1. ECDEAST Workshop
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Bologna Process and Trends in European Engineering Education

Günter Heitmann
Technical University Berlin, SEFI
1. Need for continuous innovation in Engineering Education

2. Bologna Process: Aims, action lines and state of implementation

3. Trends and Developments in European Engineering Education
1. Engineering Education needs continuous innovation: Responsive to new demands, creative towards new offers

Demands arising from:
- Scientific and technological developments,
- New teaching/learning approaches and environments,
- Global economic competition and collaboration,
- Changing labour markets and work environments,
- Societal demands: Sustainability, ethics, risk care …
- Political conditions: e.g. National Higher Education strategies, International Agreements: Bologna Process, Lisbon Recognition Convention, Lisbon Strategy
- HEIs interest: Competitiveness through high quality in education, research and services,
- Call for attractiveness and accountability
2. Aims of the Bologna Process:

- Development of a common European Higher Education Area by 2010 in order to:
  - support convergence and comparability, in due course recognise diversity as a European value and strive for transparency
  - facilitate academic and professional mobility as a contribution to quality and the European Labour Market
  - promote internationalisation and global competitiveness
  - raise quality and contribute to economic growth
  - enhance European Integration, maintain cultural heritage and wealth
Bologna Process: Objectives and Action lines:

- Consecutive three-cycle system

- Easily readable degrees relevant to the labour market, based on learning outcomes, documented by Diploma Supplements

- Increased mobility and recognition of qualifications

- Implementation of internal and external Quality Assurance Systems, referring to common standards

- A common course credit system, preferably ECTS

- Promotion of recognition and transparency by a European Qualifications Framework
Bologna Process: Achievements by 2010:

- Signatories increased from 29 to 47 countries

- Three cycle system in general implemented, but with significant variations

- Increased diversity of programmes and degrees: transparency, mobility and recognition of qualifications still dissatisfactory

- ECTS implemented, but not in all countries and with differences

- Since Bergen (2005): Qualifications Framework for the EHEA, based on Dublin Descriptors, in many countries no National Frameworks yet, partly because of the competing EQF-LLL of the European Union from 2008

- Since 2005: European Standards and Guidelines for Quality Assurance in Higher Education (ESG): Accreditation accepted as approach

- London 2007: European Register of Quality Assurance Agencies (EQAR)
Bologna Process: Deficiencies and perspective:

- National interests and conditions dominate over Bologna process requirements

- Transparency, comparability and recognition still lacking, mobility partly decreased, also because of social and financial reasons

- Basic concepts not understood and implemented: e.g. the concept of Learning outcomes; subsequently: the shift from teaching to learning;

- As stated already in 2007: Action lines need to be comprehensively approached

If the Bologna Process is to be successful, all countries need to use learning outcomes as a basis for their national qualifications frameworks, system for credit transfer and accumulation, the diploma supplement, recognition of prior learning and quality assurance. This is the precondition for achieving many of the goals.
Bologna Process priorities until 2020:

- social dimension: equitable access and completion,
- lifelong learning;
- employability;
- student-centred learning and the teaching mission of higher education;
- education, research and innovation;
- international openness;
- mobility;
- data collection;
- multidimensional transparency tools;
- funding.

(according to Leuven Communiqué of Bologna Follow-Up Conference 2009)
3. Challenges, trends and developments in European Engineering Education:

- Structures, cycles and profiles: how much Bologna?
- Quality assurance: what kind of standards and procedures?
- Curriculum development: outcomes-based and learning centered?
Structures, cycles and profiles: How much of Bologna?

- Three cycle structure in engineering education implemented in the majority of the meanwhile 47 signatory countries, but significant variations and increased diversity:

- France did not change its 2+3 Grandes Ecoles system with programmes leading directly to a second cycle degree after 5 years

- UK did not care about Bologna structures and implemented four year integrated programmes to an MEng degree as new academic requirement for registration as Chartered Engineer; 3 years BEng qualifying for Incorporated Engineer registration

- Italy first in Europe to implement a 3 + 2 structure, government regulations for curricula: subject- not outcomes-related, no accreditation students not satisfied by the professional quality after 3 years, about 80% of first cycle graduates in engineering continue
Structures, cycles and profiles: How much of Bologna?

- **Germany**: Three cycle structure in engineering education implemented, but wide range of variations:

- Germany allowed a 3+2 or 4+1, even a 3 and a half plus 1 and a half structure: Universities prefer a 3+2 solution, at the same time arguing that their 3 years bachelor does not qualify for professional practice as engineer but for a continuation to a master degree;

- Different profiles: theory based and research oriented (Bachelor or Master of Science) and application and practice oriented (Bach. or Master of Engineering)

- Not strictly linked to type of HEI: Fachhochschulen (Universities of Applied Sciences) can also offer Bachelor and Master programmes of both profiles

- All programmes must be accredited: ASIIN as specialized Agency refers to QF-EHEA and EQF, but also to EUR-ACE, focusing on outcomes

- Increasing number of transnational, joint or double-degree programmes
Different preparatory studies

Age 19

Upper secondary school

Upper secondary school

B

B

General studies

A

A

General studies

Vocational studies

Vocational studies

C

C

NTNU

2 years Master

15%

15%

2 years Master (Special progr.)

