

OFF CAMPUS INTEGRATING THEORY AND PRACTICE WITH PROGRESSION

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ABSTRACT

In this paper, an enhanced integration of theory and practice through progressive contact with the industry, developed at the School of Engineering, is discussed. The contact between bachelor's students and industrial partners during the initial stage of education is in the form of company visits and guest lectures. This contact is gradually expanded through a trade fair at campus, followed by a special course named *Off Campus Integrating Theory and Practice, OITP*. In this course, students spend seven weeks, individually, or in pairs, at a company and are allocated a supervisor by the company. The purpose is to explicitly integrate theory with practice, keeping the study programme more reality-based. Many of the students may also do their thesis in a project together with the same company. When a student chooses to study at master's level, it is an engineer who will participate in *OITP 2*, the advanced level of the course. Therefore, at this level, it is possible for the student to perform more advanced tasks at the company. The final moment after almost five years of collaboration with the industrial partner, is the thesis for the master's degree. Furthermore, each teacher makes individual visits to at least one industrial partner every semester in order to keep abreast of developments and find appropriate examples of projects using current technology related to teaching. The expected outcome from the course is discussed from three perspectives in this paper; the student, the industry and the faculty perspective. For example, the student gets an opportunity to integrate theory and practice, the company gets an opportunity to follow and hopefully also later employ a student familiar with their concept, and among the benefits to the faculty are pedagogic advantages. Expected challenges and solutions have been identified and are also discussed.

KEYWORDS

Off campus practice, industrial relevance, theory into practice, concept of engineering education, company partner, internship

SCHOOL OF ENGINEERING AT JÖNKÖPING UNIVERSITY, SWEDEN

The School of Engineering, the encircled building in Figure 1, is one of four schools, or faculties, that constitute Jönköping University. The other three are specialized in health, business and education. The School of Engineering conducts research and offers education on bachelor's, master's and doctoral's levels – which encompasses a total of 2500 students.

INTRODUCTION

The School of Engineering has for the last 15 years been well known in Sweden for having an extensive collaboration with the industry (in this paper defined as business communities, organizations, authorities and companies). This collaboration has resulted in a high number of students applying to the school and the school being regarded as a “national model” for this kind of collaboration. In addition to the teachers' common network with the industry, the collaboration so far consists of:

- The course Engineering Methodology, 7.5 credits (the equivalent to 5 weeks of full-time studies) at the BSc level is a course where each student group (2-3 students) visits a tutor at a host company 4-5 times during one year.
- The thesis at the bachelor's level (15 credits, i.e. equal to 10 weeks full-time study) is always in collaboration with external partners.
- Master thesis (30 credits, i.e. equal to 20 weeks full-time study) are mostly individual and usually with external partners.
- For more than five years, there has been a management team associated with each degree programme at the School of Engineering. The management team consists of representatives from the industry, the faculty and the students.

The above described system has worked out quite well, but there are opportunities for improvement:

- Students experience the visits to the host companies too short and insubstantial.
- Master's students have in some cases no contact with any industries before their thesis work.
- The industry requests closer collaboration.
- Only some of the staff is actually in contact with the collaborating industry at present.

The need for an increased collaboration between the industry and faculty to integrate theory and practice can be expressed in different ways. Below are two comments, one from a prospective student and one from possible employers:

Hanna Carlsson, who just finished high school, said in an interview published in Ny Teknik, a Swedish journal for engineers: *"Everyone says, study engineering, then you can work with anything. But what you actually do when you work with that **anything** is hard to understand."* Hanna does an internship with a large government supported project in Sweden, The Technology Leap (Tekniksprånget), aimed at young people who are indecisive about future studies [1].

Teknikföretagen (an employers' association in the Engineering Industry in Sweden) recently wrote in their policy: Universities should *"provide courses with content consistent with the needs of today and the future"* [2]. This is not only discussed in Sweden. Already 1998, Denise Denton pointed out that in the U.S., enhanced collaboration with the industry will be important in Engineering Education for the 21st Century [3].

To remain an attractive choice for both students and the surrounding industry, a project was initiated during the spring of 2011. The goal was to suggest a new concept of engineering education at the School of Engineering, including all of the study programmes [4]. In December 2011, a decision was made regarding the new concept. This concept was developed with the CDIO standards 4, 8 and 9 in mind [5], and involves all aspects of teaching, such as

- How disciplines outside the field of technology should be integrated into teaching.
- How students should become aware of the "anything" that Hanna mentioned, i.e. what engineers actually do and how students become successful in their coming profession.
- Being up-to-date in terms of technology.

