
The International Semester in Environmental Construction Engineering at the Engineering College of Aarhus

Peder Maribo

Jørgen B. Nielsen

Engineering College of Aarhus

Dalgas Avenue 12, DK-8000 Aarhus C, Denmark

In August 2003, the Engineering College of Aarhus (IHA), Aarhus, Denmark, will offer a new International Semester (30 ECTS credits), which will be called Environmental Construction Engineering. The article introduces the IHA, the town of Aarhus and the IHA's programmes in engineering. The objectives of this semester-long curriculum are also presented. These include the outline of the content, the learning strategy and the measures that need to be taken in order to meet the challenges in the internationalisation of the learning environment. These challenges are expected to include such elements as cultural and linguistic problems, maintaining quality and issues in accreditation.

THE ENGINEERING COLLEGE OF AARHUS, THE TOWN OF AARHUS AND THE ENGINEERING PROGRAMMES

Aarhus is the second largest town in Denmark with a population of 300,000 people and has a reputation as being a *students' town*. Indeed, Aarhus has (with the University, the School of Architecture, the Aarhus School of Business and the National Institute of Social Educators as the largest) more than 60,000 students enrolled.

Since 1915, engineering education has been offered at the Engineering College of Aarhus (IHA). The programmes are state-approved and supported by the state, and therefore no tuition fees are charged. The College has approximately 1,300 students and 140 academic, technical and administrative staff. All programmes commence twice a year (August and February). The technical library, also open to the public, is the country's second largest.

The College offers education at the Bachelor level within civil and constructional, mechanical, electronic and computer engineering, as well as in Information and Communications Technology (ICT). An admission course of one year is included in this portfolio.

At the Masters level a selection of programmes are offered in cooperation with other universities and in-service courses within the fields stated above are prepared according to demand.

Since 1989, the College has participated in the various European and Nordic programmes that target facilitating student exchange. This is accomplished through the following activities:

- Providing economic support.
- Making programme descriptions and credits transparent.
- Strengthening the links between academic staff members.

These continuous efforts have thus far been limited by the lack of theoretical courses in English, which the present initiative will remedy.

Key teaching objectives of the programmes at the IHA include the ability to cooperate, to utilise results from research work and to produce ready-to-use projects. Apart from the courses and projects, the programmes include six months of practical engineering training. Furthermore, the theoretical content should prepare the students for continued graduate studies.

PROFESSIONAL OBJECTIVES AND STRUCTURE OF THE INTERNATIONAL SEMESTER

The aim of the semester is to combine traditional civil engineering skills related to the construction of urban environmental infrastructure with environmental process know-how and a deeper understanding of infrastructures' functional aspects.

The focus of the semester will be the urban infrastructure for wastewater management and purification. The semester will comprise a number of courses (each 2½ ECTS credits) and a multidisciplinary project (15 ECTS credits) to be completed in teams of two or three students.

The choice of professional focus has not been made randomly. Environmental concerns have long been on the agenda in Denmark and by passing the Aquatic Action Plan in 1984, the Danish Parliament began a process in which billions of Euro have since been invested in upgrading the country's sewer systems and wastewater treatment plants. The experience gained from these projects has created a significant level of expertise among researchers, as well as within Danish engineering companies.

The International Semester on Environmental Construction Engineering is founded on this expertise. The international perspective is acknowledged by focusing not on national, but primarily on European Union (EU) and international standards, regulations and requirements.

Courses and project work will focus on the analysis, planning, design and construction of sewers and wastewater treatment plants. An outline of the courses available is as follows:

- *Environmental planning and management:* This covers the legal, political, organisational and other aspects in the planning of the development of municipal environmental infrastructures.
- *Wastewater treatment:* The processes in, and the design of, mechanical, chemical and biological wastewater treatment plants are looked at, as well as at sludge management.
- *Receiving water bodies:* This subject tackles water pollution, methods of measurements and analysis, water chemistry, data processing and assessment of the pollution index.
- *Sewer systems:* The construction and renovation of the sewer systems is covered; this includes a systems analysis by utilising the computer model MOUSE and related models [1].
- *International engineering:* Procedures, regula-

tions and traditions are studied regarding the export of systems, the formation of syndicates, financing, preparation of proposals and project management in foreign cultures.

