Technical Education and the Bologna Process - From London to Leuven/Louvain-la-Neuve and Beyond

Sebastião Feyo de Azevedo  
Professor of Chemical Engineering, University of Porto, Portugal  
National Vice-President, Ordem dos Engenheiros-Engineers Portugal  
Chairman BFUG, July-December 2007

sfeyo@fe.up.pt  
http://www.fe.up.pt/~sfeyo

Workshop on  
Scientific & Technical Education and the Bologna Process  
at the Università La Sapienza, Rome,  
14 November 2007

To say what I am going to say...

1. The Bologna Process and the European Strategy for Development
2. Paradigm shifts in engineering education
3. Qualifications Frameworks
4. The Directive for Recognition of Professional Qualifications and Academic Degree Structures
5. Quality Assurance issues
6. Closing Notes
The Bologna Process revisited
I - What needs to be understood?

- Understand the Bologna Process as one of the dimensions of a strategy for European development, designed and decided by European Countries around the years 70-80 of last Century

- Understand the Bologna Process as having two main groups of objectives, naturally interlinked
  ✓ Objectives of political, social, and economical nature
  ✓ Objectives of a dominant academic nature

- Understand that indeed these objectives mean, in many countries, a major reform (... a small revolution...) in Higher Education and in Society

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European Strategy for Development
I - Driving forces for changes

- Last quarter of the 20th Century - Intense search of new routes for Europe and for the role of Europe in the World, driven by
  ✓ Progress observed in Science and Technology, namely
    ➢ in digital systems and communications
    ➢ in health and life sciences
  ✓ Political changes that took place in Europe
  ✓ Expectations and demands of Society
    ➢ Education for All
    ➢ Quality requirements
European Strategy for Development

II - Life Today

- Economy and market forces - driving force of Today's Societies
- The computer and communications era - dramatic changes of the concepts of time and space - globalisation
- The increase of Expectation of Life - Social sustainability
- Sharp increase in standards and competition - Worldwide and within the European Space
- Significant change in the concepts of individual career management
- Job market and opportunities - wider than ever

European Strategy for Development

III - World Competition

(A) Geographic breakdown of world chemicals sales

World chemicals sales in 2004 is estimated at €1.736 billion
The EU accounts for 33% of the total

Source: Cefic
Definition: Rest of Europe includes Switzerland, Norway, and other Central & Eastern Europe (excluding the new EU 10 countries) Other: Including Canada, Mexico, Africa & Oceania

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**European Strategy for Development**

**III - World Competition**

(B) Scientific development and the Market

Scientific Computing, March 2007
Drastic reductions in development time

**European Strategy for Development**

**IV - A New Model...**

- Culminated with the European Council of Heads of State and Governments, March 2000, Lisbon
  - The Lisbon Strategy for Growth and Jobs
  - Competitive positioning relatively to the other blocks of the Planet
  - Stating a strategic objective:

  “By 2010, making Europe the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion”.
European Strategy for Development

V - The three dimensions of the Strategy

A strategy based on Knowledge and Transnational Cooperation, where we can recognize:

- The Economy Dimension -
  - Including the movement that converged in the creation of the EURO

- The Social Dimension -
  - In line with the European culture of humanism, reasoning, freedom and democracy

- The Knowledge Society Dimension -
  - Identified with the Bologna Process and the creation of the European Higher Education Area

The Bologna Process Revisited

I - Building the European Area of Knowledge... till 2010 !!!

