Capítulo 3 / **Chapter 3**

University-Industry Interaction: An Experience at the University of Halmstad, Sweden

Interacción Universidad-Industria: una experiencia de la Universidad de Halmstad, Suecia

Leif Gunnar Nordin, Jonas Rundquist, and Luz Stella Pemberthy-Gallo

Abstract

To take advantage of knowledge and improve interaction between students, universities, and companies, the University of Halmstad in Sweden has developed a method over the last 30 years that has produced significant results.

This method contains a philosophy and a structure that promote the university's academic development, while fostering learning among students and directly adding long-term value to regional companies. The method is described in this chapter, together with reflections and results. The conclusions are presented in relation to the program, the interaction, and the significance of this process for students and companies.

Keywords: new product development, engineer education, University-Industry interaction, educational model.

Resumen

Para aprovechar el conocimiento y obtener una mejor interacción entre los estudiantes, la universidad y las empresas, en la Universidad de Halmstad de Suecia se ha desarrollado durante los últimos treinta años un método que ha permitido obtener importantes resultados.

Este método contiene una filosofía y una estructura que proyectan el desarrollo académico de la Universidad, impulsan el aprendizaje de los estudiantes y agregan valor directamente y a largo plazo a las empresas de la región. El método se describe en este capítulo, junto con las reflexiones y los resultados. Las conclusiones están presentadas en relación con el programa, la interacción y el significado de este proceso para los estudiantes y las empresas.

Palabras clave: desarrollo de nuevos productos, educación de ingenieros, interacción Universidad-Industria y modelo de educación.

Author profiles / Perfil de autores

Leif Gunnar Nordin
Master's degree in Industrial Management. Professor and researcher at the University of Halmstad, Sweden.
E-mail: leif.nordin@hh.se

Jonas Rundquist
PhD in Industrial Management. Master's degree in Innovation management, Professor and researcher at the University of Halmstad, Sweden.
E-mail: jonas.rundquist@hh.se

Luz Stella Pemberthy-Gallo
Master's degree in Business Administration. Researcher in the Regional Models of Competitiveness Group, Universidad del Cauca, and the Regional Center of Productivity and Innovation in Cauca (CREPIC). Professor of the Tourism Science Department at Universidad del Cauca, Colombia.
E-mail: pemberthyls@gmail.com

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Introduction

Universities in Sweden have three official tasks: research, education, and collaboration. In 1992, the Ministry of Education officially defined collaboration with companies and public institutions as "the third task" of Swedish universities. Accordingly, more universities include a strategy for external collaboration in their documents[1]. The first two tasks occur naturally, but what does the third task involve? It can be understood in different ways. One of these is to categorize the interaction between science and society, as well as between education and society. The term society refers to businesses, companies, and similar organizations.

The opportunity for collaboration presented in this chapter is between education (undergraduate) and society, represented by industry. This occurs through meetings, support courses, visits, and projects, as well as a close relationship between the student and their university tutor, and between the student and their mentor in industry or a company.

Both students and the business community are naturally interested in collaboration. Our experience allows us to confirm that great interest exists on both sides; however, many aspects are missing for the organization.

Academia-Industry: A contradiction?

In the great majority of cases, the business sector is very interested in establishing contact with university students, given that they are usually the employers of graduates. Generally, companies prefer not to invest time in relationships that do not yield results in the short term (Tell, 2001).

One question that often arises is: how is a company project consistent with an academic approach to science? Interestingly, university education is supported by "scientific basis or proven experience" (Högskolelagen, 1992, p. 1), and industry is by no means indifferent to this basis, although sometimes it seeks more practical solutions to specific problems.

In Sweden, students in the Development Engineering program write a "report" as the result of their graduation project; those studying social sciences, on the other hand, write an academic thesis. Table 3.1 shows the differences between a graduation project report (undergraduate engineering) and a thesis (undergraduate social sciences).

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[1] Högskolelagen, Law of Higher Education 1992, 1434.

Table 3.1 Comparison of undergraduate Development Engineering report and social sciences academic thesis

Graduation project (engineering tradition)	Undergraduate thesis (social sciences academic tradition)
Solve applied/practical problem based on existing knowledge	Solve general problem. Create new knowledge.
Rational and logical method	General research method based on reflection
Specific results – experimentation method	General results – method validated by academic peers
Credibility obtained through practice	Credibility obtained through prior analysis of the literature
Abstraction – inverted pyramid	Abstraction – hourglass

Source: The authors.