- *Project management:* This looks at project planning, organisation and management in general, as well as the identification of the criteria for success and the choice of management tools. Other areas studied include the control of time, resources and economy through WBS (Work Breakdown Structure), CBS (Cost Breakdown Structure) and RBS (Resource Breakdown Structure).

Further to this, there is a special introductory course for international students that seeks to provide greater understanding of the learning culture at the IHA in order to provide the best conditions for teamworking in internationally mixed groups. A more detailed description of the course content can be found at the IHA's Web site [2].

The courses are evaluated on a pass/fail basis through a number of mandatory written assignments.

The project work serves to train the application of theories from the courses through the proposal of technical solutions to a given environmental project in its entirety. This project requires the analysis of an existing sewer system, the design of new sewers, a draft design of a wastewater treatment plant, as well as an evaluation of the project's impact on the receiving water body.

The starting point of the project entails a number of drawings, reports and other information, which describe a real-life situation that requires analysis and the proposal of solutions to a number of specific problems. It is a requirement that the project groups discuss and define their own focus of work within the project framework.

The focus of the project can be either a more analytical approach or a more practical oriented contractor's approach. The use of computer models for the analytical part of the project will also be encouraged. The IHA will provide each group with a PC and programmes, such as MOUSE and others [1].

During the semester, the project groups are required to produce a written report that describes their analysis and presents their solutions and recommendations.

THE LEARNING STRATEGY

Five years ago, a reform of the studies at the Engineering College of Aarhus was introduced. Key terms include:

- *Make students study more independently.*
- *Allocate more time for supervision than teaching.*
- *Combine each semester's curricula to entities.*

Basic principles of the learning strategy are explained below, and it is argued in the following section why this is believed to be particularly suited to the International Semester.

In practical terms, each semester presents its own large project, incorporating the theory from the courses during the initial periods of the semester.

In order to work as close to reality as possible, the project has to be completed in groups of students as teamwork. The group becomes a forum in which various approaches to a problem can be discussed and the best solution found through argumentation. The learning process is stimulated as the students share their different professional insights and views on how a problem should be solved.

Insights into how group work can be organised and successful cooperation can be established is facilitated through lectures that present relevant theories and techniques. Furthermore, each group is assigned a supervisor who will meet with the group on a regular basis (typically weekly), assist in professional discussions and consider how the group may resolve any problems in cooperation that the group may encounter.

Nevertheless, it is the sole responsibility of the group members to organise their work, complete quality assurance on parts of the work, which is usually delegated to individuals or sub-groups, and to produce a written report that documents the group's work. This group report then provides the basis for the later evaluation of the project at the end of the semester.

A workspace with tables, chairs and a PC are at the disposal for each group during the whole semester to facilitate group work.

The project is evaluated in an examination at the end of the semester. The project group members presents their findings and the methods and results are discussed. The supervisor will be in charge of the examination, which is conducted in the presence of a censor (external examiner) appointed by the Danish Ministry of Education. An individual grade is given based on the written project report and the examination.

The group size is gradually reduced over the programme period, starting from the first semester with five to six students (emphasis on the process). In the final semesters, the group size consists of two or three students (emphasis on the product).

Every programme has its compulsory component formed in the first four semesters. The fifth semester is dedicated to engineering training, during which the students are expected to acquire a critical and realistic approach to the application of their knowledge.

The International Semester will follow immediately after the engineering training period.

THE CHALLENGES OF INTERNATIONALISATION

Cultural and Linguistic Challenges

Over the last decade, teaching in the English language has become increasingly widespread among Danish universities and other higher educational institutions. Systematically setting up curricula and subjects in English has the immediate advantage of attracting more students and creating a more inspiring and versatile study environment. Furthermore, as the present programme is solely based in Aarhus, it will contribute to a level of parity in the volume of student exchanges. Danish colleges have experienced that an approximate level of balance is crucial in order to maintain the possibility to offer exchange periods for (other) native students, at least in certain countries.

Inviting students from various countries with different cultural and professional backgrounds, as well as changing the language to non-native English, involves a number of challenging issues in order to maintain a high professional level and to secure favourable integration of the foreign and native students. These language and cultural challenges need to be taken seriously for the International Semester to succeed. Fink et al describe experiences with international students at the University of Aalborg, Aalborg, Denmark, where the learning environment is somewhat similar to that of the IHA [3].