European Area of Knowledge

- European R&D&I Area
- European Area of Education
- European Higher Education Area
- European Area of life long learning
The Bologna Process Revisited
II - Objectives

(A) Social, economical and political objectives

- From a social and economical point of view - to guarantee development and competitiveness through -
  - The increment of transnational cooperation and mobility, both in higher education and in R&D

- From a more political point of view - to contribute for European cohesion
  - Again, through mobility and cooperation, at all levels, of both students and professional

- Still at political level
  - To promote the External Dimension of the European model

(B) Objectives of a more academic nature

- Political / academic
  - Restructuring the offer of higher education - more attractive and nearer to the needs and interests of Society

- Academic
  - An evolution of teaching/learning paradigms - adapted to the concepts and perspectives of the modern society and to the available technical tools, projecting education to more adult phases of life
What Matters for Today’s Talk

- The Bologna Process and the creation of the European Higher Education Area (EHEA), of which the latest development is
  - The London Communiqué, signed by 46 Ministers of Education on May 18, 2007
- The Directive for Recognition of Professional Qualifications, approved by the European Parliament and by the Council on September 7, 2005
  - National laws will be passed in all EC Countries till the end of 2007

From Bologna … to London… and beyond...

I - Directions expressed in the London Communiqué

- Mobility - a central issue, far from a success...
- Curricular reform -
  - Degree System and Teaching / Learning Paradigms
    - Stabilising the closely related concepts of Learning Outcomes and Credit System
  - Quality Assurance - implementing the Register
  - Qualifications Frameworks - National Qualifications Frameworks
  - Recognition of degrees and study periods
  - Lifelong Learning
- Social issues - Employability, social dimension...
- Global dimension - Attractiveness
From Bologna … to London… and beyond…

II - After all, where are we now?

- The Bologna Process is now accepted - and not only in Europe...
  - We do not discuss anymore if we should carry on... we discuss how far have we been able to get...

- We should recognize the mountain of work ahead
  - The design is there...
  - The construction is at its beginning

- Speaking of structures, objectives and methods - The changes of paradigm are extremely difficult to achieve
  - Promotion of employability for first cycles...
  - Student centred learning
  - Learning Outcomes, the ECTS System and NQF ...
  - The Quality Assurance System

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From Bologna … to London… and beyond…

III - Still the same keywords

- MOBILITY, COOPERATION, TRUST, ACCREDITATION

  MOBILITY AND COOPERATION require professional recognition

  Professional recognition requires TRUST

- TRUST requires transparency and readability of structures and professional qualifications

  Readability means to understand and make visible the differences - in quality levels and profiles

  Such is guaranteed through Quality Assurance procedures - ACCREDITATION
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A little bit of History
Paradigm shifts in Engineering Education

- Paradigm shifts are changes in mindset or in basic assumptions
  - Here, I do not speak so much of changes, but rather of adapting basic assumptions

- 1st Paradigm(s) ? - In general terms - First quarter of the XX Century - Education close to industry and to industrial operations

- 2nd Paradigm(s) ? - In general terms - Third quarter of the XX Century - Education shift to Engineering Science

- 3rd paradigm ? - We are at present on the process of developing a model and of conceptualizing the evolution for a new paradigm... which is not yet quite identified...
Inspiring words from Chemical Engineering Education
We should not forget the Sine Wave of Life

The words of A.B. Newman, President AIChE, 1938
‘Theoretical descriptions should be limited to illustrate the engineering fundamentals, because a manager does not hire a young engineer just because he is able to describe how a product is produced’.

Words of Ralph Landau, Stanford University, 1997*:
‘I believe chemical engineering’s third paradigm, if there is one, is to return the discipline closer to the practices in industry’

New Directions for Engineering Education
I - Methods and contents for ...

Of course directed to technical and sound scientific knowledge (depending on the discipline)

BUT

Should include developing of skills and competences valued by Industry and Society in general

- Skills and competences for innovation and entrepreneurship
- Job related skills
  - Teamwork, Communication, Leadership
- Competencies (How tasks are done)
  - Holistic thinking, influencing, self-management, achievement of objectives..

Should foster Lifelong Learning
New Directions for Engineering Education
II - Methods - What to change and how to change?

鹡 Adapt curricula, methods and tools for teaching and inducing self-learning, holistic thinking and integrated development

鹡 Change from

➢ Teacher-Centred to Student-Centred methodologies
➢ Teaching based on Teacher Inputs to Learning Centred in well defined objectives - Learning Outcomes
➢ Teaching Times to Student Workloads

鹡 Which mechanisms to promote all such changes?