A very important part of the new concept is enhanced industrial collaboration. Some main features of the concepts are:

- The concept involves all programmes starting autumn 2013 regardless of education level. This concerns 750 students per year.
- Support areas for technology; accounting, project management, reporting, sustainable development, etc. will be communicated to the students through basic study modules as distinct parts of courses as well as integrated into engineering courses.
- Teaching staff visit at least one company each semester. The aim is that each teacher will expand his/her network and thereby keep themselves updated with industrial sector developments.
- Overall goals for all programmes is that students immediately after graduation should be a qualified employee whether it's a bachelor's or a master's degree that the employer is recruiting.

In order for the students to experience a natural and understandable transition from being a freshman student to becoming an engineer, requires a thoughtful progression of industrial collaboration throughout the programme.

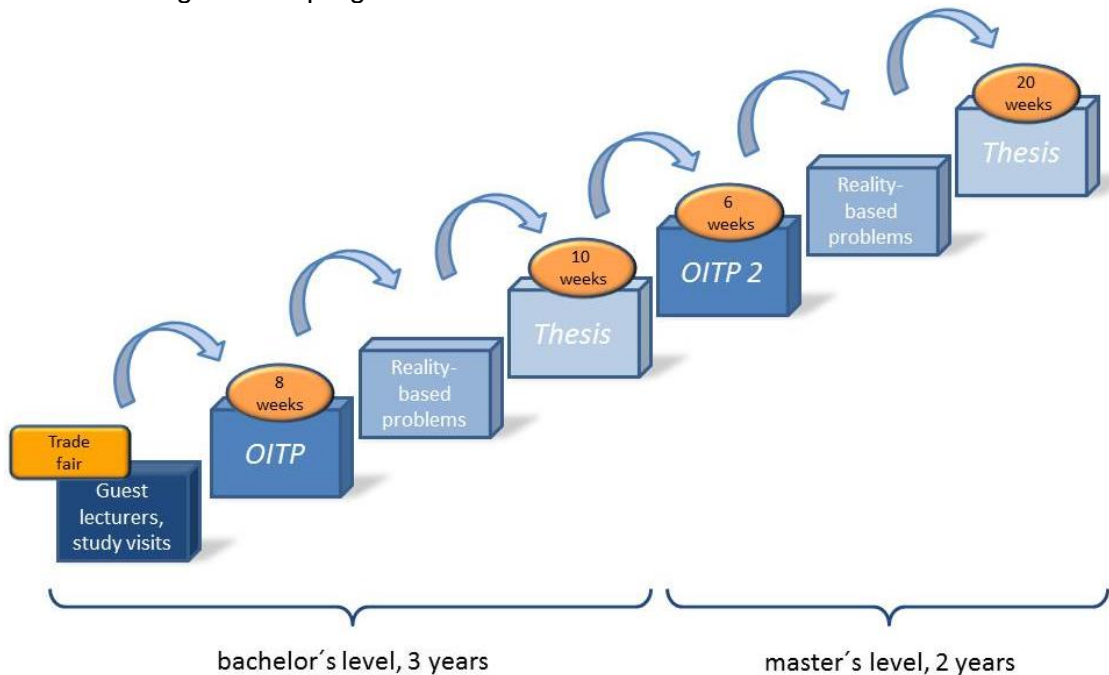


Figure 2. Progression of industrial collaboration throughout the programmes.

The progression for collaboration with the industry at bachelor's and master's levels is shown in Figure 2, previous page. On bachelor's level the following steps are identified:

- Guest speakers, company visits and reality-based cases in class.
- Trade fair on campus where 80-100 representatives from host companies demonstrate products, describe their company activities and needs, discuss *Off Campus Integrating Theory and Practice, OITP* and offer ideas for future theses.
- The course *OITP* which is given during the second half of the programme, where students spend seven weeks at a host company, described in the next section.
- Project-based courses where students work in groups with reality-linked, or real, problems.
- Thesis work for an external partner during half a semester, which is followed by a fair, when the industry visits the School of Engineering [6].

