Advanced Technology, a Broad Technical Bachelor Programme at the University of Twente

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Abstract

Advanced Technology is a unique bachelor program at the University of Twente that has a strong multidisciplinary character. The technical component is dominant but is clearly linked to social sciences with emphasis on entrepreneurship. The courses like "Introduction to Engineering" have a leading mathematical line that is applied to examples in mechanical and electrical engineering and physics and chemistry. Students follow several projects among which are the accelerometer project for designing, fabrication and testing, and an entrepreneurial project called Startrix for learning to write a business plan for bringing a real industrial product to the market.

Keywords: interdisciplinarity; integrated courses; project approaches.

1 Introduction

The University of Twente is a young entrepreneurial research university, leading on the area of new technology and its application for human beings and society. The organization has five faculties: Science and Technology (TNW), Engineering Technology (CTW), Electrical Engineering, Mathematics and Computer Science (EWI), School of Management and Governance (MB) and Behavioural Sciences (GW). Each faculty is divided in several departments. As an example, Science and technology has the departments Applied Physics, Chemical Engineering, Biomedical Technology, Advanced Technology and Technical Medicine and Nanotechnology. The research is concentrated in a number of Institutes. One of them is the famous MESA+ Institute for Nanotechnology. The overall structure is in fact a matrix structure. The total number of students at the University is around 8000. The university is well-known for the large amount of spin-off companies.

About 8 years ago the frequent discussions with industry revealed that there is a big need for well educated engineers with a multidisciplinary background. The University of Twente had already several education programmes which are more or less mono disciplinary, like physics, chemistry, mechanical and electrical engineering but a multidisciplinary technical bachelor closely connected to the more entrepreneurial disciplines was missing. In 2004 a bachelor program was established were all technical disciplines are represented, together with courses from social sciences such as Innovation and Entrepreneurship. The bachelor programme is unique in the Netherlands. Within Europe only a few comparable studies are present. We started with about 20 students and now between 60 and 70 students enter the program each year. Although the programme language is mainly Dutch we aim to fully transform the bachelor to the English language within a few years.

In this paper we will briefly describe the curriculum of the bachelor degree programme with special attention to the various projects.

2 Bachelor Programme Advanced Technology

The curriculum is built up of three years. The programme in the first year is compulsory for all students. The courses are:

- Introduction to Engineering I, II and III
- Materials Engineering I and II
- Fundamentals of mathematical methods
- Analysis of Technology in Society
- Innovation and Entrepreneurship

- Instrumentation practice
- Lab practice
- Two projects concerning Energy and Accelerometers.

In the second year the students have to follow a fixed programme (40 EC) but they can also choose a rather limited amount of courses of their interest (20 EC). The fixed courses are:

Engineering of complex systems I and II

- Mathematical modelling
- Differential equations
- Quantum phenomena
- Long term development of Science
- Two projects concerning Lab on a Chip and Entrepreneurship.

The student has to choose four courses from the next seven:

- Basic Chemistry
- Interfaces and Catalysis
- Production Technology
- Vibrations and Waves
- Electronic basic circuits
- Modelling of Physical systems
- Molecular and cellular biophysics.

Only one course in the third year is obligatory for the students:

- Modern Physics

In the third year a maximum of 30 EC (about a half year) is spent on following one of the special course packages that prepare for entrance in one of the regular master programmes. In some cases this package is a regular minor (20 EC) out of the large amount of minors that are offered by the university. Depending on the choice of the 3rd year package the Advanced Technology bachelor students can enter directly one of about 20 different Master programmes.

The third year is completed with a bachelor assignment (a 15 EC project), which is performed within one of the research groups at the university. Multidisciplinarity is one of the keywords for this research. The student is independently doing his own research under the guidance of a staff member, he has to write a report and defend it for an examination committee. It is the final proof that the student has met all the criteria of the bachelor degree.