The Bologna Process as part of the paradigm shift
Mechanisms for inducing changes

鹡 New degree structures and new complementary diplomas promoting lifelong learning

鹡 A Credit System based on Learning Outcomes and on the required Workload to achieve them
➢ If well defined, they will have clear influence on learning methods

鹡 Transparent National Qualifications Frameworks (NQF)
✓ Including descriptors at the required differentiated levels

鹡 Quality Assurance Systems with criteria that are taken from the NQF
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Qualifications Frameworks

I - Understanding the terminology

- **Knowledge**
  - The ability to recall or remember facts without necessarily understanding them (Bloom’s taxonomy)

- **Skills**
  - Cognitive skills - the use of logical, intuitive or creative thinking
  - Practical skills - Manual dexterity or the use of methods, materials, tools, instruments...

- **Competences**
  - Capacity of doing, measured in terms of autonomy and responsibility-

- **Learning Outcomes** - what a learner is expected to know, understand or be able to do after successful completion of a process of learning, this being expressed through Qualification Descriptors
Qualifications Framework
II - Requirements for QF definition

A conceptual framework should define/identify (TU-3 proposals)

- A system of competences - areas of competences characterised by qualification descriptors
- Ways of characterizing those competences
  - Academic Dimensions
- A system of grading the academic dimensions

We should understand that a complete QF may involve up to 4 levels of descriptors

- related to modules, courses and cycles, that have to be compatible with national, sectoral and European qualifications frameworks.

Qualifications Framework
III - Example of levels for descriptor - Engineering

- High Level Descriptors - Eg. Dublin Descriptors
  - Characterize high level groups of competences

- Sectoral Descriptors at the different levels of qualifications
  - Ideally resulting from wide transnational agreements
  - EUR-ACE, CDIO...

- Specific Descriptors
  - For each engineering discipline
  - Including the identification of professional activities for which the candidates are to be prepared

- Contents - core curricula
  - LEARNING OUTCOMES ARE THE REFERENCE, BUT
  - They must earn the TRUST of society through the specialists opinion
    - Contents and workload
Qualifications Frameworks

IV - What is available

- European Qualifications Framework for the European Higher Education Area (EQF - EHEA) - based on Dublin Descriptors
- EQF for Lifelong Learning (EQF-LLL)
- TUNING methodology
- E4 proposals for Engineering
- TU3 proposals - Delft, Eindhoven e Twente
- CDIO - Conceive-Design-Implement-Operate
- EUR-ACE standards for professional quality assurance
- ABET standards for professional quality assurance
- Specific low level descriptors - Core curricula - European Working Parties on Education

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Qualifications Frameworks

V - Two High Level Frameworks ... requiring convergence...

- EQF-EHEA - European Qualifications Framework
  - Adopted in Bergen 2005, within the Bologna Process, with descriptors for the three cycles in higher education

- EQF-LLL - European Qualifications Framework for Lifelong Learning
  - Adopted by the EC, adopting 8 reference levels
  - Levels 6 to 8 correspond to the three Bologna cycles, with some linguistic differences in defining knowledge, skills and competences

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Qualifications Frameworks

VI - General Descriptors - the Dublin Descriptors (2003)

Dublin Descriptors for the Bologna degree structure

- Characterizing levels to be attained in
  - knowledge and understanding
  - applying knowledge and understanding
  - making judgements
  - communication
  - Learning skills

These are high level broad descriptors that will have to lead to more specific descriptors in each area or specialty within a given area

Qualifications Frameworks

X - The CDIO Syllabus for Engineering

(Chalmers, Linköping, KTH, MIT) (I)

CDIO - Conceive - Design - Implement - Operate

Building Blocks

1 TECHNICAL KNOWLEDGE AND REASONING
   1.1 KNOWLEDGE OF UNDERLYING SCIENCE [a]
   1.2 CORE ENGINEERING FUNDAMENTAL KNOWLEDGE [a]
   1.3 ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE [k]

2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
   2.1 ENGINEERING REASONING AND PROBLEM SOLVING [e]
   2.2 EXPERIMENTATION AND KNOWLEDGE DISCOVERY [b]
   2.3 SYSTEM THINKING
   2.4 PERSONAL SKILLS AND ATTITUDES
   2.5 PROFESSIONAL SKILLS AND ATTITUDE
Qualifications Frameworks
X - The CDIO Syllabus (II)

Building Blocks (Cont.)