The progression continues for those who study for a master's degree. The host company will now meet a complete engineer when the master student is studying the off campus course. The thesis work at this level stretches over one semester. The course "*Off Campus Integrating theory and practice*" *OITP* is an important part of the new concept of engineering education.

DESCRIPTION OF THE COURSE "OFF CAMPUS INTEGRATING THEORY AND PRACTICE"

The course *OITP* involves more extensive and deeper interaction with the industry. The course is part of the contact with the industry that the students have during their 3rd or 4th semester of the programme. Figure 2 shows the positions of the course in the whole context, including both bachelor's and master's level, and how they strengthen the progression of company contact. When a student chooses continued studies on the master's level, it is an engineer who comes to implement the practical part of *OITP 2*, thus increasing the ability to perform more advanced tasks.

Implementation in three parts

The course essentially consists of three parts, an introductory, a company, and a final part where the students present their experiences in a written report and orally at a seminar.

Before the course starts, the student is responsible for contacting and applying to appropriate companies and to perform in a timely manner in order to execute the company part of *OITP*. Available assisting tools are e.g. an introduction given early in the programme, a trade fair and a company database on the faculty webpages.

Two parts of the course are campus-based, the first and the last. An introduction will be given in the beginning of the course, spanning lectures about topics such as corporate culture, privacy, trademark creation and how to act as a student ambassador as preparation for the industrial part of the course. This kind of preparation has been found to be valuable [7]. Guest speakers from the host companies are involved in the introduction. In the final part of the course, the student discuss in a written report the links between previous courses and experiences from the internship. The student must also relate to the learning outcomes for the course. The company part of the *OITP* can be performed individually or in pairs. The external partner decides the number of students who can work together.

The most important part of the course is the time at the chosen company and the tasks the students perform, at least 70% of the course will be done at the external partner as a full time work. On bachelor's level this means about 6 weeks at the company. During the internship, students individually writes daily logs containing commentary on completed tasks and personal reflections. The supervisor comments the student's work and signs the log every week, and thereby also documents attendance.

Within one week after the company part, the log will be provided to the contact person on campus who will include it in the examination. Students are expected to have daily contact with the supervisor of the co-operating company. The practical part of the *OITP* is normally performed during the study period when the course is scheduled. However, it can also be carried out during the summer if that is suitable for the company. The tasks must be linked to the courses the student previously studied within the programme, in order to connect theory with practical exercises. The work can be of different nature depending on the company and its size. A few examples:

- The student follows and contributes with knowledge in an ongoing project.
- Study of the ongoing production process related to previously completed courses.
- Try several different practical operations relevant for the education.
- The student contributes with competence development at the host company based on past courses and experiences.

When *OITP 2* is conducted in the master's level there are higher demands on the tasks the student is supposed to work with at the company.

Examination

The course ends with a final seminar during which students present their experiences. This also provides an opportunity for discussion and comparison between experiences from various companies. The industrial part described in a written report, the oral presentation, active participation in the seminar and the log are the main criteria for assessing the course work.

Syllabus framework

The syllabus for the *OITP* course has a common framework and an extension that is associated with the main field of study. Examples below are from the framework of bachelor's level. On completion of the course, the student shall

- demonstrate knowledge of the different relationships between the experience of the practical work and the earlier acquired theoretical knowledge
- demonstrate ability to describe, analyze and document the practical work
- demonstrate ability to reflect on their need for knowledge and skills based on the experiences at the client

The common framework for *OITP 2* for master's level has more advanced requirements on students' work.

EXPECTED OUTCOME

There are several reasons to give a more practical course such as the *OITP*. Firstly, the course itself is important to fortify how theory can be applied to practical work, and thereby relevant to the industry. Secondly, the course is a key part in the increasing contact between the student and industry, established in the planned progression. The expected outcome from the course, as well as the whole progression, can be discussed from three different perspectives; the student, the industry, and the faculty perspectives. It is interesting to notice that there is something to gain for all partners involved.

Student Perspective

The main target for the course, and also the reason why it is developed, is of course the students. The aim is to develop and strengthen the understanding of their future profession. Besides, encouraged by the course, they also get an opportunity to understand and appreciate the combination and importance of both theory and practice. In many cases students find it difficult to relate the more theoretical courses to industrial practice. To see how theory is implemented into practice is important not only for understanding but also for the learning process. In this way the student can appreciate why the courses are important for their future work in engineering, and also how the courses and their progression in the curriculum make sense and relevance to their education.

