of academic papers. Thus, this becomes part of the student's interaction with society as a whole, and careful preparation and feedback during practice presentations at the research group's meeting become even more important.

The teaching carried out by doctoral students develops their ability to explain and present with authority technical concepts and also research results at various levels of detail. Almost all courses on which the doctoral students covered by this report work as teaching assistants include exercise classes; these involve presenting problems for and discussing solutions with undergraduate and masters students, and provide excellent experience of teaching through dialogue. When teaching, doctoral students are exposed to undergraduate and master students with varying levels of competence in and interest for the subject being taught. In some courses, the students are from other disciplines than computer science (for example Physics or Mechanical Engineering), and this places additional demands on teaching assistants, honing their ability to communicate well with many different types of people.

In addition to the above 'learning by doing' driven development of teaching skills, each student is required to take a dedicated course on teaching. This course is either "Teaching and Learning in Higher Education 1" (5 credits) for PhD students at the University of Gothenburg, or "Teaching, Learning and Evaluation" (3 credits) for PhD students at Chalmers. Both courses develop teaching skills and the understanding of the principles and practice of effective teaching in higher education, covering lectures, labs, tutorials and projects.

Popular scientific presentations and papers are important ways to build links to the surrounding world, and to train students to become effective communicators, even outside academia. For PhD students at Chalmers, it is mandatory to do one popular science

[11] https://www.youtube.com/watch?v=gQmDeq9eyF8&feature=youtu.be

presentation, and for PhD students at the University of Gothenburg, this is strongly encouraged. Students must present their research work to an interested public that lacks deep knowledge of the area, for example at the Gothenburg science festival. Presenting one's research to the general public requires one to reflect on, and discuss, the overall potential and limitations of the research field and contribution, from a societal perspective. Afterwards, the student has to hand in written reflections on the presentation. The main assessment criterion is the capability of presenting one's own research, its context, purpose and findings, to a non-expert public in an accessible way. Workshops are available for students to help with preparation of the presentation and to follow up the result.

2.2.3 Contribution to the development of society

The majority of our doctoral students are initially employed on externally funded projects, with The Swedish Research Council, Swedish Foundation for Strategic Research, and the EU being the main funding agencies in the computer science area. Should project funding end after three or four years, faculty funding is used to fund the student, but typically the research will continue to be related to the initial project. Being part of and funded by a project provides a context for the research, and often also contacts with researchers and practitioners in academia and in industry, both locally and internationally. The project typically aims to contribute to the solution of societal problems (such as the security of personal data) and this link to the surrounding world is important in making the research meaningful for doctoral students and in giving them experience and training in research that contributes to society.

2.2.4 Systematic Follow-Up

For the individual student, the ISP and follow-up meeting cover all of the skills discussed in section 2.2, including research planning, choice of adequate methods, oral and written presentation, research visits, courses taken and taught, level of independence and progression in collaborations and publications.

The CSE-team member chairing the meeting always meets the student alone afterwards, so that problems with supervision or with other aspects of the education can be brought up.

The fact that different the CSE-team members may chair the follow-up meetings of a student is deliberate; it spreads knowledge of the research in the department and of good supervision practices among the team, and it improves our contacts with both faculty and students, giving us a better overview. Good supervision practices can be turned into guidelines. For example, we note that some groups systematically train students in paper reviewing, giving academic credits for it, while others do not. This practice will be encouraged by adding a question about it to the ISP. The results of each meeting are shared among the CSE-team, again spreading knowledge among the team, and allowing us to identify common problems early. In recent months, and doubtless influenced by this self-evaluation, we have noted a greater need to communicate information about the doctoral studies to the faculty as a whole (national learning goals including requirement on breadth, rules at Chalmers and the University of Gothenburg, available doctoral courses at the department and in other departments) and to ask the faculty for input, for example about perceived needs for new doctoral courses. A faculty meeting devoted to doctoral studies is therefore planned for May 2017.

The internal organisation that assigns teaching to doctoral students is systematic and well-functioning, with three directors of undergraduate education assigning and following up all teaching for the entire department. Feedback from the doctoral students indicates that they

appreciate the fact that the amount of teaching for each student is well defined, and typically the same (20%) for all students.