At first glance, the aspects of each appear to be very different, but none of them is a contradiction when looked at more closely. For example, the process of developing a new product can be considered as a knowledge gap (Kennedy, 2009). During product development, more and more knowledge is obtained about the product in question to be considered as new knowledge, which then verifies the selections/decisions. Managers want to do everything correctly from the outset; of course, this is commendable, but then knowledge about what lies "outside" the decisions that are made is lost. Nevertheless, it must be noted that different interests can compete for the time that students allocate to finishing their work (Holmdahl, 2010).

Discussion

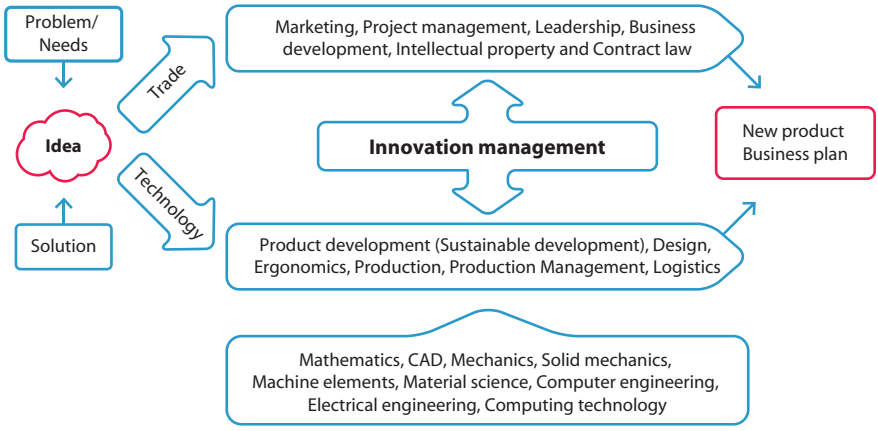
Case study: Product Development Engineering and Innovation Management Program

The experience presented in this chapter is based on more than 15 years of active participation as coordinator for what was one of the first programs in Sweden, with extensive interaction with the surrounding community: the Development Engineering program (in Swedish: Utvecklingsingenjörsprogrammet or "U-programmet") at the University of Halmstad, which can be described as "moving from product concept to market readiness." It has similarities to the industrial economy and industrial organization programs, but differs in its focus on the development of new products. Students in the program are characterized by their high degree of active participation in academic achievements and student activities related to social skills.

Program structure

Figure 3.1 offers an overview of the structure of the Product Development Engineering and Innovation Management Program. Projects play a fundamental role and are supplemented and supported by courses on business, product development, and business management, as well as technical support courses, shown at the bottom of the figure.

Figure 3.1 Development Engineering program structure



Source: The authors.

A story to share: Raising the profile of an undergraduate program

Halmstad's Development Engineering program began in 1979, with the University of Lund initially involved as the main institution. When the University of Halmstad opened its own central campus in 1983, the program was one of the first in Sweden to be known as interdisciplinary or multidisciplinary. From the beginning, the program has maintained a high level of cooperation with industry and the environment; in this case, students work with "real" projects and "real" money in close collaboration with companies.

The program quickly became popular and for a number of years attracted more than 20 candidates per intake. Currently, the program accepts 40 new students each year. Word of the program spread across the country rapidly and, interestingly, each Saturday saw a broadcast on national television in which Halmstad students solved the problems of people in the audience. This was dubbed "the inventors program" and became an icon of the University of Halmstad. The university has

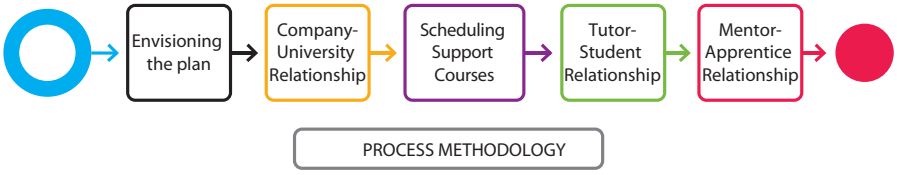
always incorporated innovation into its vision and strategy documents, and a process is currently underway to establish its profile as "the innovation university."

Over the years, "U-programmet" has received a number of national awards including: "Best education for Swedish entrepreneurs" from the Entrepreneurship and Small Business Research Institute in 1999; "Best collaboration in Sweden," granted by the Swedish business community in 2010; and "Best technical program," selected by technology companies in 2011.

