HOW TO INTEGRATE ETHICAL ASPECTS IN A TECHNICAL PROJECT COURSE

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ABSTRACT

The aim of the course is to create understanding for how to be an engineer; this is achieved by imitating the situation many engineers face when they are introduced into the workplace. As a new employee at a company, it is often many things the students need to learn in a short amount of time. In the course the students are expected to take on the role of a new employee in a company. They are expected to learn about the technical-, group-and project aspects that are needed for working within the company. The student is expected to live up to the company's requirements for technical solutions, professional communication with customers and internal requirements. They learn to cooperate actively with the project members/customers/experts with different backgrounds and knowledge and see how organizations influence the structure of the team and the individual's freedom of action. In addition, they must learn to see the big picture and thus reflect on societal and ethical aspects. They also gain knowledge of the organization's significance from an economic perspective and how organization affects the team structure and process which in turn can affect an individual's freedom of action and behavior. The course is connected the CDIO Syllabus v2.0 in that sense that the student shall

- construct an architectural plan for a large technological system taking into account, inter alia, economic (in terms of time frames)-, social-ethical-, business-and business conditions.

- create a larger technical system based on analyses and evaluations of existing partial solutions.
- evaluate a subset of an implemented project deeper into an independent project.
- describe some basic normative ethical theories, principles and concepts.
- describe and reflect on social science theories of risk and communication, especially in relation to technology and technological development.
- apply ethical, psychological and social sciences perspectives on a specific case.
- apply basic normative ethical theories, principles and concepts on societal information technology cases satisfactorily.
- from an ethical perspective, reflect on societal issues related to the use of information technology, particularly with respect to issues of priority, security and risk.

KEYWORDS
applied ethics, learning to be, integration, project course, soft skills, standard 2.

INTRODUCTION

The Swedish examination regulation for engineering students states, among other things, that the students shall demonstrate an ability to develop and design products, processes and systems with regard to the conditions and needs of people and society's goals. They shall show insight in the possibilities and limitations of the technology, its role in society and people's responsibility for its use, including social and economic aspects as well as environmental, health and safety aspects. This is in line with what is written in the CDIO Syllabus v. 2.0 about personal and professional skills and attributes.

Based on this, the program and planning committee for the engineering program in information technology, has designed a soft skill module to be integrated in the course *Secure Mobile Systems*.

ETHICAL REFLECTION

Technology-based solutions have a strong potential to shape society and the ways we live. In many ways novel technological systems and services can empower us and facilitate our lives but may also alter conditions and behaviors in unforeseen and unwanted ways (Palm et al., 2013). The strong influence is an argument in favor of an inclusion of ethical reflection in the developing phase of novel technological solutions or modifications of already existing technology. Ideally, ethical reflection should not be carried out by ethicists in isolation from the technology development but in interaction with those responsible for and involved in the development process (Palm and Hansson, 2006) and actual or potential users (Palm et al., 2013). By training those who are working with technical innovations and system design in ethical reflection, ethics can be integrated in developing process and safeguard ethically sound solutions. What should this training look like then? One alternative suggested in this project term is that ethics is integrated in the project term as one of several; mutually dependent components that the students enrolled in the project term must consider and accommodate. Rather than adding ethical reflection as an isolated task, separated from the rest of the project, within this project term, ethical concerns is integrated in the whole project chain, from design to final product. Students are asked to anticipate ethically relevant implications of the service/system/artifact developed within their project, to avoid drawbacks and suggest solutions that promote an ethically sound end product. It is stressed that they should be able to inform the "client/buyer" why the product/solution they have developed is ethically sound, what ethical standards it meets and how these are safeguarded. A central aim of involving ethics in the course is to train students in conducting systematic ethical analysis and to demonstrate the need for continuous ethical reflection rather than point-wise assessments.

Theoretical underpinnings

The ethics component of the project term draws on theoretical ideals of ethical assessment – ethical technology assessment (eTA) (Palm and Hansson, 2006), constructive ethical assessment (Schot, 2001) and interactive technology assessment (Palm et al., 2013). What these models have in common is a proactive approach to service/system/technology development. A general feature of the methodology of ethical assessment models is that questions concerning values, moral principles, and norms like autonomy and privacy are considered within the development. That a project is *constructive* means that it is integrated in the design and development of a new technology (Schot, 2001) and that it is *interactive* means that it involves different stakeholders (Palm et al., 2013). A key feature of the interactive ethical assessment model that has been suggested for development of systems, services and technological artifacts, and a central component of the project term, is that reflection should be carried out from an early stage and continuously throughout the project. Ethical reasoning and deliberation should be integrated in the whole project, from the innovative/investigative early stages to the finalization (Palm et al., 2013). Most importantly, emerging services/systems/technologies should be influence by ethical reflection before the services/systems/technologies have reached the market. If aspects in need of modification are pointed out at the prototype stage, technology developers are more likely to alter the design than what they would be later on in the developmental process when a change is more inconvenient and costly (Palm and Hansson, 2006). An interactive ethical assessment conducted at an early stage of technology development/implementation can encircle concerned parties needs, interests and opinions. Based on such results, service providers/system designers/technology developers and those responsible for the introduction of certain services, systems and technical solutions can adjust the system, service, technology, promote positive aspects thereof and avoid negative such as far as possible. An interactive ethical assessment can show who is affected by a service, system, technology and in what way and may contribute to a fair distribution of benefits and drawbacks (Palm et al., 2013).

