

Integration of Environmental Aspects and Ethics in the Undergraduate Engineering Curriculum at University of Trondheim, Norwegian Institute of Technology (NTH)

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ABSTRACT

An upgraded and enlarged block of core subjects within social sciences including environmental education as a part of the undergraduate part of the "Sivilingeniør" (MSc.) programme at NTH, is under implementation. This paper describes goals, pedagogical approach and content and for these subjects with emphasis on one of the subjects (Introduction to Work Science, Environment and Ethics),

INTRODUCTION

As a part of NTH's strategic plan a new, upgraded and enlarged block of subjects within social sciences, is under implementation. The block is compulsory for all students at NTH and includes the subjects "An Introduction to Organization Theory", Introduction to Environment, Work Science and Ethics" and "Introduction to Economics"

In this presentation we will only discuss the introductory social sciences subjects at NTH. The three subjects are placed in three different terms (term 1, term 3 and term 4 with 3 hour lectures and 1 hour exercise a week). All together it represents about half a term or 5 percent of the total study programme.

The block of introductory subjects is compulsory for students from every engineering discipline at NTH, and together with the consequences of limited resources and time allocated to the programme, the subjects have to be rather general compared to other programme integrating environment, social aspects and technology /1/. Of course many other environmental and environmental engineering subjects, of different academic levels and with different approach, are available later in the study depending on the interest of the student or on the study line in question /2/.

GOALS FOR INTRODUCTORY SOCIAL SCIENCES SUBJECTS

The over all goal of this package of subjects is to emphasize the close relationships between engineering, society and environment in a way that is useful for the students in their further study's (including advanced courses in environmental engineering and management) and later as professional engineers.

The courses should contribute to knowledge about essential aspects of health, environment, safety management, ethical, economical and juridical problems in a way that may help the students to form, analyse and critically discuss professional questions.

The courses should also increase the knowledge about technological and non-technological interaction in organizations, with the environment and society in a way that increase the student's ability to use theory as a tool for analyzing, assessing and acting.

The courses should further contribute to seeing the relationship between persons and organisation and their different options for action, and to understanding the result that may be produced from such options. This approach may help the students to formulate and present problems and analyse them, rather than copy apparently already solved problems.

The courses should also focus on how to arrange and organize a group's work in question to work efficiently and to develop internal solidarity and common responsibility for the result of the work.

At the moment a comprehensive review of the goals, pedagogical approach and structure of the complete study programme at NTH is going on. The Curriculum Development Committee has so far only produced sub-reports /3/, but it is clearly stated that the Master of Science study should meet the following pedagogical approach:

- * Comprehensive solutions and inter-disciplinarity
- * Understanding of relations e.g. between raw material, process, product and environment.
- * More emphasis on solving problems and problem-oriented learning.
- * The student shall be train to work efficiently in groups on complex issues, write reports and make oral presentations.

We hope that the environmental project will increase the student motivation for learning and increase the curiosity on knowledge, because the need for knowledge and better understanding will appear through the process of work on a certain problem.

THE ENGINEER'S ROLE AND RESPONSIBILITY

We think that engineers in the future even more than today, have to see technology in a broad and conceptual way related to culture and society.

We recognize that engineers are intermediaries between nature and culture. Engineering is not applied natural science. It is more than that. Engineering is construction; not only physical construction but also social construction. We will not go further into that discussion here, only refer to the works of French social scientist Bruno Latour /4/ as one of the main contributors of understanding technology as negotiator between nature and culture and construction making.

The role of the engineers is to look towards nature to find out what it is possible to do and look towards culture for what it is necessary, desired or acceptable to do. To understand the interaction between technology, nature and culture is essential. One of the textbooks /5/ that we use, emphasis that approach (Fig. 1).

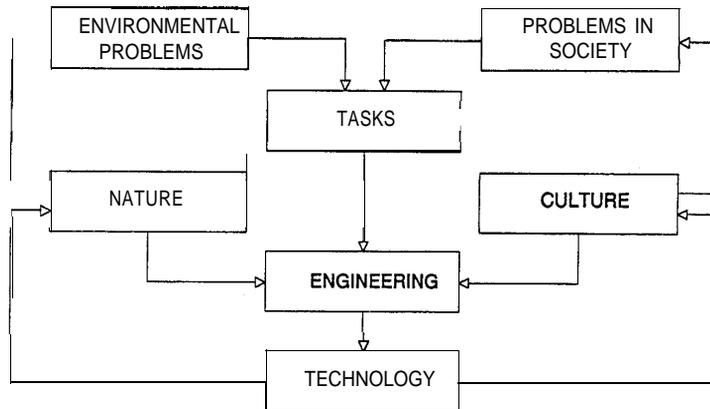


Figure 1 The structure of engineering.
Based on Andersen and Sørensen /5/

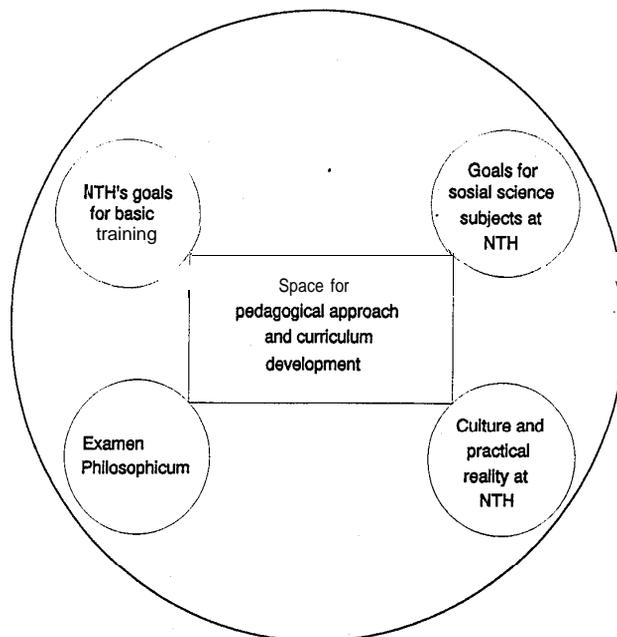


Figure 2. Space and framework for establishing the block of subjects within social sciences.