Through the program, students can access scholarships and prizes worth half a million dollars each year, and those who have completed particularly successful thesis projects can also enter competitions. This year, for example, one thesis won the national "Embedded systems" competition.

The methodology used in this process is presented in Figure 3.2 and explained below.

Figure 3.2 Process methodology



Source: The authors.

Envisioning the plan: A time to envision, test, and reflect

1. As the students are very young and have relatively limited experience in approaching projects, it is vital to provide time for reflection, for trial and error, and for establishing a good understanding of what is to be achieved. It is simply feeling a shared spirit in what they are doing and identifying its potential.
2. Most projects contain creative elements, and creativity does not usually (or at least very rarely does it) begin in an organized way (Holmdahl, 2010). It must be clearly understood that there is a need or problem that requires a solution. Although this solution may appear to be good enough in many areas, it can be difficult to identify at any given moment; however, it can be made available later (through a deadline). In this phase, many different creative methods can be used, including one of the most common and well known: brainstorming (Rundquist & Grönevall, 2004). Brainstorming often provides some form of solution, which generally has to be refined and developed.

3. Vision is important when developing a new product because its image must be considered. This task should be fulfilled by members of the group, working intensely and in an organized fashion to achieve a common goal, trying to avoid making last-minute decisions that incur high costs for the company. It is vital that decisions not be made too quickly at the beginning that cause overspending in product development later (Ottosson, 1999).

The need for mutual benefits: Reciprocity between company and university

In any relationship or collaborative process there should be cooperation pacts or agreements supported by an atmosphere of trust, constant communication, and the identification of a win-win for the parties involved (Pemberthy, Plazas, & Castillo, 2012). This reciprocity is not necessarily focused directly on money or time, which are measurable; in this case study, the collaboration was conceived with the awareness that companies are often driven by the market and its demands, whereas training almost always has inflexible forms of collaboration due to the university's methods (Hörte et al., 2008).

Scheduling support courses

A crucial and almost fundamental advantage lies in ensuring that support courses take place simultaneously with, or a little earlier than, the projects. This provides two important benefits: First, students apply their knowledge (teaching often lacks this practical context); and second, the results of the projects can be greatly improved. Before undertaking their first large project (PFN), students study mechanical engineering and design. In tandem with the project, they study product development and finance. All of these courses are applied in this project.

Tutor-student relationship: Orientation, commitment, and monitoring

Tutoring is the job of accompanying students and is undertaken for one project during one semester. There are two options for tutoring: 1) three meetings with the students during the semester: at the start, approximately at the halfway point, and upon finishing, before the exam; 2) a weekly meeting with the students. Both options have their advantages, and the choice is made depending on the type of project. It is important to take into account the preparation time needed to participate in a project as a tutor (Jönsson, 1999); it is a responsibility that goes beyond merely keeping an occasional or regular appointment.

The tutor should not control or manage the project; they must monitor the progress, listen to the students, and answer their questions. Of course, the tutor should provide help and information on the project, but the tutor should never be so involved that at the end the graduation project is more their own than the student's. Every project is different and, consequently, questions for the tutor cannot be answered directly.

The tutor should have at least two (preferably three) contacts at the company in order to strengthen relationships; demonstrate commitment; and facilitate revisions, suggestions, and corrections of project results. The meetings with company contacts take place at the start, at the halfway point, and before the end of the project.

An interesting (and perhaps somewhat controversial) aspect of the tutor's job is to let students make mistakes (Barnevik, 2011). This is particularly important. The only way of not making mistakes is to do absolutely nothing. The philosophy here is: *ex nihilo nihil fit*, or nothing comes from nothing. Often, a project involves the creation of something new: simply the search for knowledge.

One usually effective way of obtaining this knowledge is to do something. If it is not done well on the first attempt, it does not matter, as at least something will have been learned. Here the Pareto principle applies (Holmdahl, 2010): If 80% of an activity is carried out correctly, three activities will be carried out up to 99% correctly . This is compared to zero if, in order to totally avoid mistakes, nothing is done.

In some cases, the students, in their haste to do a good job, make proposals that the tutors feel are clearly irrational. The tutor should be aware that the student risks not obtaining the required results, or that the investment will go over budget; however, they are advised not to reject these proposals directly and instead ask questions so that the students perceive their faults. The goal of this process is that the students venture to make suggestions. Their proposals are generally not stifled by excessive experience and may occasionally contain valuable elements.