3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
   3.1 MULTI-DISCIPLINARY TEAMWORK [d]
   3.2 COMMUNICATIONS [g]
   3.3 COMMUNICATIONS IN FOREIGN LANGUAGES

4 CONCEIVING, DESIGNING, IMPLEMENTING, AND OPERATING SYSTEMS
   IN THE INTERPRISE AND SOCIETAL CONTEXT [h]
   4.1 EXTERNAL AND SOCIETAL CONTEXT
   4.2 ENTERPRISE AND BUSINESS CONTEXT
   4.3 CONCEIVING AND ENGINEERING SYSTEMS [c]
   4.4 DESIGNING [c]
   4.5 IMPLEMENTING [c]
   4.6 OPERATING [c]

Qualifications Frameworks for Quality Assurance
I - The EUR-ACE Standards

Programme Outcomes that must be satisfied

- 6 areas of competences are defined
  ✓ Knowledge and Understanding
  ✓ Engineering Analysis
  ✓ Engineering Design
  ✓ Investigations
  ✓ Engineering Practice
  ✓ Transferable (personal) Skills

- For each category, the EUR-ACE Framework Standards
  list the expected Programme Outcomes of First
  Cycle and Second Cycle Studies
Qualifications Frameworks for Quality Assurance
II - The ABET System -
ABET 07-08 Criterion 3 - Outcomes and Assessment

a. An ability to apply knowledge of mathematics, science, and engineering.
b. An ability to design and conduct experiments, as well as to analyse and interpret data.
c. An ability to design a system, component, or process to meet desired needs.
d. An ability to function on multi-disciplinary teams.
e. An ability to identify, formulate, and solve engineering problems.
f. An understanding of professional and ethical responsibility.
g. An ability to communicate effectively.
h. The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i. A recognition of the need for, and an ability to engage in life-long learning.
j. A knowledge of contemporary issues.
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Example of Standards at Discipline level
Contributions in Chemical Engineering Education
The WPE-EFCE Recommendations

See WPE site on http://www.efce.info/wpe.html

These recommendations cover
- Learning outcomes
  - General chemical engineering skills and knowledge
  - Transferable skills
- Achieving the learning outcomes
  - Core curriculum
  - Teaching and learning
  - Industrial experience
  - Review of the educational process
  - Student assessment

The core curriculum proposed covers only approx. two thirds of a first and a second level degree study
Example of Standards at Discipline level
Contributions in Chemical Engineering Education
The CHEMEPASS Project


Co-ordinated by Sebastien Gagneur, CPE Lyon

Milestones

Identification of relevant general and specific Learning Outcomes for Chemical Engineering Programmes

Identification of knowledge to be tested among Chemical Engineering core subjects

Development of a database with test questions

Quality Assurance and Qualifications Frameworks
What is equal, what is different: CDIO-Dublin-EUR-ACE-ABET

Table 1 - Relation between CDIO - Dublin Descriptors - EUR-ACE Standards - ABET EC2000 accreditation requirements

