University of Twente

# Is an innovative curriculum a must for accreditation ?



Laboratory of Design Production Management

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ASIIN Workshop
Göttingen

# 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)

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# Menu

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

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# Trends in engineering education

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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

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# 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

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# 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?*

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# 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

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# Reasons for in new approach

- <u>Project-oriented curriculum implemented in 1994</u>
  - 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.
- <u>Redesign of the program in 2001 for the BaMa structure</u>
  - 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

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# 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")*

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# 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

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# 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)

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# 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

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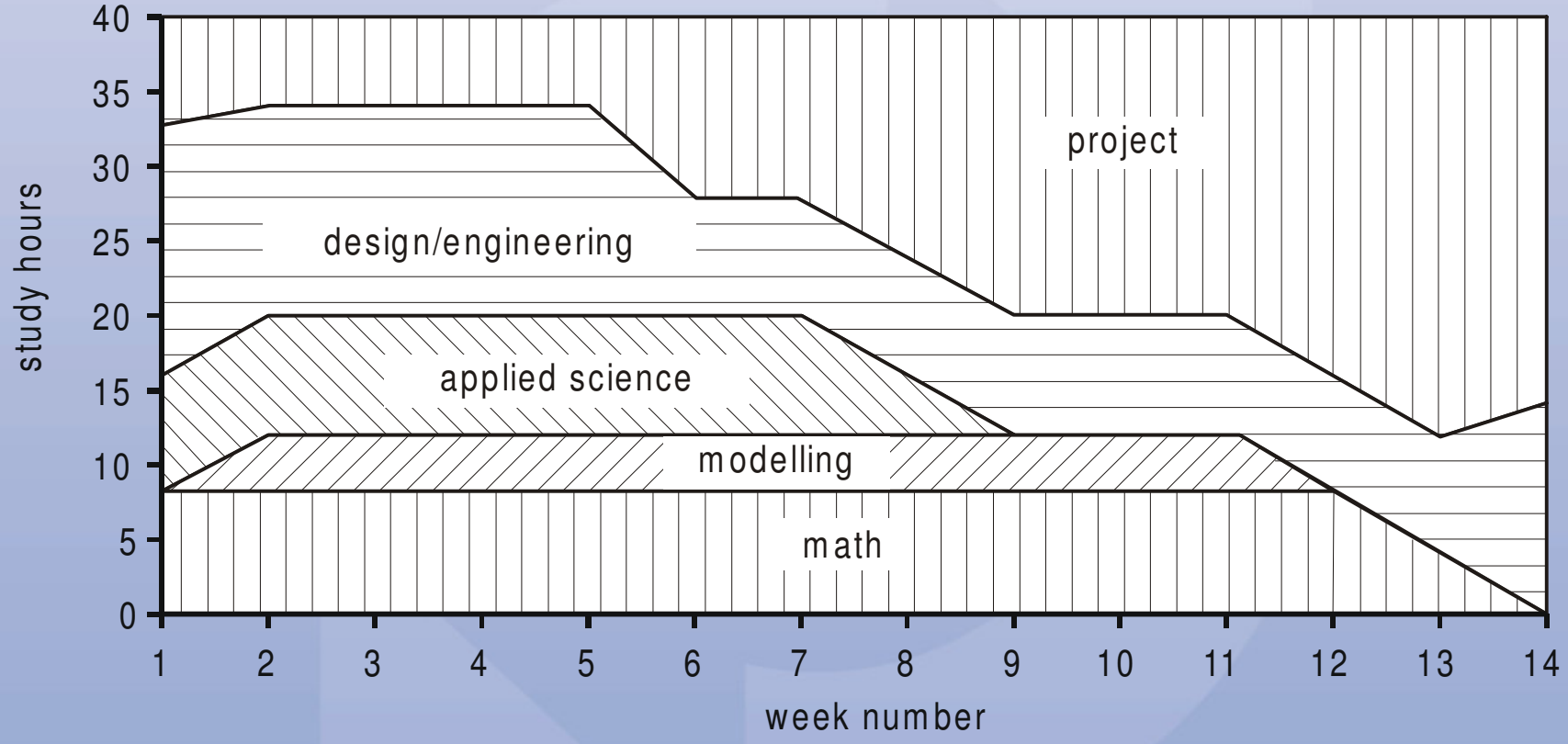
# Structure of the curriculum (2)