The weekly tutorials consist of short sessions, and generally 30 minutes is sufficient. If necessary, times can be agreed on for other meetings. Tutors are usually responsible for three of four groups, although it obviously also works with more or fewer groups. When more groups are involved, it can be difficult for the tutor to remember what they have said to the group. In the case of fewer groups the process is less efficient when there are common activities independent of the number of groups. It is worth pointing out that as the project progresses the tutorials become less frequent; in some instances the meetings have taken place every other week.

If all tutors reach an agreement to review the projects on the same day, and even at the same time, the students benefit from having the opportunity to meet

and support each other in the project process, especially in the finding of solutions for the problems/needs of the projects.

Another advantage that the students have in finding solutions to issues in their projects is a team of supervisors with different backgrounds and histories; it is a group with a wide variety of academic credentials and industrial work experience. The students can thus seek support or guidance from a known tutor with specific skills for their project.

Before the tutoring sessions, the students present a weekly report to the tutor (Holmdahl, 2010) in order to support the progress of the project. In many cases, these projects deal with activities that are difficult to plan. Nevertheless, it is necessary to plan for the immediate future, at least the week ahead. The content of the weekly report is simple:

- What have we done in the past week, particularly in relation to the plan in the previous weekly report?
- What do we plan to do and achieve in the week ahead?
- How many hours have we spent on the project in the past week?
- What resources have we used (above all in terms of cost)?

It is important to highlight that the weekly report is carried out to improve the project, not to satisfy the tutor. Furthermore, students must keep a daily journal (Holmdahl, 2010).

The tutors also meet on a weekly basis, generally on the same day as the meeting with the students. The aim of this meeting is to discuss any problems that emerge in the projects. Many questions do not have one correct response, but several good responses may still be heard. These meetings also take the form of forums in which experiences are shared with new tutors. A recurring theme in these meetings is project status, or at least a short version: are any projects at risk, or are there any particularly successes to report? It is worth noting here that when working with companies, many situations can arise.

Mentor-apprentice coordination: A relationship for exchange and reflection

In education, the term mentoring (Hultman & Sobel, 2002) refers to a form of collaboration that occurs in a private relationship between a working professional (mentor) and a student (apprentice), although there are other interested parties, such as the mentor's company, that provide the foundation for this commitment. Mentors have been used to help new or less-experienced employees in their

professional career (Rasmussen & Sorheim, 2006). The mentor is able to share his or her particular work style, something not taught in the university, with the apprentice (tacit knowledge) (Kirwan van der Sijde & Klofsten, 2008). It is worth highlighting that the mentor receives a great deal in return, such as the reflection and rethinking of the apprentice who is "exempt" from the mentor's background and experience. The mentor does not help the student with his or her studies, but instead enables the mutual exchange of much broader questions, and frequent discussions take place about curriculum vitae, the job, the future, and thesis topics.

Within the academic program, a mentoring program has been included as an elective course for students. This complements other forms of collaboration with the company, and the mentor can even take the course. The apprentice usually has a heavier workload than the mentor, and in many cases, the two stay in contact even after graduation, but probably in a more sporadic manner.

The mentor-apprentice relationship is relatively close and filled with trust with regards to professional life. It is recommended that confidentiality be maintained, or that at least only superficial details are shared with others (Rasmussen & Sorheim, 2006). Personal chemistry plays an important part in this relationship; if for some reason the mentor and student cannot establish a good relationship or an unsustainable situation arises, the mentoring should be stopped.

What value does mentoring have for the apprentice?

It is easy to see what the apprentice gains from mentoring. Some examples are presented below:

- Experience, contacts, sounding boards, understanding, and career decisions.
- Scheduling, reflections, asking for a mentor in a work situation.
- Thesis project, the future, knowledge of working life.
- Salary negotiations, communication.
- Learning more about himself/herself.
- The use of external advisors and being open to others.

The above information was obtained through interviews with apprentices in the mentoring process (at the end of their studies).

What is the value for the mentor?

The value of mentoring for the mentor is not as obvious as it is for the apprentice. Nevertheless, in an evaluation conducted after mentoring had finished, the mentors

expressed their satisfaction with the process. The following were the most positive experiences of being a mentor (some overlap):

- The apprentices ask questions and are always alert.
- Trust, sensitivity to listening, and asking instead of demanding.
- Understanding of current training, recruitment.
- Questions, development, perspectives, learning to listen, openness.
- Reflecting on their professional role and their own experiences.

Interestingly, although the mentor is a manager in the company, in the mentor-apprentice relationship there is no hierarchy (although the mentor can be thought to play the role of leader). In some companies, mentoring is also part of the mentor's career development, and he or she is responsible for the development of one or more apprentices in company life.

