Competence based EE-learning: (How) Can we implement it?

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Purpose

- Define successful engineer:
  - Technical content + competencies
    - goals to mission and competencies
    - competencies to education and 'examination'
- 'Involve' competencies in an EE-curriculum:
  - Connect complex competencies to explicit reflection in project work

Contents

1. Introduction and challenges
2. From goals to competencies
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4. Eventually portfolios
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1. Introduction and challenges

- Mission is rationale of existence
  - institutional profile
  - relation to professional programmes
  - coping with competetion
- Competencies are derived from professional 'habitus'
  - content focus, but include ability focus
  - examining content $\Rightarrow$ examining ability

2. From goals to Competencies

- What is EE?

DESIGN = development + research

BSc innovative

- 'system'
- methodology
- analysis
- research
- business environment

- conceptual level
- 'research' in BSc?
- theoretical abstraction

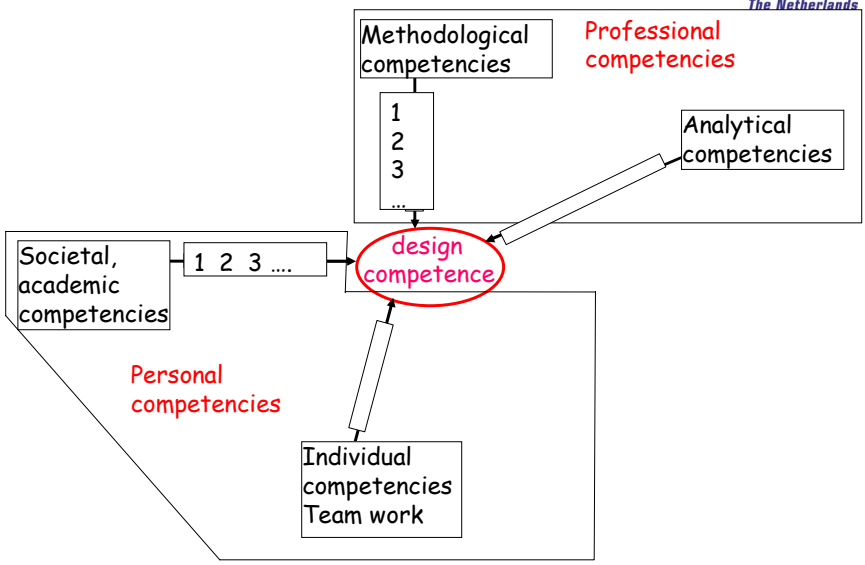
BEng standard

- 'mechanical'
- product level

MSc: BSc +specialisation

2. Continued….

- What makes you a good engineer?
  - knowledge is passive state of mind
  - competency transforms complex of knowledge to ability
  - ultimate competency: design
  - rework to 'orthogonal set'
    - learnable, testable



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3. Reflections on competencies

- Where is the training? and testing?
- Courses are isolated, necessarily provide limited context for theory
- Hence lab works and projects
  - what's new?
  - process of guided (self)reflection

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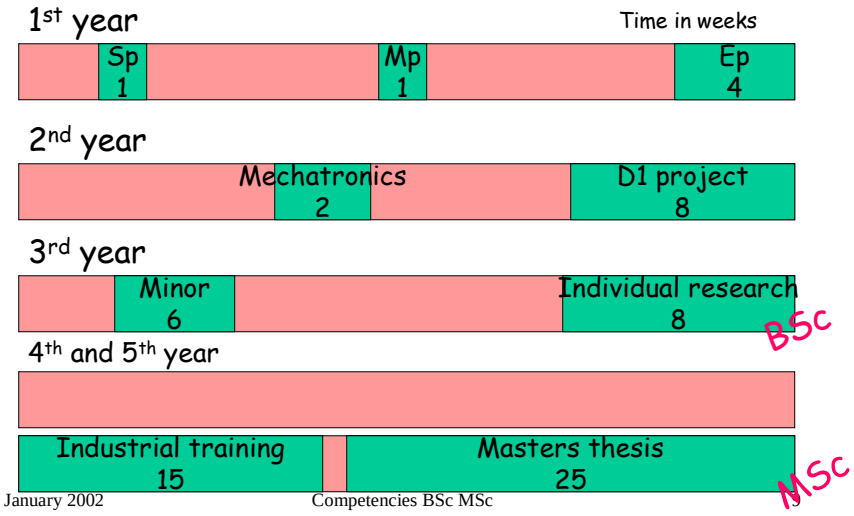
3. Continued…