OVERVIEW OF THE CONTENTS OF THE THREE SUBJECTS

In the following we will briefly present the different issues covered by the three subjects

ORGANIZATION THEORY

Gives an introduction to:

- * the understanding of thinking and science (a philosophic approach),
- * the relationship between natural science and social science,
- * the interaction between technology , people and organizations, and development and selection of technology,
- * the connection between understanding of organizations and options for action and actions,
- * practical training in cooperation and group work, and
- * juridical thinking and theory, and some important legislative aspects of society and business.

WORK SCIENCE, ENVIRONMENT AND ETHICS

Gives an introduction to:

- * the interactions between development of the society, development of technology and consequences for the environment,
- * ethics and values, environmental ethics and profession ethics including discussion of options for action, decisions and responsibility,
- * environmental issues like population and resources, energy and environment, and pollution and pollution control,
- * work and indoor environment,
- * environmental management mainly legislation,
- * health, environment and safety management, and
- * to a comprehensive approach and the need for multi or inter-disciplinary work on complex problems.

ECONOMICS

Gives an introduction to:

- * micro and macro economy related to consumers and producers ability for adaption and action,
- * problems related to decisions made to day and their consequences in the future,
- * economical and mathematical models and calculations, and
- * the international aspects of economy.

THE SUBJECT “WORK SCIENCE, ENVIRONMENT AND ETHICS”

As mentioned above the subject shall cover a number of different issues and topics. It is a problem that teaching only can cover the surface of each topics. We still believe that the parts put together will give the students an adequate introduction. In the exercise part of the subject it is possible to go deeper into the problems.

The group work and exercise programme

The total number of students is 1400 annually, and the exercise programme is based on group works. In the beginning of the first term the students are put into groups of 6 students, and that makes about 230 groups.

The exercise programme for the subject Works Science, Environment and Ethics have to parts:

PART 1: Two or three assignments on selected subjects associated with the lecturers on a) technology, culture (society) and environment, b) the role of engineers as an intermediary between nature and culture, and c) ethics and values. Supervision is taken care of by the Department of Organization and Work Science.

PART 2: A small “decentralized” techno-environmental project work for the assessment of typical environmental problems within the different areas of engineering.. Design of assignment and supervision of the project is delegated to supervisors at the different faculties and departments. Some 70 supervisors handle 1 to 3 (4) groups each

The Techno-Environmental Project Work

The project should give students in an early stage of their study, an impression of how the different departments respond on the environmental challenges, and link them up to their fields of teaching and research.

Preferably the supervisors should design a small project within their field of interest in way that a certain kind of technology can be discussed by the students in relation to environment, environmental problems, or how technology could contribute to solve certain environmental problems.

The subject may be within outdoor or indoor environment, use of resources, energy, work environment, ergonomy, safety, etc.

The arrangement is an opportunity for the departments to present for the students at an early stage of their study, a number of interesting issues, technologies and problems. It is also an opportunity for faculty to a stronger involvement in environmental and problem-oriented aspects of their field of work.

For the students this occasion will be the first contact with the faculty teaching engineering subjects or advanced courses, and for some students it will be the first step towards an environmental engineering profile of their study.

Further, we will not present technology in the context of good or bad, but more that technology could be both good and bad depending on what kind of technology that is developed and used, and not at least how it is used. We will emphasize the view that technology can both serve and rule us. This approach can be enhanced to include effects and impacts on the environment from the use of technology.

It is well known that many people have rather deterministic view of technology. Some with the conclusion that we are mastered and lost as slaves of technology, while other mean that technological development is positive even like a natural continuing of biological evolution, and that technology can serve us forever.

In our approach we emphasize that it is possible to understand why some technologies developed successfully and other lead to misuse, accidents, destruction or catastrophes. From this understanding it is important to look not only at technology but even more at the technologist. What was the circumstances around the choice, implementation and running of a certain kind of technology. One method to achieve this is to use well known controversies as background for reflection, discussions and learning.

In the ethical part of the curriculum we try to give an overview of ethics and ethical systems in general, including ethical attitudes towards nature and use of resources, and for the future generations. We do also focus on professional ethics and standard engineering ethics. But it is even more important to discuss values, dilemmas and methods for handling difficult cases. We feel it is more important to increase the ability among the students to discuss ethical questions in general, rather to reduce the issue to learn ethical rules.

The package of introductory courses comprises all students at NTH, and it is important to recognize that such a programme have to be a compromise of NTHs goals for basic training, goals for the different social science subjects at NTH, culture and practical reality, and pressure and expectations from the world outside campus. Authorities and different interests outside are expecting that NTH offer a more philosophical approach to the introductory courses. At the Norwegian Universities students have to pass "Exam Philosophicum" (about one semester full time study) which includes history of philosophy, logic etc. Among these different interests we try to explore the space for a new pedagogical approach and development of the curriculum (Fig. 2).

We think the curriculum should include material for reflection and general discussion, and material that are useful for the future work as engineers. To meet the last part we include knowledge and tools for environmental management.

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