Results

A three-party relationship: University, company, and student

In this trilateral relationship, the responsibility of each party is not entirely clear. From the university's point of view, it may be valuable for the Student-Company relationship to continue, as long as it does not greatly interfere with studies. It is debatable whether the university has a formal responsibility for students' actions, particularly after the project; however, it is widely recognized that the university has an informal responsibility, at least if it wants to preserve good relations with the company involved in the project. Close dialogue with students is thus recommended, especially during the project, to help them maintain professional conduct in their relationships with companies. There are also examples of students who have been hired as consultants after their projects have finished, in an agreement between them and the company. The university assumes responsibility for this relationship.

Sweden has a far-reaching concept of the public, and universities are public authorities. All of their activities are therefore public, and all documents produced in a project (including correspondence) can be freely accessed, meaning that anyone has the right to look at records, request documents, access professors' e-mails, and so on. Accordingly, it is important to consider special agreements between students and companies in order to maintain the confidentiality that companies seek for their projects.

In some instances, particularly the undergraduate thesis, larger companies consider remunerating students economically. Generally it is the company that assesses this; however, the university is advised that the financial compensation

should not be the reason for selecting a project and that students' learning should be prioritized over money. It is worth noting that if the company does grant a payment to the student for what they produce, he or she obviously does not have to refuse it.

In the university's projects, students are generally recommended to sign a project contract, which is very simple but strict in relation to commitments. The contract considers matters of confidentiality, intellectual property (in the full sense of Swedish law), responsibility for performance (students are not responsible for financial results), the company charging direct costs (costs that the university cannot charge by law), and accounting. Additionally, the contract confirms that the students will deliver an oral presentation and a written report for the company. The intellectual property clause has been developed in accordance with Swedish law on workers' rights with regards to inventions (Rundquist, 2007). Filling out the contract is a good exercise for students.

Sponsor companies: An important opportunity to learn

In Sweden, the concept of a sponsor company is very commonly referred to by students looking for collaboration to complete their work. This search for a sponsor is generally undertaken by students through visits to companies and through their academic work.

There are two ways in which this relationship can be established: Firstly, there are often companies that award projects or jobs (thus, students obtain a sponsor); secondly and conversely, the students are the ones who must search for a company for the project. This is a social and useful pedagogy. The university sees the advantage of getting to know different companies, as opposed to just one. Experience suggests that the project companies will not return regularly every year, but rather when they have important company projects.

Students have access to a database of approximately one thousand companies that have implemented projects. Companies can register their interest in this database and add projects. Interestingly, private individuals call between five and ten times a year to mention ideas that they have had and would like help to develop. Generally, these people are older engineers who have reflected on their ideas for a long time, but there is a wide variety. Using the database, students can find appropriate projects, and they are urged to look for projects that suit their interests and needs.

Projects in the context of the program: A foundation for experience

The Development Engineering program includes three large projects (each lasting approximately six months) over three years. This has been the approach since the program began in 1979, with some changes over time. The three large projects are undertaken in collaboration with industry; however, students have the option of developing their own idea, to be completed with the same requirements as industry projects. In Sweden, students of the Development Engineering program are widely recognized in the business world.

A project for every situation

A brief description of the projects is provided below:

Product Development Project (PPK), 3.0 ECTS credits, first year, first semester: this is a small project and the first one that students undertake. The objective is to develop a relatively simple new product, including most elements of the development process at a superficial level. Students are organized into groups of five or six and occasionally receive collaboration from companies; otherwise, the product is presented to companies when the project is completed and is sometimes purchased by them.

Product Renewal Project (PFN), 6.0 ECTS credits, second year, third semester: this is a large project with the aim of analyzing a product and determining its deficiencies and weaknesses. Students must renew (simplify or improve) the product to rectify the issues. Students are organized into groups of four to do this work, and the projects are carried out exclusively in collaboration with companies. The company presents a product that needs to be renewed; the project often relates to a good rather than a service and is undertaken with the execution of the Development Engineering program, preferably using the content and approach (often both parts) found at the bottom of Figure 3.1.

Business development project (FUP), 4.5 ECTS credits, second year, fourth semester: the objective of this project is to analyze a business and identify potential for increasing profitability (making more money). Students are organized into groups of four and develop action plans that will allow the company to improve in the areas identified. These projects are undertaken exclusively in collaboration with companies, which often present concrete requirements, such as specific problems or needs for improvement. The project should be carried out using the approach in the top part of Figure 3.1. Occasionally, the approach at the bottom of Figure 3.1 can be considered, if appropriate for the company.