2.3 Aspekt: Måluppfyllelse – värderingsförmåga och förhållningssätt

Bedömningsgrunder:
A. Utbildningen säkerställer genom utformning, genomförande och examination att doktoranderna, när examen utfärdas ska visa intellektuell självständighet, (konstnärlig integritet), och vetenskaplig redlighet/forskningsmässig redlighet samt förmåga att göra forskningsetiska bedömningar. Doktoranden ska också ha nått fördjupad insikt om vetenskapens/konstens möjligheter och begränsningar, dess roll i samhället och människors ansvar för hur den används.

B. Systematisk uppföljning görs av utbildningen för att säkerställa att utbildningens utformning och genomförande är av hög kvalitet och att doktoranderna uppnår målen. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

2.3.1 Intellectual Independence

By the end of the PhD studies, a student should show independence in structuring a goal into subgoals, in choosing methods, in performing the identified steps, in evaluating and publishing the results. Those aspects of independence belong to the previous section (2.2). See the appearances of 'självständig' in Higher Education Ordinance under 'färdigheter och förmåga'.[12] *Intellectual* independence, however, is more than the above. It includes the ability to question what is given to you, by authorities of your context, to form your own judgement, defend it, and act accordingly.

> *"To employ one's own reason means simply to ask oneself, whenever one is urged to accept something, whether one finds it possible to transform the reason for accepting it, or the rule which follows from what is accepted, into a universal principle governing the use of one's reason." [Immanuel Kant]*

In the context of research, intellectual independence includes questioning the goals that are set by a specific context, questioning the research methods and lines of argument common in some (sub-)community and context, and judging the overall - positive and negative - impact of the contributions. Achieving such a high level of independence to a full extent can be seen as a lifetime goal for a researcher, rather than the immediate outcome of a five years education. However, by exposing students to - and making them *participate* in - an open discourse on the right goals, the right methods, and (un)desirable impacts, in both local and international contexts, lets them develop a good level of intellectual independence.

2.3.2 Progression

We achieve this by a progression in the level of discourse participation. It starts with the - in the beginning passive - exposure to discussions and discourse in the student's own research group, where the seniors regularly question each other's viewpoints, constructively and critically. The highly international recruitment of seniors to our department leads diverse research groups, whose members like to challenge each other's implicit assumptions or (suspected) scientific 'folklore'. Gradually, the students take a more active part in this, meeting an increasing demand to defend their own approach. The next level is exposure to and participation in scientific debate in the broader context of international workshops (at first) and conferences (thereafter). The focus on conference publications leads to the

[12] "... visa förmåga att [...] självständigt [...] identifiera och formulera [...] planera och [...] bedriva forskning"

recurring task for students to defend all aspects of their work in scientifically diverse contexts, not only in writing, where the co-authors can potentially step in, but also orally, in conference talks where they are on their own. (To facilitate these opportunities, PhD students normally deliver the talks about articles they co-author.)

Research visits to other institutions or to industry expose PhD students to new ideas. A recent questionnaire among the 52 active PhD students in Computer Science, which was answered by 23 students, showed that 48% visited another institution or company, for at least a week. This average covers all students, including those who started recently. Students who started more than two years ago made 1.5 such visits on average. Being placed outside one's scientific comfort zone demands and trains the ability to debate, question, defend, and reform one's own judgement of assumptions, goals, methods, and impacts.

This progression culminates in Licentiate and PhD theses and defences, where the assessment of the ability to defend your own standpoint is more pronounced. Already the participation in fellow students' defences - which we encourage and follow up on in the individual study plan - raises awareness for, and shows examples of, the ability to defend not only the how, but also the why and what-for, of one's own goals and approach. Then, when a student approaching his/her own licentiate and PhD graduation, the locally typical model of cumulative theses dictates a great emphasis on the thesis introduction. In that process, the supervisor and examiner together encourage, facilitate, demand, and assess the student's ability to critically question his/her own goal, approach, and contribution (to a greater extent in the PhD). The defence itself is then the student's ultimate demonstration of these abilities, again, to a degree that can be expected after five years of research education.