80%

80%

5 years integrated Master (300 ECTS)

15%

15%

3 years Bachelor

15%

15%

2 years Master (180 ECTS)

5%

5%

(General open Univ)

(General open Univ)

(Comm. College)

(Comm. College)

PhD 3+1 years

PhD 3+1 years

PhD 3+1 years

PhD 3+1 years

(1 year teaching)

3 years Bachelor

3 years Bachelor

3 years Bachelor

3 years Bachelor

(Ung. of Stavenger + UMB)

(Ung. of Stavenger + UMB)

(Comm. College)

(Comm. College)

PhD

PhD

PhD

PhD

3+1 years

3+1 years

3+1 years

3+1 years

(1 year teaching)
Engineering Education in Denmark

- Technical universities
  - 3 years
- Technical universities
  - 2 years
- General Universities (Science)
  - 3 years
- Bachelor of Science
- Bachelor of Engineering
- Technical Universities
  - 3 years
  - 3½ years
- Colleges of Engineering
  - 3 ½ years

Preparatory Studies

Age 19

Upper secondary school

Vocational Studies
Quality assurance: what kind of standards and procedures?

- Trend towards outcomes-related standards instead of in-put criteria and standards: need for sectoral and even branch related specification and for transnational or global agreements (EUR-ACE, WA, OECD-AHELO)

- HEI: comprehensive internal quality management needed, based on outcomes-assessment and stakeholder feedback;

- Programme accreditation by external agencies more favourable in engineering education than institutional accreditation or quality audits: expansion of ENAEE and the application of EUR-ACE

- HEIs should use their autonomy to go beyond the minimum standards of accreditation, in particular with regard to specific profiles
University defined standards: CDIO – Concept: Conceive, Design, Implement, Operate

- 70 competence-based Outcomes in 4 areas:

1. Technical Knowledge and Reasoning,
2. Personal and Professional Skills and Attributes,
3. Interpersonal skills: Teamwork and Communication;
4. Conceiving, Designing, Implementing and Operating Systems in the Enterprise and Societal Context
Curriculum development in engineering education in the context of the Bologna Process

- **Opportunity for innovative curriculum development:**
  - Explicit competence- and outcome-orientation,
  - Shift to a learning-centered approach,
  - Holistic curriculum development and quality management concept,
  - Development of appropriate outcomes assessment,
  - Flexibility to address different student interests and learning styles,
  - Appropriate use of new teaching/learning methods
  - Approaches to promote life-long learning
  - Motivate and qualify faculty and staff and
  - Make use of engineering education research and good practice
Structures of Innovative Curricula:

Instead of curricula structured by subject based courses:

- Modularized curricula
- Project-oriented and problem-based curricula
- Work-based or research-related curricula
- Transnational Joint or Double Degree Programmes
Modularization at Aalborg University - Engineering

M.Sc. (5 yrs)

Spec 2 yrs

Diploma (3½ yrs)

Spec 1 yr.

Sector 2 yrs.

Basic studies 1yr.

General Structure

Project units
- Project work
- PU-courses

Study unit courses
- Science
- Technology
- Other courses

Optional courses (voluntary)

Example

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<tr>
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<th>Project units</th>
<th>Study units</th>
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<tbody>
<tr>
<td>1st term</td>
<td>Project work (15 ECTS)</td>
<td>(5 ECTS)</td>
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<tr>
<td></td>
<td>PU-Courses (10 ECTS)</td>
<td></td>
</tr>
<tr>
<td>2nd term</td>
<td>Project work (15 ECTS)</td>
<td>(8 ECTS)</td>
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<tr>
<td></td>
<td>PU-Courses (7 ECTS)</td>
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Twente University - Mechanical Engineering: 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
Paradigm shift from teaching to learning

- Provide a vast range of different learning situations,

- In particular arrangements for active, project oriented and problem-based learning in teams,

- Promote reflective learning and develop explicitly abilities for life long learning,

- Recognise prior and experiential learning,

- Address different interests, access levels, learning styles, gender and intercultural diversity.
ABET - Evaluation & Assessment Cycles

“2-loop Process”

1. Input from Constituencies
2. Determine educational objectives
3. Formal Instruction
4. Student Activities
5. Evaluate Objectives/Assess Outcomes
6. Determine Outcomes Required to Achieve Objectives
7. Establish Indicators for Outcomes to Lead to Achievement of Objectives
8. Determine How Outcomes will be Achieved
9. Determine How Outcomes will be Assessed
Survey of assessment and program evaluation

2. CDIO Syllabus survey and learning objectives*

Identify best practice and possible innovation

1. Principle that CDIO is the Context*

3. Curricular Design*

4. Introductory course

5. Design-build Courses*

6. Workshop development

7. Authentic learning experiences*

8. Active learning

9. Enhance faculty competence in personal, interpersonal and system building*

10. Enhance faculty competence in teaching and learning, and in assessment

11. Student assessment*

12. Program evaluation

Program operation and student learning

Existing faculty T&L competence

Survey of assessment and program evaluation

Faculty survey on teaching, learning and assessment

Identifying opportunities to improve T&L

Design assessment & evaluation framework

Existing assessment & evaluation

Existing curriculum

Lab/workshop space survey

Curriculum benchmarking

Design curricular assignment of CDIO topics

Design workshops and usage mode

Existing learning spaces

Existing assessment & evaluation framework

Existing T&L competence

Identifying best practice and possible innovation
Thank you for your attention!

Waiting for your questions and remarks

guenter.heitmann@alumni.tu-berlin.de