The interactive assessment methodology presupposes a social constructivist theory of technology. In contrast to technological determinism, social constructivists insist that new technology is the result of social interests, forces, and choices. The theory is both descriptive and constructive. It informs us that technologies are not neutral, but instead serve the interests of some institutions and social groups. And, if we are aware of the fact that a technology is not fixed or given but may be shaped according to our needs and values, technological development becomes an ethical challenge. The process of technological construction is intimately connected to questions of what constitutes a good life and which values we want to realize (Palm et al., 2013).

The role of ethics in project term

In this project, students are offered tools for systematic ethical reflection. These tools consist of an introduction to normative ethical theory and key values essential in most development projects. Other tools provided are different models of ethical technology assessment and an introduction to professional responsibility, discussing moral responsibility from a normative perspective and the meaning and value of written codes of conduct (e.g. the ethics codex for engineering students). Students are made aware of the fact that conditions may change in the course of the project development, and thus, that an initial ethical assessment may need revision and modification later on. Initially, students are required to take stock of their project, identifying and listing intended and potential unintended consequences. It is stressed that students should seek to, as far as possible, foresee possible uses and misuses of the service/system/technology, make an inventory potential risk and design the project in such a way that these risks are avoided. Certainly, students are not expected to be able to “see into the future” but at least map possible scenarios. Examples of scenario writing are provided in the lectures. Importantly, each of the steps taken should be documented. At an early stage, the students are also asked to conduct a stakeholder analysis encircling potential stakeholders and for each of the stakeholders identified, sketch ways in which these stakeholders may be affected by the service/system/artifact they develop. Furthermore, for each step, they are expected to critically discuss what the least harmful design/conduct would be and suggest a minimally intrusive product. In addition to the ethical assessments of the service/system/artifact developed during the project term, the students are asked to reflect on the ethics within their own project group and the relations between the group, the client/s, customers and users. This analysis should reflect ethically relevant aspects such as responsibility, respect and trust. In this, way, the work within the project term should be a service/system/artifact that meets the requirements of an ethical life cycle approach.

THE PRACTICAL DESIGN OF THE MODULE

The course is a project course and is combined with the student’s bachelor thesis. Both the course and the project stretches over students' entire sixth semester. Students who take this compulsory course are already used to work in groups because the pedagogy and methodology applied in the first five semesters are problem-based learning, PBL. The methodology means that the students solve realistic problems that are relevant to their future profession in the so-called basic groups of 6−8 students. To their help the students have a mentor that will inspire them, assist them in the learning process and in the group process. The framework for the work of the basic group is formulated by the group in a contract which group members jointly will be responsible for. The issues that the group is working with will be formulated in such a way that, based on their skills, the group should be able to identify problems, generate new ideas, make new hypotheses, set new learning goals based on what kind of information and knowledge they are looking for and generating new knowledge. Even if they work in the group, the focus is on the individual's development.

In 6th semester this concept is changed and the students work as a team without a group supervisor and after a certain project model. The focus is shifted to the group's joint results. The aim of the secure mobile systems course is to teach the content by imitating the situation many engineers are introduced to when they begin their professional careers. As a new employee at a company there is a lot to learn in a short time. Many companies send their employees on intensive courses, where they are expected to learn skills that are necessary in order to work with the company's projects.

The students are expected to take on the role of a new employee at a company. They are expected to learn technical, group and project aspects that are necessary to function within the company. They are also expected to fulfill the technical requirements as well as the professional communication skills necessary to communicate with clients and internal decision makers. During the semester they will work within a project and get practical experience both in project planning and feedback. The group’s results are presented to a fictitious company management which is played by the course management.

They will learn to cooperate with other members of the team, clients and experts with a different background than their own. They will see how organizations affect the working group’s structure and the individual's ability to act. Furthermore, the students will learn to see the wider picture and thereby reflect upon the social and ethical aspects.

On the basis of these conditions the course has been designed so that students are supposed to be employees in a consulting firm commissioned to construct a secure mobile communication system that is meant to be used by first responders during an emergency or a disaster like the earthquake in Haiti 2010. Students are divided into project teams which will present a solution for team’s fictional customer. The customers are health services, the police force, the municipal emergency services and the Armed forces. In order to understand their clients ' organization and their needs the students have a contact person from each organization. This in order for the students to understand the broader context in which their system may be implemented dealt. They also have to understand issues such as psychological processes during a crisis, how society looks at different types of risks and how risk is assessed and managed. The individual's responsibilities to other team members, clients, but also the engineer's responsibilities for a created product or service are examples of ethical issues that are addressed.