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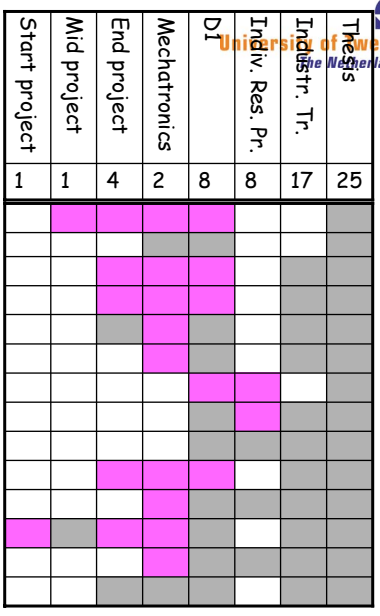
3. Continued…

Methodology

- Specify design
- generalise design
- translate into flow
- making evaluate choices
- concrete design specifications
- specifications for (sub-)systems
- *formulate research questions*
- explore new avenues
- *translate research products for use*
- execute a design cycle
- use appropriate modelling
- realise and test
- compare modelling and realisation
- judgement of design process



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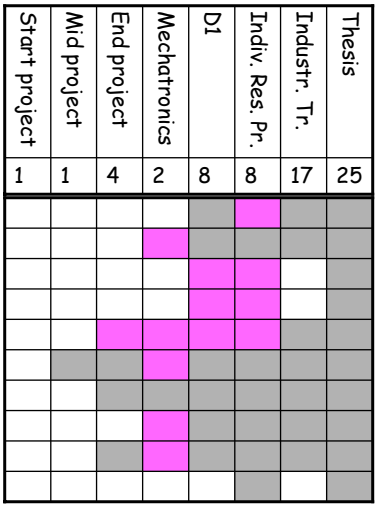

Analysis

- comprehend literature
- integrate tools and techniques
- *make a research plan*
- carry out research plan
- formulate hypothesis and test validity
- use a base of techniques and tools
- judge use of specific techniques
- comprehend new techniques
- effective and efficient modelling
- *contribute to literature*

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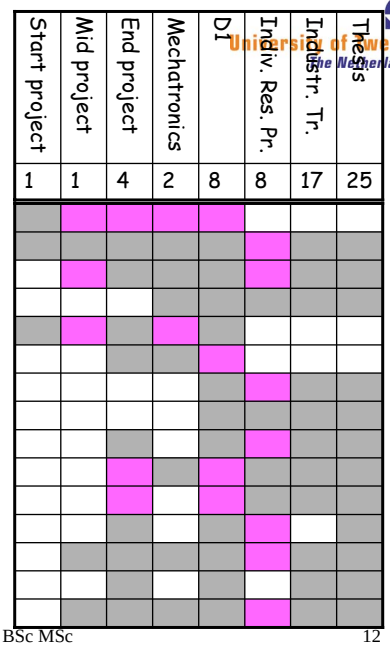
3. Continued...

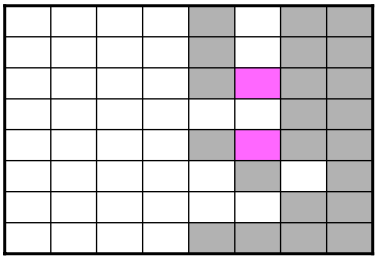


Team work and individual Attitude

- structuring group work
- attitude of curiosity
- creativity
- comprehend general literature
- understanding group dynamics
- use reflection techniques
- independent learning and mastering
- *comprehend specialised literature*
- explore resources
- attitude of self assessment
- ability of self adjustment
- verbal communication
- written communication
- *convincing in argumentation*
- recognise shortcomings in knowledge

3. Continued…

Start project	Mid project	End project	Mechatronics	D1	Indiv. Res. Pr.	Industr. Tr.	Thesis
1	1	4	2	8	8	17	25