At the same time, we should note that the final skill assessment is not entirely done during and after the defence. The culture at our department, and probably in Sweden in general, aims at proactively avoiding that a student fails the examination at the day of the defence. Rather, the process which leads to it has to embrace the quality control which can spot differences between the learning outcomes and the skill profile of the candidate, before a defence is fully set up, plan and implement countermeasures, and if necessary delay the final defence (see example in Section 2.1.3).

When it comes to the ability to make judgements of ethical kind, this is at first supported in the process of individual supervision and in research group discussions. More systematically, however, these specific learning outcomes are achieved through the Generic and Transferable Skills courses, which specifically target ethical, societal, and sustainability issues. Our PhD students at Chalmers have to take one of the below courses. Our students at the University of Gothenburg, the second of the below courses is mandatory.

- Sustainable Development: Values, Technology in Society, and the Researcher (3 credits). Through this course, students acquire a thorough understanding of sustainable development, its ethical underpinnings and possible interpretations, stimulating them to reflect on their own view of sustainability and what role and responsibility we as researchers have for sustainable development.
- Research Ethics and Sustainable Development (3 credits). The course enables students to explain the meaning and relevance of ethics and sustainable development, including in research. They learn to describe potential ethical and sustainability consequences of their own research, and apply a framework for analysing and dealing with ethical dilemmas and issues in sustainable development.

The course *Career Planning - Your Personal Leadership* (1,5 credits) focuses on the individual's *independent* perspective, and so contributes to the development and examination of intellectual independence. The course is compulsory for PhD students at Chalmers.

2.3.3 Systematic Follow-Up

All PhD courses on Generic and Transferable Skills (GTS) are evaluated, both with the help of web-questionnaires, where all students can respond, and with help of discussions with student representatives. In particular, this is true for the courses covering sustainability and research ethics. It looks like the high relevance of the research ethics part may be more immediate to many students. Sustainability, however, is not always perceived as an important part of their education by the students. Therefore, finding the right forms of education for this topic is particularly important, such that this element of the education feels relevant and interesting. The course evaluations have in the past greatly contributed to that, improving on the forms, structure, and examples used in the teaching. In a recent discussion in the local PhD forum, one student expressed that “you get out from the GTS courses what you put in”, meaning that the student’s willingness to take advantage of the courses greatly influences the learning effectiveness. Also, it was expressed that the interaction with students from mixed fields in the Generic and Transferable Skill courses is appreciated in particular.

Earlier discussions with PhD students revealed a demand for education on ethics and intellectual independence that is more specific to our field. This was addressed by creating a new course *Ethics and Philosophy of Computing*, which trains the capability of critically reflecting on ethical and philosophical aspects and consequences of research in computing, with a focus on the impacts of Information and Communication Technology on contemporary society. The course was given during 2015, and was very well received by the PhD students. A 2016 iteration did not materialise, as the teacher was overloaded by other duties. We will strive to continue giving the course, as this was an excellent initiative from a young faculty member.

3. Arbetslivets perspektiv

Bedömningsgrunder:
A. Utbildningen är användbar och förbereder doktorander för ett föränderligt arbetsliv, såväl inom som utom akademien.

B. Utbildningens utformning och genomförande följs systematisk upp för att säkerställa att den är användbar och förbereder för arbetslivet. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

3.1 Content and design

Doctoral studies aims to prepare and support young researchers' employability and their future career development. To meet the demands at the international research arena and labour market for researchers, Chalmers have developed and integrated a large number of courses that support the development of personal and professional skills in accordance with guidelines within the European Commission for an innovative doctoral training. These courses are also available to our PhD students at University of Gothenburg.

These courses are packaged as Generic and Transferable Skills and address development of professional skills for teaching (see Section 2.2.2), ethics and sustainability (see Section 2.3.2), and in particular, in personal leadership. Chalmers students are required to take the

course “Career Planning - Your Personal Leadership (1,5 credits)”. The course helps the students to develop their competence, personal qualities, and skills to support their career planning.