New product development project – undergraduate thesis (NYP), 22.5 ECTS credits, third year, fifth and sixth semesters (ten months): the objective of this project is to develop a new product (or service), from idea to market-ready product. The project includes both developing the product and creating a business plan for it, that is, everything contained in Figure 3.1. In the two earlier projects, students complete each part separately; now all parts of the selected technology are looked at.

As well as giving oral and written presentations, students must present their thesis at "Utexpo," a local fair for undergraduate students at the University of Halmstad, with the underlying goal of improving the project; likewise, they must prepare a presentation in intermediate-level English. For this project, the students work in pairs that they form themselves; in earlier projects the groups are organized by the tutors. Many thesis projects are based on students' ideas, without company direction.

The projects are arranged in order to familiarize students with the products and the businesses. To summarize, the first project (PPK) seeks to provide an introduction to product development and what it involves, in a broad sense. The second project (PFN) attempts to give students technical knowledge and skills for product development. It is generally based on an existing product, so students have the chance to practice methods and procedures (both creative and analytical) for product development. The third project (FUP) offers students the chance to gain knowledge and skills in enterprise and business development, and understand economic contexts and conditions by developing a business plan.

The undergraduate thesis (NYP) involves developing a new product, from the idea and concept, and creating a business plan for the product. This can be seen as a combination and consolidation of the product renewal project (PFN) and the business development project (FUP). Historically, this has been found to work well.

It is worth noting that the projects have very high levels of achievement. Of course, this is related to various factors, from the regular meetings with the supervisor to the inspiration provided by classmates as they make progress.

When should collaboration or projects start?

The answer is: not too soon. After beginning their studies, it is common (and natural) for students to not have enough experience (in a broad sense) to carry out a project that contributes to companies and that fulfills program requirements. Obviously, they can complete simple and well-defined tasks–something the companies themselves can often do. It is important to remember that projects are often complex within their context; students should therefore undertake studies before placing themselves in a situation and making decisions without the necessary information

or with conflicting requirements. Acquiring the ability to make these decisions normally takes one year. To develop this ability, the first project (PPK) is internal, but with a simulated context of collaboration.

Aspects that must always be taken into account when developing products include: sustainable development (social, economic, and environmental), ethics and morals, equality, and even accessibility for as many people as possible (universal design). On top of these, purely economic business interests have to be considered (it must be possible to make money on the product). Within the context of product development, the user is also of major interest (Ottosson, 2009; Holmdahl, 2010). If the product does not add any value, above all in terms of function, it is most likely doomed to fail from the beginning. Sensory aspects might also be considered (values of design that can be perceived through the senses), as well as the value of the image (brand).

Star projects: An event to share!

The way of working at the University of Halmstad has evolved and continues to do so; over the years it has provided a great deal of experience, strongly focused on building a closer relationship with the business sector. This has contributed to the students' outstanding performance in completing their projects.

The program begins with an awareness-raising phase to encourage students to look for networks in which to develop their projects. In this phase they are given information about the project goals, the perspective of the university, and the composition of the groups. Short success stories about previous projects are shared, and the available scholarships are explained; however, there is no mention of the remuneration that students receive from companies.

At the beginning of the semester an entire session is allocated to providing the information needed to form groups, assign tutors, and arrange spaces for projects. The project proposals received by the university are presented to the students, who can then express interest and obtain contact information for the projects. Alternatively, students present their ideas to receive appropriate information to be able to set up a project. These events may appear somewhat tedious, but they are a necessary starting point for the projects and group work.

At the end of the academic term, students present written and oral reports; these are useful for conducting special events that demonstrate the high quality of work to the university itself and to companies that may be interested in the projects. For oral presentations, students receive constant support from a tutor in Q&A sessions. They have time to practice in the auditorium where the presentation will take place, and there is always a final rehearsal in front of supervisors and teachers

of presentation skills. If the presentation is in English, students are assisted by a professor who is a native speaker of the language. It is important to highlight that the auditorium for oral presentations is exclusive and must be booked in advance to be used. This training achieves two results: 1) it builds students' confidence and sharpens their presentation skills so that when undergraduate projects are presented, they are fantastic; and 2) it allows the reports to be shared with the general public so that they are not left on a shelf and forgotten, but instead disseminated and used to develop new work.