The practical insights in the course also help students assimilate the subsequent courses and make the most of them [7]. The experience and practical knowledge from the industrial relevance make it easier to understand the forthcoming increasingly theoretical studies. Besides, the industrial experience is also valuable for any kind of future work. It is an advantage to have knowledge about company structures and routines when searching for a job. The industrial contact is also used to widen and strengthen the professional network.

There are several additional benefits, students will obtain industrial experience, insights in how the industry works in general, and a chosen company specifically. It is very common that students have poor knowledge about their future professional role. The course is therefore a possibility to see the challenges of engineering and prepare for their future profession. It is important that students form an identity and clear focus on their future profession.

It is not only the company that gets a long interview, also the student can evaluate and decide whether the company is a suitable future place of employment after graduation, as has been experienced by others [7]. The students will also be trained in how to contact and communicate with companies and organisations, etc., in order to promote themselves. This involves not only the communication itself but also how to prepare before making contact. Besides, time spent at the host company is a possibility for students to show their capability and promote themselves.

The course ends with a seminar where all students present their experience from the company practice, this in turn means that each student gets information about several companies and possible employers. They also gain insights in many companies and their organizations.

Industrial Perspective

The course is not only beneficial to the students, there are also several advantages for the industry. From an industrial point of view, a student that is connected to the company from the

beginning of the studies until the master thesis is finished, can be considered as attending a long job interview. If the company is interested in employing a former student, they will be able to hire a person who is already familiar with the company, its routines and also with their work procedures. It is also an easier way for the company to recruit personnel. The student will during a long time get introduced to the company or organisation. Besides, if not employed by the company, there might be other kinds of collaboration, as the student might end up as a future customer.

In general, the course will result in a more pronounced communication and interaction between industry and faculty. This in turn is important for future collaboration. This is an advantage that is equally important for the industry as well as the faculty. Such a collaboration can e.g. involve initiation of research projects or industrial influence on educational programmes.

Depending on whether the student is a bachelor's or a master's student, the company can have simpler or more advanced tasks, or problems, solved. At the final seminar, information and knowledge about the different companies will be shared among students. This might also make it easier for a company to recruit people in the future. A questionnaire concerning the interaction between industry and faculty was answered by a number of companies. Some of the questions were related to the *OITP* course. Twenty-one companies participated in the questionnaire. Among the questions they answered was: *Are you willing to welcome and supervise "younger" students and at the end of their studies let them perform and deliver a real project?*

31 % of the companies answered, *Yes, definitely*, and
52 % said, *Yes, probably*.
Only 16 % hesitated and none said no.

It was also interesting to notice that 61 % answered "recruiting engineers" on the question: *From your perspective, what do you mostly want to achieve by collaborating with the faculty?*

Faculty Perspective

A student that has obtained industry experience and has seen how theory can be converted into practice, is more involved and interested in subsequent courses and further learning. They will regard preceding courses as more relevant. Their curiosity will increase and the will to learn more will influence their teachers. The whole education programme as well as teaching will be perceived as more relevant.

The teaching staff will be more inspired to teach the different aspects related to the companies. As the students become more interested, teaching will be easier. It will also be easier to use examples from the industry in class. Especially in courses after the *OITP*, the students can easier adapt to teaching that relates theory to practice. This will result in teaching that is closer to, and more relevant, for the collaborating industry.

The collaboration with the industry means that it is easier to maintain an industrial point of view when education programmes are developed or improved. This not only involves a critical feedback on programme impact but also an opportunity for the faculty to identify shifts in industrial trends [8].

Also the part when teachers each semester visit companies to improve their industrial contacts is a benefit to the faculty. Both in the shape of increased contacts but also as increased teacher familiarity with industrial perspectives and more focus on things relevant to the industry.

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Evaluation of outcomes

When an *OITP*-course is completed, there is a written survey from each student as a complement to their report. Representatives of the students also get the opportunity to discuss the course with the director of education. Later, students will have the opportunity to give their impressions about the entire programme. Specific questions will be given about the *OITP* and the course's contribution to their programme. The supervisors at a company will also be asked to answer a written survey. The contact person at the faculty will discuss the implementation with supervisors at least once a year to find out if there are opportunities for improvements. This is also an opportunity to get input for how the practical part can be used in the following courses.