Societal and academic

- *discussion on societal impact*
- discussion developments adjacent disciplines
- follow developments in bordering disciplines
- *reflect on historical perspective of EE*
- *use products from bordering disciplines*
- reflect on personal contribution to EE
- *defend ethics of personal choices*
- overview on generalisms in methodology

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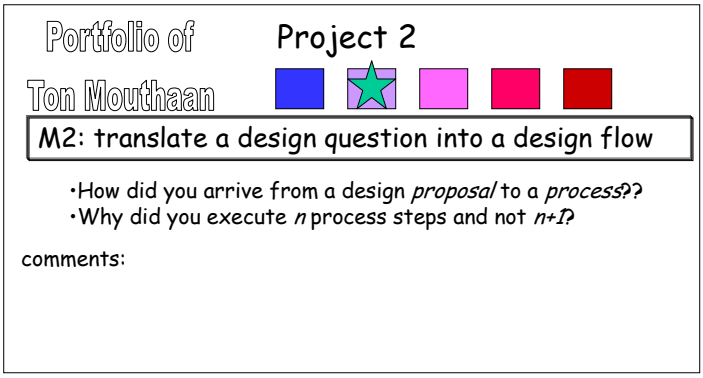
3. Continued…

- select focal points per project
- develop 5 to 10 open reflective questions
- 'serious answer' is proof of reflection

- 5 to 10 times # students of 'essays' to read (and comment..)

4. Eventually portfolios…

- fit in student portfolio:



5. Conclusions

- Competencies gives a fresh view on projects: you need a good spread of general projects
- Competencies are new … but we always did it
  - Good questions are essential (students must recognise their writing as useful exercise)
- Provides a way of evaluating a curriculum
- Student portfolios can stimulate reflection

Sample of questions:

- Start P:
  - Which abilities did you need to carry out the start-P project?
- Mechatronics:
  - What would have gone less good in your project if you had not made a clear separation between "generating alternatives" and "evaluating your concept"?
  - What is the most important benefit of having a model at each stage in your design cycle?
- D1 project:
  - Which criteria did you use to choose the moment at which you presented (and defended) your design to your 'customer'?

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Methodology

- specify, propose and defend design proposals
- generalise design questions, describe hierarchy, summarise design process in abstract terms
- translate a design question into a design flow
- making and evaluating choices made in the design flow
- translate general design ideas to concrete design specifications (given demands set by practical circumstances)
- specifying design specifications for (sub-)systems
- *recognise and formulate research questions/experiments*
- explore new avenues for problem solving, *integrate new techniques in design flow*
- *judge and define research activities, translate research products for use in design context*
- execute a design cycle, effective and efficient synthesis of partial results
- use appropriate modelling and simulation tools to describe behaviour of system
- realise and test (part of) hard- and/or software
- compare modelling and realisation results, derive conclusions and terms for possible new iteration
- independent judgement of design processes

Analysis

- find and comprehend literature, judge products of research
- integrate tools and techniques, ability to abstract, recognise universal concepts
- *make a research plan*
- carry out a given research plan
- formulate hypothesis and test validity
- use a base of techniques and tools
- judge how and when to use specific techniques
- comprehend new techniques
- effective and efficient modelling (right level of abstraction), use appropriate modelling languages
- *contribute to literature*

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Team work and individual Attitude

- structuring group work
- attitude of curiosity
- creativity
- comprehend general literature on EE
- understanding and controlling group dynamics
- use reflection techniques to facilitate group processes
- enter into process of independent learning and mastering
- *comprehend specialised literature*
- explore resources for information and effective and efficiently absorb the information
- attitude of self assessment
- ability of self adjustment
- verbal communication (self confidence, adjust level of detail/abstraction to audience, presentation techniques)
- written communication (in group, for general public, for customer/boss)
- *independence in judgement, convincing in argumentation*
- recognise shortcomings in knowledge

Societal and academic

- *give meaningful contribution to societal impact of developments in EE*
- enter into meaningful discussion on general developments in adjacent disciplines
- affinity to follow developments in bordering disciplines
- *ability to reflect on historical perspective of EE*
- *use general products of research and developments from bordering disciplines*
- reflect with sense of responsibility on personal contribution to EE
- *defend ethics of personal choices related to work field*
- overview on generalisms in methodology in general science