<table>
<thead>
<tr>
<th>CDIO</th>
<th>Dublin - Master</th>
<th>EUR-ACE</th>
<th>ABET</th>
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<tbody>
<tr>
<td>Technical knowledge and reasoning</td>
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<tr>
<td>1. Engineering principles</td>
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<td>2. Engineering fundamentals</td>
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<td>3. Engineering knowledge</td>
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<td>4. Engineering reasoning and problem solving</td>
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<td>5. Characterization and knowledge discovery</td>
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<td>6. Pattern thinking</td>
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<td>Personal and professional skills and attributes</td>
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<td>7. Personal skills and attitudes</td>
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<td>8. Professional skills and attitudes</td>
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<td>Interpersonal skills</td>
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<td>9. Communication</td>
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<td>10. Communication in foreign languages</td>
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<td>Concerning, designing, implementing and operating systems in the enterprise and societal context</td>
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<td>11. External and societal context</td>
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<td>12. Entrepreneurial and business context</td>
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<td>13. Concerning and engineering systems</td>
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<td>14. Designing</td>
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<td>15. Implementing</td>
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<td>16. Operating</td>
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</tbody>
</table>
## Quality Assurance and Qualifications Frameworks

### What is equal, what is different: CDIO-Dublin-EUR-ACE-ABET

#### Dublin Descriptors - Master Level

1. Have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with Bachelor’s level, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context;

2. Can apply their knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study;

3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements;

4. Can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;

5. Have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

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### Quality Assurance and Qualifications Frameworks

### What is equal, what is different: CDIO-Dublin-EUR-ACE-ABET

#### EUR-ACE - "Outcomes" for accreditation - Master level

1. **Knowledge and Understanding** - An in-depth knowledge and understanding of the principles of their branch of engineering, a critical awareness of the forefront of their branch.

2. **Engineering Analysis** - The ability to solve problems that are unfamiliar, incompletely defined, and have competing specifications; the ability to formulate and solve problems in new and emerging areas of their specialisation; the ability to use their knowledge and understanding to conceptualise engineering models, systems and processes; the ability to apply innovative methods in problem solving.

3. **Engineering Design** - An ability to use their knowledge and understanding to design solutions to unfamiliar problems, possibly involving other disciplines; an ability to use creativity to develop new and original ideas and methods; an ability to use their engineering judgement to work with complexity, technical uncertainty and incomplete information.

4. **Investigations** - The ability to identify, locate and obtain required data; the ability to design and conduct analytical, modelling and experimental investigations; the ability to critically evaluate data and draw conclusions; the ability to investigate the application of new and emerging technologies in their branch of engineering.

5. **Engineering Practice** - The ability to integrate knowledge from different branches, and handle complexity; a comprehensive understanding of applicable techniques and methods, and of their limitations; a knowledge of the non-technical implications of engineering practice.

6. **Transferable Skills** - Fulfil all the Transferable Skill requirements of a First Cycle graduate at the more demanding level of Second Cycle; function effectively as leader of a team that may be composed of different disciplines and levels; work and communicate effectively in national and international contexts.
Quality Assurance and Qualifications Frameworks
What is equal, what is different: CDIO-Dublin-EUR-ACE-ABET

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National Qualifications Frameworks
Bringing Bologna into Practice

- National Qualifications Frameworks will have to articulate with European Qualifications Framework

- For some countries, the most difficult bit of the Bologna Reform
  - Defining NQF compatible with EQF
  - Characterizing the programmes through ECTS - Workload plus Outcomes
  - Re-doing of all modules within this new framework
  - Giving evidence that approved Learning Outcomes are achieved

- Or simply, bringing Bologna into practice...
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The Directive for Recognition of Professional Qualifications (I)

- Reaffirms previous Directive, accepting 7 professional areas with recognized specifications
  - Medical training: Minimum education - 6 anos IT
  - Training of veterinary surgeons: Minimum education - 5 anos IT
  - Basic dental training: Minimum education - 5 anos IT
  - Training as pharmacists: Minimum education - 5 anos IT
  - Training of nurses: Minimum education - 3 anos IT
  - Training of midwives: Minimum education - 3 anos IT
  - Training of architects: Minimum education - 4 anos IT
- Engineering (as Law) is out of this group
The Directive for Recognition of Professional Qualifications (II)

**Article 11** - Five levels of qualification particularly relevant for professions that are out of the Annex

- 2 levels requiring secondary education, general or vocational
- 1 level, requiring short post-secondary education, not necessarily at higher education level, plus professional training
- 2 levels of post-secondary education at higher education level, plus adequate professional training

The Directive for Recognition of Professional Qualifications (III)

**Art. 11, e)**
...completed a post-secondary course of at least four years’ duration...at a university or establishment of higher education...and where appropriate completed professional training...