Examination of these soft skills is done in different ways. The teams are writing a diary over own group process. This part is examined by a fully qualified psychologist who also supports the groups during the project. In addition, there is an examination in two steps. The first step consists of an individual exam where knowledge of theories and concepts of group psychology, ethics and socio-technical systems, focusing on risk and safety are examined. To proceed to step 2 the student has to pass step 1. Step 2 consists of an oral exam in which one student from each team forms a new group which can be said to represent a hastily formed network, HFN.

The definition of a hastily formed network (Denning, 2006a), as an organizational structure is that it:

- is put together quickly in response to an emergency, crisis, or urgent situation. No single organization or agency has the capacity to meet the needs that arise.
- consists of a collection of entities who have expertise or local responsibility to help but have not worked together before.
- accepts no higher decision-making authority.

Denning (2006b) further notes that entities within the network have scant time to learn or adapt before producing results and therefore retain their separate identities even while they collaborate to achieve a mission.

These fictional HFNs made up by students receive an authentic case, one for each group, to discuss. The discussion is evaluated by three teachers with different disciplinary affiliation.

The framework for this discussion should be the concept of conversation space (Denning, 2006b). He argues that the conversation space, see Table 1, established in the initial phase of a response, is critical to the success of the mission.

Table 1. Components of conversation space. Denning (2006b)

Category	Characteristics	Examples
Physical systems	Media and mechanisms by which people communicate, share information and allocate resources	Telephone, power, roads, meeting places, supplies, distribution systems
Players	Players included and their roles, core competences and authorities	Citizens, fire department, policy department, highways departments, federal emergency management agency
Interaction practices	Rules of the "game" followed by the players to organize their cooperation and achieve their outcomes	Situational awareness, sharing information, planning, reaching decisions, coordination, and unified command and control, authority, public relations

The cases can be about for example an accident during a military exercise, a storm or a train accident. An example of such a case *The fire in Bodträskfors* (Lundberg et al, 2014*)*, see below.

The fire in Bodträskfors

It was unusually hot in northern Sweden in 2006, and August was among the five hottest months in 100 years. SMHI, the Swedish Meteorological and Hydrological Institute, had set the fire danger rating at between 4 and E (ground moisture and forest fire danger are assessed using an index of 1-5 plus E, where 1 stands for very wet ground with low fire danger to (E), when the vegetation is very dry and fire danger is extreme). A total of 264 fires were reported in the area near Bodträskfors that summer and several were ongoing simultaneously.

On the night of the 11th of August 2006, a call comes to the SOS Alarm emergency service. The night staff at the medical center near Bodträskfors have seen smoke rising from the forest. No action is taken because the SOS operator believes the callers had seen the smoke that is coming from an already known fire. A call comes in again later that morning at 6:05 and a couple of part-time firefighters who has been working with the extinction of yet another fire in the area respond to the scene to determine the origins of the smoke. It takes a while before they have localized the fire, but about an hour after the call, they have found it and begin to fight it with the equipment available in the vehicle they drove to the scene. The burning area is about 300 meters by 20 meters and another three firefighters comes to their help together with two volunteers from the local community. They request additional backup repeatedly through the morning hours. When fire and rescue personnel from Boden arrive at 10:13 p.m., the assessment is that the teams are beginning to get the fire under control and the first group is given a break.

What is depicted above is part of the initial phase of what then was to become the biggest Swedish fire in modern times. At its peak, the fire covered 1,900 hectares of forest within a boundary area of 3,000 hectares. The fire began as a surface fire that developed into tree top fires that were jumping as much as 100−150 meters. Due to this, along with the burnt hoses and increasing wind, the fire spread rapidly and several times was spread past the established fire lines. Large quantities of supplies were used during the response including 80 kilometers of hose and it took four trucks to transport the supplies back to the original storage site. The total cost of the fire is an estimated SEK 75−100 million. (Seminar documentation, 2006).

Many different players, including forestry companies, helicopter services, the Swedish Armed Forces, the “Home Guard − National Security Forces" and fire and rescue service personnel from Sweden and Finland as well as volunteers were part of the hastily formed network created in connection with fighting the fire. At most, about 160 people were working during any given period of 24 hours in shifts of 10−12 hours, and the total working time during the four weeks the fire was active was 750 person days. When the number of helicopters was at its highest, eight were used for air assault and two for other purposes, such as monitoring and transport.

LEARNING OUTCOME

All groups, 3−4 groups with a total of about 30 students each year, have so far managed to identify stakeholders and discuss actual and potential impact on these. Groups that not only identifies stakeholders, actual together with potential risks and benefits, but also values and desirable impacts get richer analysis. Characteristics of these very rich analyses are a serious ambition to identify and propose an alternative course of development or design in order to avoid problems and to be able to strengthen the ethical acceptability of the final product/service. Several student groups over the years have expressed that they were much surprised to find potential ethical issues related to a project that, at first glance, seemed to be ethically unproblematic or neutral. They also stated that they believed that the ethical assessment had strengthened their product.

CONCLUSION

By designing this course so close to the reality that the newly qualified engineer will face, basic normative ethical theories, principals and concepts comes in a natural way. They don’t become a separated extra add on. The students will thus become aware that reflections on ethical perspectives about social, organizational and business questions are an integrated part of the modern professional engineering role.

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