Special attention must be given to encourage the formation of internationally mixed groups and to introduce foreign students to the learning environment of the IHA, as well as Danish culture in general. This is primarily done during the International Semester using an introductory course for the foreign students and by arranging the groups administratively, based on a few questions regarding the students' desired professional focus. In this way, an international mixture of the groups can be achieved.

The importance of preparing the lecturers for potential cultural and linguistic challenges is described by Klaassen and Graaff [4]. A comprehensive

programme to upgrade lecturers' language skills is offered at the IHA. Improved awareness towards cultural challenges will also be addressed in workshops for the lecturers.

Maintaining Quality in the Professional Fields

One of the prime objectives of the Danish educational system is that programmes should be very flexible in order to accommodate the transfer of credits from one programme to another. This is not always as easy as it sounds.

At first glance, most civil and constructional engineering students are considered to have the same basic knowledge. To be convinced that the opposite is the case, one needs to look at apparently similar institutions within Denmark. Therefore, why should the differences be less pronounced when comparing programmes between, say, Denmark, Greece or China?

In the environmental construction programme, it is envisaged that the level of quality in the professional fields will be maintained by turning the variations in the students' backgrounds into an asset; the students may initially follow individual, theoretical courses, but in the project period, they will combine their knowledge in order to complete the project. For instance, a problem based on a real project – and even a known solution in the student's home country – could be analysed and compared with other solutions.

An important measure for the level of quality is the bilateral recognition of exchange students. The requirements for the admission to the International Semester are as follows:

- The students have passed the first two years of a corresponding engineering education at their home university and have passed a course in basic hydraulics.
- The students have proven proficiency in written and spoken English.
- The studies at the Engineering College of Aarhus should form an integral part of studies at the home university.

The procedures related to this International Semester are described elsewhere [2].

Accreditation

Accreditation procedures are an important tool in the process of maintaining quality that can lead to transparency in the educational system. This is no less

true in relation to international programmes that have considerable variations in professional content, as well as in the educational approach.

Accreditation methods have been described in numerous papers and proceedings. A group of member agencies from the Nordic countries, called the European Network for Quality Assurance (ENCS), has presented a model suited to those countries in order to follow up on the Bologna Declaration [5].

There is a long list of elements included in the accreditation process: a thorough course description with transparent prerequisites that is available on the Web site is one of them [2]. Maintaining quality control through the participation of external examiners common for the entire country and approved by a central body is another important factor in the accreditation process.

DISCUSSION

The Engineering College of Aarhus is investing many resources in order to ensure that the International Semester is a success.

A presentation of the International Semester at a number of European engineering colleges is planned for autumn 2002 and spring 2003.

Furthermore, a special presentation is also planned for the 6th *Baltic Region Seminar on Engineering Education*, which will be held from 23 to 25 September 2002 at Hochschule Wismar - University of Technology, Business and Design, Wismar, Germany.

Finally, it is envisaged that there will be 10-15 international students and the same number of Danish students enrolled for the start of first International Semester at the IHA in August 2003.

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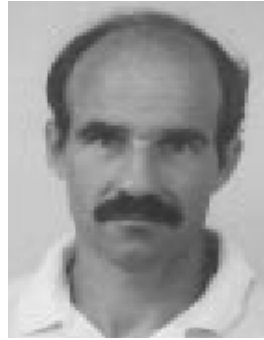
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BIOGRAPHIES



Peder Maribo graduated with an MScEng and is currently employed as a lecturer at the Engineering College of Aarhus, Aarhus, Denmark, primarily within the field of environmental engineering. Prior to this, he was a consultant and contractor involved with the design of the overall

purification process and the hydraulics of wastewater treatment plants, as well as with the erection and running-in of such plants. This job has been carried out in a number of countries.



Jørgen Bundgaard Nielsen has an MScCE and is the Vice-Rector of the Engineering College of Aarhus, Aarhus, Denmark. As Head of the Academic Board he has been involved in setting up international cooperation programmes since 1989 and is responsible for student exchanges in studies, as well

as for engineering training. Previously, he was a lecturer in hydraulics and environmental engineering.

He has worked as a consultant on the effects of the environmental impact on water recipients, and as an advisor to the Food and Agriculture Organization of the United Nations (FAO) in the area of the exploitation of water resources.



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