Utexpo is an exhibition of the year's undergraduate projects, and it is a tradition almost as old as the program itself. The exhibition is an enjoyable event that lasts three days (Thursday through Saturday) with compulsory attendance from the Engineering programs. It is the last event for the undergraduate project, and seniors usually hold a closing ceremony on Saturday afternoon.

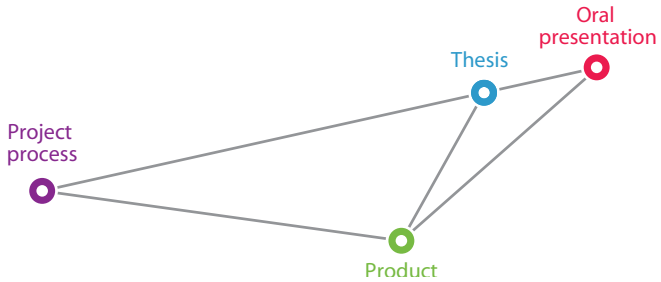
Assessment process

The report is usually the only thing kept, in case someone wishes to assess a project down the road. For projects in Social Sciences, the report is often more than sufficient for evaluating the work done, but in Engineering there is a product that constitutes part of the exam. This product is not always preserved for posterity.

Assessing the project process requires comprehensive knowledge of it. The most appropriate way to obtain this information is through frequent and regular tutoring sessions, or through a project diary kept by the students, either in group form or individually. A combination of frequent (weekly) meetings with the tutor and a diary offers a solid base for assessment of the process. With regards to assessing the product, the written report can be used as a reference. Likewise, the students give a high-quality oral presentation about the project (artistic and content) using technology, generally with results that correspond to a good process and good execution.

Consequently, there are always two areas that can be assessed in a final project (the thesis and the process), but in the majority of cases there is also a third and, if one wishes, even a fourth: the product and the presentation. Figure 3.3 shows the connections between these areas.

Figure 3.3 Areas assessed in a final thesis



Source: The authors.

A formal assessment is performed of the fulfillment of course and program objectives. These are generally learning objectives, study objectives, or some kind of equivalent. Often, they can be divided into different groups. In Sweden, these objectives are classified as follows:

- Knowledge and understanding: what the student knows (facts and models) and is able to describe.
- Skills and abilities: what the student can do (ability to apply knowledge in practice)
- Judgment and approach: assessing analysis and judgment. These are often qualitative evaluations in different contexts, sometimes with incomplete information.

With regards to the objectives above, knowledge and understanding can be shown in the descriptions contained in the report; skills and abilities are demonstrated in the results, which can be evaluated in the report, as well as in the final result (the product); judgment and approach are shown both in the report and the process description. This final objective involves a number of considerations and decisions that are impossible to describe in the report, if in fact they can be described at all due to their complexity.

The four steps followed in the assessment are:

a) The report (thesis) will be assessed from a formal perspective (structure, formal aspects, and language) and in terms of content (using group method, reasoning, performance, and activity).
b) There is a series of factors to be considered in the process, such as social relationships with the network (meetings, fixed data, and correspondence),

appropriate use of relevant methods and instruments (use, analysis, and conclusions/decisions), information management (acquisition, analysis, and conclusion, often with incomplete information) and the process looked at comprehensively (red line).

c) The product is judged against criteria such as: meeting identified needs (efficient, effective, and adds value), usability (tested, easy to understand, reliable, anyone can use and design it), SWOT (strengths, weaknesses, opportunities, and threats) and sustainable development (social, economic, and environmental, as well as ethics, morals, and equality of conditions).

d) The presentation is the last element of evaluation. This is done orally in front of an audience, or in a fair or in similar situations where an assessment can be made of performance (language, clarity, and attracting interest), content (needs, processes, and products), and use of media (multimedia, accessories, etc.).

Once the evaluation aspects and criteria have been identified, a table can be created by placing evaluation aspects in the rows and the criteria for each grade in the columns. Creating the table makes students feel more secure, as they know in advance how they will be assessed. It is also recommended that the aspects and criteria have overlap; this may make assessment more difficult, but it reduces the risk of students' projects not being fully optimized due to only evaluation aspects being considered.

A common question among students in the Development Engineering program is: "What could I have done better to get a higher grade?" If the table is too narrow and does not cover all aspects and criteria to be assessed, there could be an awkward situation that is, unfortunately, detrimental to the students' projects. The assessment should be true and reliable.