An estimation is that approximately 60-70 % of the students get employment in industry after graduation, and 30-40 % in academia. In many cases, students conduct their research in collaboration with industry partners. It means they are trained to work in projects, take responsibility, meet deadlines and provide supervision. After graduation, it is often relatively easy to get employment in industry, which is a testament to the quality of the doctoral studies at Chalmers and the University of Gothenburg. From a gender perspective, we cannot see that there is any difference between the groups getting employed in industry vs. academia.

Some companies have set up industrial PhD programmes (e.g. Volvo Car Corporation, who employ one of the three industrial PhD students covered here). For the individual student, doctoral studies often lead to a continued career within the company. Other companies have no organised industrial PhD programmes, but can finance individual PhD students.

For graduate students who are focused on an academic career, the entire education can be said to be preparing for that. For these students, the possibility to visit other universities or research sites is essential, because it provides preparation for a post-doctoral stay at another location (which is often the target for the student). The research group’s network plays a significant role in this. The new financial support at the department level is a way to ensure that each student gets a chance for at least one such visit. Doctoral students at our department have also had the possibility to take part in workshops about grant proposal writing, concentrating particularly on how to write proposals to The Swedish Research Council. The most recent workshop was held in 2014 for the entire department. Although most participants were faculty members, some doctoral students took part. For example, one student applied for an International Postdoc grant. He got good reviews but was not funded; however, he was able to take up the postdoc position at Indiana University in any case. Learning how to write a convincing grant proposal is useful for any doctoral student, even those who do not intend to become academics. We should consider offering credits to students who take part in such grant proposal writing workshops.

4. Doktoranders perspektiv

Bedömningsgrunder:
A. Utbildningen verkar för att doktoranderna tar en aktiv del i arbetet med att utveckla utbildningen och lärprocesser.

B. Utbildningen följs systematiskt upp för att säkerställa att doktorandinflytandet används i kvalitetssäkring och utveckling av utbildningen. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

4.1 Doctoral students in the preparation and decision processes

At university level, PhD students participate in several ways in preparation and decision-making and take an active part in efforts to develop and assure the quality of education. An example is that Doctoral Student Guild (DS) annually elects representatives to the universities’ various decision-making bodies at the central level (e.g. University Board, Doctoral Programmes Committee (FUN), Committee for Working Environment and Equality, and the Committee for Ethics and Misconduct). From 2017 at Chalmers DS is also

represented in a new group that prepares FUN meetings (FUN beredningsteam). Through individual meetings with Vice president of research education, DS has ample opportunities to directly raise important questions.

DS representation contributes to a close collaboration between students and management that allows for early identification of graduate students' perspective and to connect graduate education decision-making and change management. At the same time, it is crucial that the representatives have the opportunity to make their voices heard during the meetings. This is done for example by DS has its own standing item on the agenda at FUN meetings at Chalmers. Examples of questions raised by DS centrally at Chalmers that have led to a change are: the decision that new students as a rule are employed in PhD student positions (doktorandanställningar), simplified access for students to Ladok, clarified PhD student perspective in the employee survey, and the development of a web based PhD student portal.

4.2 Doctoral students in quality assurance and development of education

PhD students' representation in FUN, local committees, and course evaluations are all ways to gather views and feedback on course content and learning processes, which is used for continuous improvement. Specific PhD student polls are used to capture students' feedback, and compiled results form an important part of the overall assessment process. The evaluation concludes with action lists and activities that are communicated to FUN, DS and our management team for doctoral studies.

4.3 Doctoral students and work on physical and psychosocial work environment

Work environment includes components such as access to occupational health services, annual performance reviews, annual employee survey, and indicative information on the intranet. The annual appraisal meetings are conducted with the line manager, and the annual follow-up meetings are conducted with the follow-up group and a member of the CSE-team.

At the initiative of DS and with their help, the annual employee survey has developed a strong PhD student perspective, and this work will continue. DS is represented in the Work and Gender Equality Committee, and also arranges other activities that aim to improve the work environment. Introductions for new PhD students at Chalmers, at the University of Gothenburg, and at the department also consider work environment issues. Some students feel that there are too many introductory events, while others participate in the activities late in their education. It would be a good idea to reconsider the design of the entire set of introductory events for doctoral students at both universities.

