Is an innovative curriculum a must for accreditation?

Hans Ponsen

Faculty of Engineering Technology
University of Twente

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My Background

• My discipline : Mechanical Engineering (ME)
• My university : University of Twente, The Netherlands
• My profession : Lecturing
  - Curriculum development
  - Design of educational projects
  - Coordinator of educational teams
• My background : Research (forming technology)
  - Industry (sheet metal, automation)
  - Knowledge transfer (third countries)
  - Education (polytechnic, university)
Menu

- Appetizer : Introduction
- Starter : Accreditation and curriculum innovation
- Main course : Project oriented education
- Dessert : Conclusions
- Coffee & brandy : Discussion
Trends in engineering education

Job requirements
- Backpack knowledge → Knowledge on demand
  Life-long learning
- Solitary thinker → Global team player

Education requirements
- Object of teaching → Subject of learning
- Content to be imparted → Competence to be gained
- Swotting up on facts → Situated learning
- Lecture room → Learning environment

Recognition requirements
- National degrees → International recognition
The Netherlands model for accreditation

- Accreditation of programs and not of institutions
- Periodic review by independent evaluation agencies for continued approval, under control of the NVAO (Netherlands-Flemish Accreditation Organization).
- QANU (Quality Assurance Netherlands Universities) offers external assessments of academic education and research programs.
- Evaluation based on self evaluation reports with clearly defined objectives and outcomes.
- Accreditation is related to funding
- No engineering agency, role of expert committees
Objectives of the UT/ME program

The program aims to educate MSc’s with an academic thinking level and working attitude, able:

• To analyze complex mechanical engineering problems, related both to products and processes
• To create solutions for these problems
• To convince others of the quality of the suggested solutions and used methods
• To develop communicative and social skills, necessary for working in multidisciplinary teams
• To be prepared for life-long learning
The German Model for accreditation

- Transition from institution focus to program focus
- Starting point for evaluation are also self-reports
- Special accreditation agency ASIIN for new degree programs in engineering, computer science, natural sciences and mathematics.
- Modular programs with study modules of at most one semester.
- Explicit demands with respect to projects, team work and interdisciplinary activities.
- Explicit notice to the choice of teaching & assessment methods, just as the acquired competencies.

**NB. Who defines the technical competencies?**
What are innovative curricula?

- Dictionary → Introduction of new methods, alteration of established methods.
- Educational science → Introduction of more interactive learning methods, like problem based learning, project oriented learning, etc.
- Industry → Introduction of curricula better corresponding to the needs of industry, like business knowledge, project management, international perspective, etc.
- Accreditation → Programs also with training in required competencies, which are missing in traditional programs.
Reasons for in new approach

- Project-oriented curriculum implemented in 1994
  - To improve the study results in terms of pass rate
  - To make the relationship between the various courses more transparent
  - To develop communicative and social skills
  - To stimulate the motivation, team spirit, etc.

- Redesign of the program in 2001 for the BaMa structure
  - Team work and project management as a basic goal
  - More emphasis on application of knowledge and skills, just as on competence training
  - Better preparation for life-long learning
Life-long learning

“Motorola no longer wants to hire engineers with a four year degree. Instead we want our employees to have a 40-year degree”

(Christopher Galvin, Past President of Motorola)

“The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn and relearn”

(Alvin Toffler, author of “Rethinking the Future”)
Philosophy of project-oriented education (1)

- Combination of theory courses, project-supporting courses, instructions, practical training and project work
- Project work about 50% of the student’s study effort
- Student teams solve realistic engineering problems, bringing immediately the acquired knowledge and skills into practice
- More ‘solution driven’ than problem-based education
- Stronger focus on the development of students and their competencies
Philosophy of project-oriented education (2)

- **Orientation on the engineering practice**
  - Combination of problem analysis and synthesis of solutions
  - Building a bridge from scientific knowledge and methods to engineering applications
  - Combination of technical knowledge, project management and communication skills

- **Motivation and attitude building** (active learning)

- **Competence training** (e.g. life-long learning aspects)
Structure of the curriculum (1)

- Undergraduate Program (Bachelor)
  - 3 years project-oriented curriculum
  - 40% theory courses
  - 20% project supporting courses
  - 40% project work

- Graduate program (Master)
  - Specialization in Mechanical Engineering
  - 1 year courses
  - 1 year project work in industry & master thesis project
Structure of the curriculum (2)