*Typical trimester contents*

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# 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

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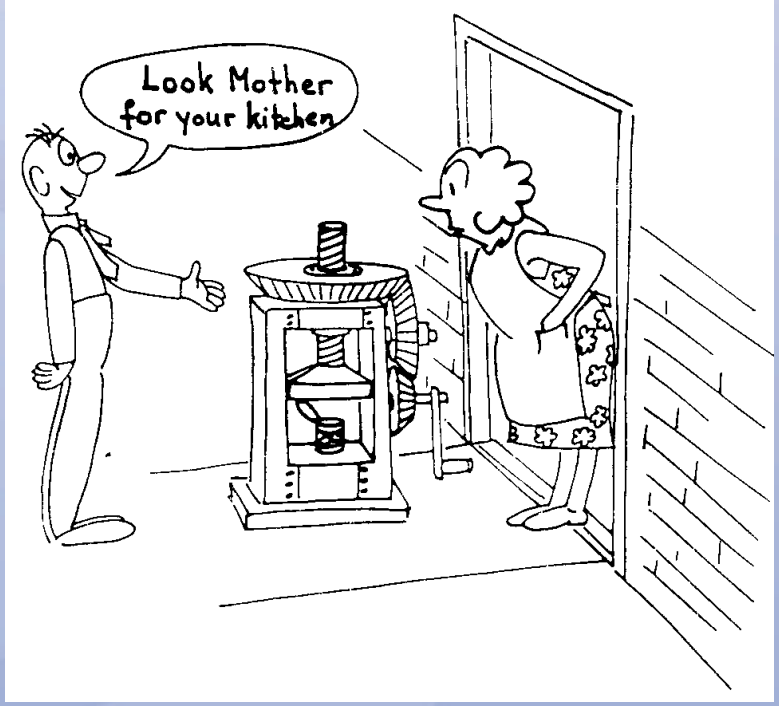
# Evaluation of the curriculum (1)

- 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

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# 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

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# 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

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# 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

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# 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

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# What did we learn and improve ? (3)

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## 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)

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## 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*

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# 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.)*

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# 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

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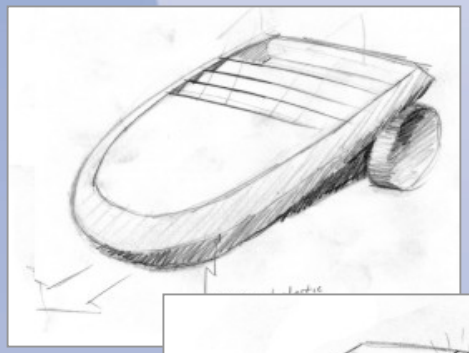
# Results of the V-mouse Project



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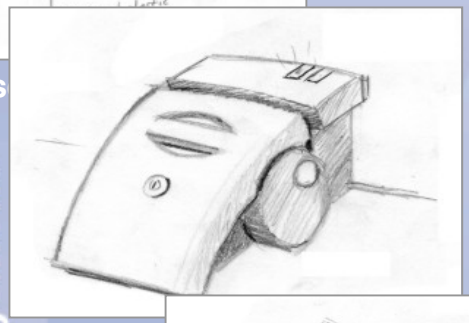