The Doctoral students' representative (DOMB) is employed directly by the DS Board of Doctoral Students, and so is independent and neutral. DOMB provides support and advice with strict confidentiality, and helps with contacts to union organisations. On request from the PhD students, DOMB puts forward cases to the Vice president of research education, writes reports and proposes measures. The requirement of confidentiality makes it however difficult to learn from these cases since experience can only be discussed at a global level to avoid that identity is disclosed. Periodically, DOMB has had a heavy workload, which resulted in waiting time. While it is gratifying that those who need support increasingly know where to turn, the employee survey showed that not all students were aware of DOMB, in particular at departments that lack local PhD councils. Therefore, DS works to spread information about this.

At our department, we are reviving the local PhD council during the spring of 2017 (having lost representation and activity during 2016). The council helps to identify and discuss issues, disseminate information and ensure that graduate students are represented in the right context. It also forms an important link between students and department management.

We are in the process of re-initiating a research education committee with representatives from PhD students, supervisors, and examiners, together with the CSE-team, with formal meetings one or two times per semester, to complement the informal monthly meetings between all PhD students and the CSE-team that started in November 2016. Our aim is to increase involvement, support social aspects, improve our work environment, and raise quality.

5. Jämställdhetsperspektiv

Bedömningsgrunder:
A. Ett jämställdhetsperspektiv är integrerat i utbildningens utformning och genomförande.

B. Systematisk uppföljning görs för att säkerställa att utbildningens utformning och genomförande främjar jämställdhet. Resultaten av uppföljning omsätts vid behov i åtgärder för kvalitetsutveckling och återkoppling sker till relevanta intressenter.

5.1 Gender equality

The recruitment base for the doctoral studies has a gender imbalance and this pattern continues from the graduate student group to the supervisor level, without noticeably deteriorating further. Thesis topics do not have gender patterns or gender-marked areas.

According to the annual employee survey, PhD students' perception of equality is slightly lower compared to other employees at Chalmers as a whole, with quite a big difference between men and women. Women are more negative. The quantitative inequality can be a factor to this. At the same time, a larger proportion of graduate students would recommend someone they know to work at the department than the average for Chalmers. For supervisors it is not possible to get gender-disaggregated data from the survey, due to too few female employees and the risk of revealing identities.

Regarding qualitative aspects of gender equality, there is awareness that certain environments and contexts reproduce stereotypical notions of gender. This issue will be part of the change process that has started within the framework of gender mainstreaming. The work with gender mainstreaming, which is initiated at the department level, also means that the graduate education will participate in various surveys and analyses to develop the internal environment from a gender perspective.

Gender mainstreaming work will have been implemented at the two universities in 2019. For example, this will bring the gender perspective to questions about the distribution of departmental work and the opportunity to participate in conferences. A particular focus is on recruitment. Active work to attract a diverse group of applicants is expected, and where this fails, posts will be re-advertised. This is part of our aspirations to achieve recruitment targets that have been set, both internally and by the state.

An annual employee survey evaluates the psychosocial and physical work environment. The result can be divided by gender and type of employment. PhD students are asked how they feel that supervision works and whether they have the resources they need to carry out their studies successfully. There are also questions about gender and equality. Results cannot be viewed separately for the group of PhD students in the topic computer science, but concern the entire group of PhD students at Computer Science and Engineering. However, the survey records information about division membership. This has been useful to identify issues with higher levels of stress among graduate students within divisions, and work on improving the situation is in progress.

It is mainly the employee survey, appraisal meetings with line managers, and follow-up meeting that serve as systematic tools to identify problems, act, and follow up to see that measures taken have been effective. In general, equality is perceived to be good at Chalmers and PhD students are slightly above the average compared to other employees. Male students are slightly more satisfied than female. Those who say that they are less satisfied with equality, specify gender aspects as the main reason. Lower satisfaction with equality can often be related to the gender-unbalanced nature of the environment. To get in-depth knowledge about the situation of students in gender-unbalanced environments, interviews were conducted in 2016 with a selection of graduate students and their supervisors at four departments at Chalmers. The study identified a number of areas where changes will be implemented to improve the PhD students' work, inter alia, that for students, regardless of gender, it was important to find ways to manage stress and develop an academic identity.