Typical trimester contents

- Design/Engineering
- Applied Science
- Modelling
- Math
- Project

Week numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Study hours: 0, 5, 10, 15, 20, 25, 30, 35, 40
Mean features of projects

- Students are working in co-operative teams
- Team members have different tasks, but an overall responsibility for the final product
- Students choose their own team-mates
- Final assessment comprises a group part and an individual part
- Some theory tests are included in the project assessment
Evaluation of the curriculum (1)

- Students are well-motivated to work harder (from 32 to (over) 40 hours/week)
- Learning effect of the projects is satisfying
- Products of the projects are of considerably high quality
Evaluation of the curriculum (2)

- Pass rate of the first year has been improved significantly (from 17% to over 50%)
- Significant improvement of the student progression over a 3-year term (more than redoubled)
- Drop-outs are leaving considerably earlier
- Majority of the staff is reasonably positive and enthusiastic
- Curriculum proves to be somewhat inflexible
Evaluation of the curriculum (3) (dilemmas, problems and wishes)

- **Performance assessment**
  - Risk that some students ‘hitch a free ride’

- **Project assignments**
  - Each year new assignments requires creativity

- **Balance between theory courses and projects**
  - Students give project work a higher priority

- **Doubts about possible knowledge gaps**

- **Scientific attitude**
  - Strongly focussed on the products, less on the process, evaluation and reflection
What did we learn and improve? (1)

1. Projects of only 12 weeks
   - It is difficult to keep projects challenging during one semester (18 – 20 weeks)
   - Assessment of large projects with too much project-supporting courses becomes too complicated

2. Assessment
   - Assessment of a project together with at most two project-supporting courses
   - Examiners have to prepare the session very carefully
   - Short training of the examiners is important
What did we learn and improve? (2)

3. More special lectures and company visits
   - Multidisciplinary assignments requires input from specialists from other departments and industry
   - Short special lectures integrated in the project
   - Company visits as an integrated part of project

4. Application oriented mathematics
   - Traditional mathematics and training in mathematical modelling of physical and technical problems
   - To narrow the gap between theory and application
   - To improve the pass rates
What did we learn and improve? (3)

5. Reduction of the number of projects

- First year: Three trimester projects
- Second year: Two trimester projects and 2 blocks of 7 weeks without project
- Third year: One trimester project after a minor

- Disadvantages of too much projects:
  - Students get a kind of ‘project tiredness’
  - Curriculum becomes less flexible
  - Accumulation of the peak times
What did we learn and improve? (4)

6. More time for reflection
   - Sufficient time for reflection, generalization and learning from each other’s errors
   - During the last week of the trimester after the examination
   - Using evaluation lectures and workshops
First year Projects

- **Project 1.1: Design & Manufacturing**
  *Examples*: Bending device for strip material
  Device for positioning of stickers

- **Project 1.2: Design & Strength of Materials**
  *Examples*: Ski for a handicapped person
  Monorail carriage

- **Project 1.3: Chain Management**
  *Examples*: Design of a waste incinerator
  Design of a electricity plant with a combined gas turbine and steam cycle
Second and third year projects

- **Project 2.1: Design of consumer products**
  
  *Examples*: Autonomous vacuum cleaner
  Drying machine for persons

- **Project 2.2: ‘Heat and flow’ project**
  
  *Example*: Windmill for electricity generation

- **Project 3.1: Mechatronic design**
  
  *Example*: Design and realization of a mirror device for rapid precision displacement of a laser beam (spot welding, hardening, etc.)
Example of a Project Assignment

• Design the housing for an autonomous vacuum cleaner: the V-mouse

• A couple of specified standard components have to be used (motors, sensors, etc.)

• Principal objective: Design in polymers using software for injection molding

• ‘Vacuum cleaner technology’ delivered by industry with some guest lectures
Results of the V-mouse Project
Conclusions (1)

- The expression ‘innovative’ is related to time, place and culture.
- The accreditation process stimulates the implementation of new, more interactive, teaching and assessment methods.
- Some required competencies can hardly be gained in a traditional education system.
- The project-oriented educational concept stimulates the engagement, self-activity and motivation of students.
Conclusions (2)

- Complexity of the project assignments is a key element. The assignments must be really challenging from the very beginning.

- Integration of different subjects within one project is also motivating for the teaching staff.

- Educators have a lot of tasks, but to motivate students is one of the most important.

- With a project-oriented educational program it must be possible to realize the objectives with respect to an academic thinking level and working attitude.
Finally . . . . .

Thank you for your attention

Questions and remarks are welcome

Hans Ponsen