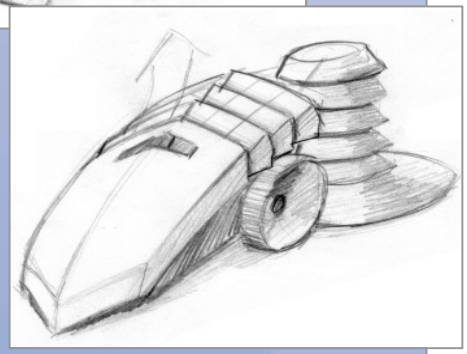

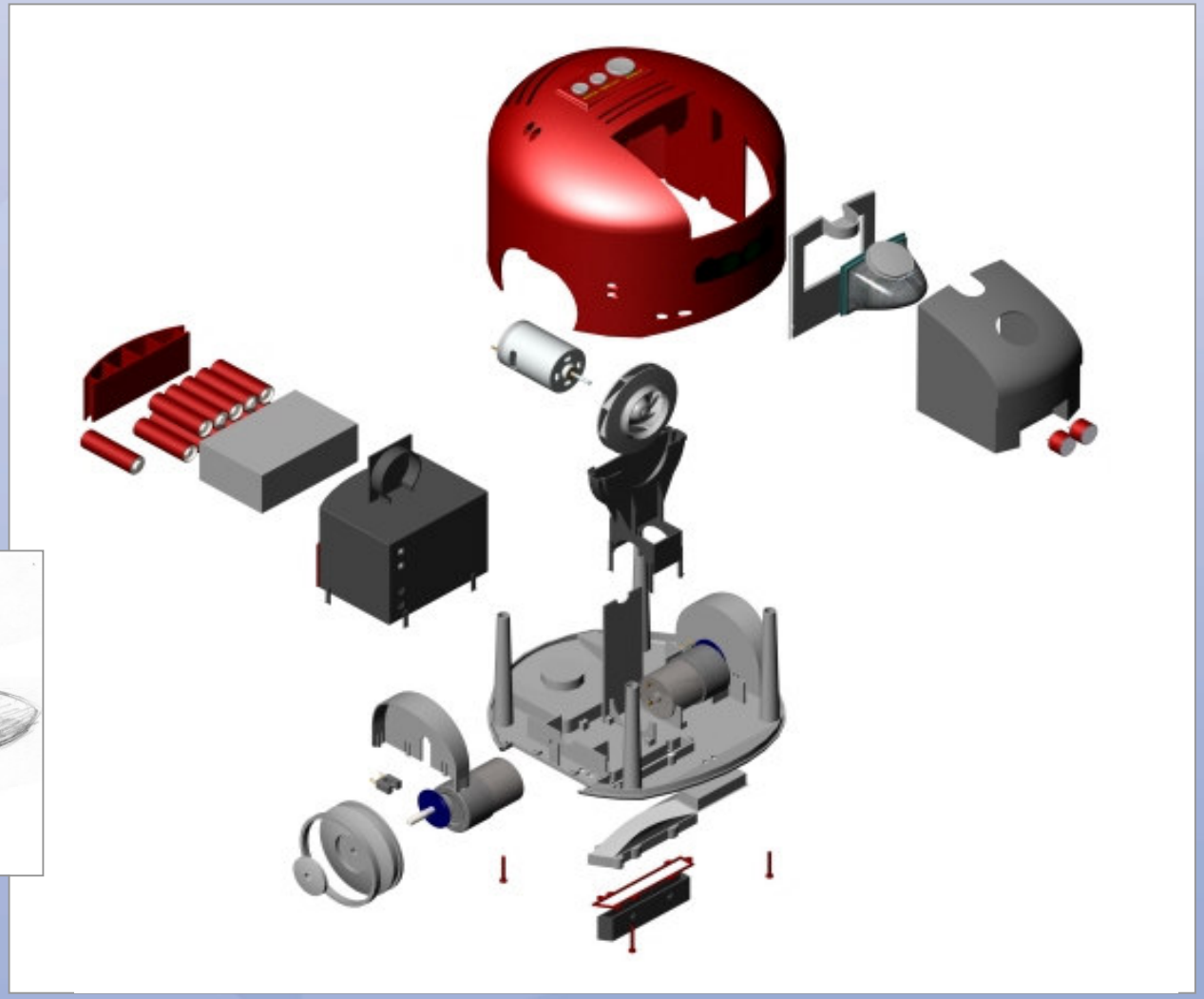

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# Conclusions (1)

- 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.

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# 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.

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# Finally . . . . . .

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Thank you for your attention

Questions and remarks are welcome

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