CHALLENGES AND SOLUTIONS

Problems will most probably display prior to the start as well as during the course. Even if it is difficult to prevent all kinds of problem, some have been identified and countermeasures have been suggested. Some of the challenges will result in positive development while others will be of a more negative character.

Before the start of the course, the student should find an external partner where the practical part of *OITP* can be performed. The search for an external partner and appropriate companies, organisations or agencies, may for example be done by:

- Active participation in the trade fair.
- Participation in speed dating and after work, activities in connection with the trade fair.
- Checking the company list on the faculty web or use students own contacts.
- Checking the faculty web where the companies will have the opportunity to advertise and look for students for the *OITP* course, the thesis work and recruitment of engineers.
- Sending a CV to chosen companies.

The number of potential companies is critical, as all students at School of Engineering are involved. The first time the course *OITP* will be given is autumn 2014. In 2013, the main focus will be on visiting and recruiting a large number of companies suitable for the *OITP*. When the courses *OITP* and *OITP 2* are fully operational, we expect to involve approximately 400 companies. Later, the really hard work will be focused on maintaining contacts with the companies encouraging them to receive students also the coming years. This will e.g. be done through company visits, events, personal contacts and different projects. Companies in the region have recruitment needs of engineers and technicians. The interaction between the companies and the School of Engineering can in these cases lead to a win-win concept, as they early come in contact with engineering students.

Should a student encounter difficulties and fail to find an external partner, there will be a number of services and measures to help:

- Lists of chosen companies contracted by the faculty.
- Coaching - how to locate and contact different external partners.
- Various internal projects of different character that involve both sharp or fictitious projects.

We are aware that students will act different. The students are of different ages, some have work experience while others come direct from upper secondary school. We assume, however, that the majority of the 750 students solve the challenge in an excellent way. Others have not reached the maturity required or have the motivation needed to step outside campus. We will meet these students with described assistance. Probably, there will be a small group of students left without an external partner. For this group, we will find special solutions.

Another expected challenge is to get companies in the region to receive master's students who do not speak Swedish. This might be a problem in the course *OITP 2* followed by the thesis work. Focused efforts are necessary towards companies with great international contacts in the region. This is planned to be done by pointing out the benefits of receiving students from e.g. Asia, Europe and the U.S., that may contribute to the company's development directly or in the future.

Handling students' experiences from the industry will be a new challenge for the faculty. Students will return from different companies and with different experiences. How these experiences are taken care of and utilized in the classroom is crucial. It ought to be a benefit to the whole group, and not only individually. We expect the off campus work to improve students understanding of future theory courses, as well as increase their motivation. It is not only the theory that will be translated into practice, also the opposite will be possible. The interaction between practice and theory will also be improved, which has been discussed by e.g. Kolb et al [9].

Teachers and staff at the faculty agree that it is important to get more practical parts in the educational programmes. When it comes to the task of visiting companies and interacting with them in order to maintain the network, there is some internal hesitation. The goal is to get all staff to embrace the idea, but there is some work left to do. The new concept states clearly that it is both a vision and a goal to increase the interaction between the faculty and the surrounding industry.

In the previously mentioned questionnaire about interaction between industry and faculty which was answered by twenty-one companies the following question was asked: "*In the new concept teaching staff is supposed to visit companies, what do you think about that?*"

Several companies responded:

- | | | |
|------------------|--------------------------|------------------------------------|
| - Very good | - Good | - They definitely need to come out |
| - Quite positive | - It is good | - More visits would be appreciated |
| - Very positive | - It would be about time | |

Finally, another identified challenge is if supervisors and students for some reason disagree. A contact person at the faculty will therefore act as a support for both parts.

SUMMARY

Off Campus Integrating Theory and Practice is a course where students will translate theory into practice. The course is also a key part in the progressive contact between students and our industry partners within this new concept developed by the faculty. The main target for the course is of course the students. The purpose is to make it easier for the students and their learning but it is at the same time a win-win situation for both the industry and the faculty. The course was developed with the CDIO standard 8 [5] in mind, and it will increase the relevance of education at The School of Engineering for the surrounding industry.

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BIOGRAPHICAL INFORMATION

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