Although the student can go to industry with his bachelor degree the majority of them follows a master programme. The student's choice for the master shows a broad variation: e.g. Nanotechnology, Sustainable Energy Technology, Mechatronics, Business Administration or a master at another Dutch university, and even at universities outside The Netherlands.

A significant number of AT-courses have a unique structure. In the three successive courses "Introduction to Engineering" (in total 17 EC) a special area of mathematics like first and second order differential equations is treated and applied to different fields, from mechanical and electrical engineering to physics and chemistry. In this way the student becomes familiar with the multidisciplinary character of science and applications which is so characteristic for many industrial fields.

The first two courses are given in a condensed block of four weeks. The students have no other courses in this period. The schedule of one day is: lectures in the morning, exercises in the afternoon and a test at the end of the day. This turns out to be a best practice. The results are very positive.

In "Engineering of Complex Systems" students work in small groups, solving assigned engineering problems. They have to gather and digest new information themselves, but staff and (student) assistants are available for

consultation. Each assignment is finished with an oral presentation. The problem directed learning is also one of the main elements of this program.

A very important part of the curriculum is constituted by the four projects the students have to execute in small groups (4-5 students). The projects are “Energy”, “Accelerometers”, “Lab-on-a-Chip” and Startrix. Al these projects have their specific learning goals, but a strong link with preceding and/or parallel courses is a major component in the project philosophy. Especially the possibility to apply the more theoretical learning from the various courses to practical ‘hands on’ projects helps the students to more effectively digest the offered knowledge.

3 Project Approaches in Advanced Technology

The four projects aim to develop different attitudes and experiences in the students. The theme of the first project is ‘Energy’. With the current subject ‘Fuel Cells’ students learn the scientific principle, the current status of research and development and the major roadblocks towards general implementation in society. There is a strong correlation with the parallel course ‘Analysis of Technology in Society’. The overall aim is to promote ‘Academic Attitude and Aptitude’ in the students, which includes working effectively in a group, communication skills, project organisation, literature search and evaluation. Also the students are introduced to ‘scientific writing’, the start of a continuous educational process. Each group is assigned a tutor who has the task to monitor and guide the process. The project is completed with an extensive group paper and individual 15 minute oral presentations, which are both graded by a ’jury’ (staff members).

In the second project ‘Accelerometer’ the students are challenged to use their just acquired theoretical knowledge into a practical application. Starting point is the mathematics of a mass-spring system. Simple differential equations describe a real product. Accelerometers are widely applied and can be realised in bulk or in micro-system technology. The students are free in the choice of the application but often a bulk approach will be followed. The realisation of an accelerometer in a clean room does not fit in the curriculum in this phase of the study. The project follows the problem analysis, design and simulation, and finally actual realization route. A demonstration of the accelerometer with a poster presentation and a detailed report form the course requirements.

In the third project, ‘Lab on Chip’, the students are invited to explore novel ways in typical lab on a chip applications. They follow a short introduction course on (nano-) fluidics and related subjects. With relatively simple means designs are made and fabricated in PDMS or silicon. The results are presented in an open poster session but also in the format of a scientific publication.

In the final project a small group has to develop a business plan for a recently developed marketable idea, either from a (start up) company which has a relation with the university or from one of the research groups within the university. Within this project the necessary tools for building a proper plan are provided by various experts. Here a change is that the groups are no longer guided by a tutor, but information and feedback is provided on a demand basis. The quality of the business plans and the presentations of plans are judged by an external jury, selected from the economic area. Until now the best plan has been awarded with a significant prize, made available by one of the larger spin-off companies.

Within these four projects the students learn many aspects of science, technology, its relations with society and the economics of product development. It also brings them to a level of independency in learning, creative thinking and working in a group.

4 Conclusion

The educational program of the unique broad technical bachelor Advanced technology is characterised by several specific elements. A large part of the courses has a structure where integration of different disciplines has been realized. Students are trained in small groups performing various projects with each a typical set of learning goals. The bachelor programme prepares the students for entering a very wide range of Master programmes.