Assessment becomes complicated when it is necessary to assess group work in order to produce a grade for each individual; it is not possible to know who did what, or if all students contributed in the same way, or if the interest of one group member represents the interest of all the others. To solve this issue, a group meeting is arranged for each student to present objectives, expectations, and commitments. This may sometimes lead the tutor to award a higher or lower grade than a student deserves. To avoid this situation, two previously mentioned tools are used to improve individual assessment: relatively frequent and regular meetings with the tutor, and the keeping of a diary by each student in the project. In terms of the meetings, a student frequently missing the meetings with the tutor (which are recommended to be mandatory) can be seen to indicate a lack of commitment. The diary, meanwhile,

establishes the different activities carried out by the students: who has done what? Comparing the students' diaries and the subsequent discussions can provide the basis for assessment.

Conclusions

Based on the methodology and results presented in this chapter, various conclusions can be highlighted. These are divided into conclusions at the program level, interaction, and what this means for the students.

Education program

In terms of the program, it must first be noted that this is an Engineering program that focuses on product development and innovation management. The program therefore includes product development management and organization, and the creation of new business opportunities with that focus. Courses such as Business Administration, Accounting, Marketing, and Intellectual property are subjects in the core part of the program, and technology courses (for example, Mechanical engineering, Electrical engineering, and Computer science) are required or optional support courses. This results in training that produces a special type of engineer, centered on the needs and opportunities for developing new products. Students use the different technologies required by the product, working towards a process of innovation.

Second, the program is organized so that each semester includes a project that is supported by the theoretical courses. All projects are undertaken in direct collaboration with a company and are aimed at solving real and current problems in the company. Students thus become familiar with a future work situation and learn to focus on how their knowledge will be of practical use. The region's companies have individual contact with students and receive direct benefit from them and the university's research (Tell, 2001).

Third, one feature of the program is that each group of students has a physical space in which to complete their project (part of an office), where they can carry out tasks and learn how to manage a work environment. The office has a phone, a computer, and a desk, and students can leave their materials there when they go home at night. As well as working on their projects, students do a great deal of their course work in these spaces.

Interaction with companies

First, it is worth mentioning that the tutor is listed as the contact and guarantor of quality for the undertaking of the project. The tutor plays an important role as project advisor and supervisor. He or she certainly supports the work, but does not always have experience in the specific area of technology or the economic component. This motivates the students to seek experience in the company or with other types of experts.

Second, this way of working has generated strong cooperation with the company and has left a mark in the sense that these same companies come to the University of Halmstad to involve students in their projects. This aspect of the program shows that the interaction is mutually beneficial. It also indicates that the companies offer good projects for the students and can be counted on as partners.

Third, the mentoring program is a specific type of interaction. The companies have a close relationship with the students, whom they provide with new perspectives of leadership and business. Likewise, students have an experienced mentor who can help them advance their career, and they might even have the possibility of becoming an employee of the company in the future.

Finally, it is important to mention the experience and high performance that the University of Halmstad has with its contacts in Swedish industry. Many universities have special departments for working in this way, but with very low performance.

Student participation

The positive impact that this interaction has on students must also be touched on. In addition to being able to participate in good projects, they are assisted with scholarships and products, and are put on the job market. Some thoughts on alumni are presented below.

It is often argued that a very detailed training program produces graduates with a great deal of knowledge in few areas, while simple training programs produce graduates with superficial knowledge in many areas. Thanks to the ongoing collaboration with companies throughout the program, development engineering graduates have sufficient knowledge in many areas and also know how to put this knowledge into practice.

The different projects undertaken with real clients provide the students with self-confidence and orient them towards action. They are not afraid to call an expert or another company to obtain information; they do not worry when problems arise in a project or conditions change. They are accustomed to dynamics that often exist in the real world and to making decisions despite not having all the information.

Additionally, students develop social skills that cannot be taught in academic courses. The experience of carrying out a project with randomly selected groups of students allows them to learn to work with people whom they have not chosen. It should be mentioned here that from a learning point of view, it is beneficial if there is some tension within the group.

As the students maintain contact with the companies, they have to learn how to speak with them and listen to their specific needs. As a result of exercises in presentation skills and selling projects to stakeholders, they learn how to interact practically with companies and the surrounding community. With their social skills and a suite of knowledge in different areas they will also be good clients when facing experts, as they can explain what they want.

Finally, we hope that this method and the experiences described and analyzed in this chapter serve as inspiration and an input to training and collaboration in engineering teaching. If anyone feels that our way of thinking could contribute to the development of future programs, we would be very happy to discuss these topics.

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