**Art. 11, d)**
...training at post-secondary level of at least three and not more than four years’ duration...at a university or establishment of higher education...as well as the professional training that may be required...

**Art. 11, c)**
...training at post-secondary level other than that referred in d) and e) of a duration of at least one year...as well as the professional training which may be required in addition to that post-secondary course...
### Academic Degree Structures

**I - Concerning levels of qualification - Art. 11, d) and e)**

- Two levels of qualifications associated to those levels approved in the Directive
  - **LEVEL 1** - Art. 11, d): (3-4)U + Professional Training >= Y, with Y=?
    - First Cycle Degrees are the basis for achieving the qualification of Technical (or Associate) Engineers, whatever the European designation
  - **LEVEL 2** - Art. 11, e): >= 4U + Professional Training >= X, with X=?
    - Second Cycle Degrees are the basis for achieving the qualification of Engineers, or equivalent European designation

### Academic Degree Structures

**II - Concerning Profiles**

- Two main engineering profiles
  - **More Theoretically oriented**
    - Programmes with a stronger emphasis on basic and engineering sciences in the first years
    - Generally linked to Second Cycle degrees
  - **More Applications oriented**
    - Designed to qualify after First Cycle, independently of pursuit of studies through Second Cycles, be it directly or through bridging programmes

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Academic Degree Structures
V - Prevaling concepts in the design of the Degree System (I)

The Bologna Process has brought unprecedented pressure on the Higher Education Institutions for more dialogue with the Society to incorporate its more immediate interests

- More flexible paths - MORE differentiation (competences) offered
  - Either more research oriented, or more innovation oriented, or with a higher entrepreneurial spirit, etc....
  - Bringing in the concept of “Communication Pipes” between different profiles of education - BRIDGING PROGRAMMES
Degree Structures and Qualifications Frameworks

I - The difficult bits

- Still fuzzy the relation Workload-Outcomes
  - New guidelines for ECTS are about to be proposed

- There are still difficulties in interpreting EQF and in developing and applying related accreditation criteria, especially in the comparative distinction between FCD (Bachelor) and SCD (Master) programmes.
  - The EQF and the Professional Directive 2005/36 are not always 100% clear in this respect.

- Overcoming these difficulties will be also a fundamental test for the validity and applicability of the EQF

Degree Structures and Qualifications Frameworks

II - Understanding differences between levels of qualifications

- Programme Outcomes must be evaluated in relation with the level of intervention in the Engineering Activity
  - Social responsibility (namely, signing projects)
  - Capacity to tackle large, complex problems
  - Capacity to adapt to new jobs of high complexity and responsibility
  - Capacity for effective activity in the production line
  - .......

- For the different subsets of Programme Outcomes, and for the First and Second Cycle Degrees, the differences in requirements are mostly related with
  - scope, depth and breath

- For the Master degree, developing the right ATTITUDE to use knowledge or skills in a given situation is a major outcome
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Quality Assurance - Recognition of Professional Qualifications

I - Programme Outcomes for Accreditation

- Quality assurance procedures rely on accepted qualifications frameworks
- Programme outcomes for accreditation should always be related to potential professional recognition of engineering qualifications

As such:

- There should be only one set of programme outcomes for accreditation of Second Cycle Degrees
  - (Whatever the profile and programme)
- There should be only one set of programme outcomes for accreditation of First Cycle Degrees
Quality Assurance
II - The EUR-ACE Project and ENAEE (I)

European Project that aimed at establishing an European System for Accreditation of Engineering Education programmes

- to ensure suitability of programme as entry route to the [engineering] profession

- 14 European Institutions, among them ‘Ordem dos Engenheiros (OE) / Engineers Portugal’

- FEANI, SEFI, CESAER, EUROCADRES, ENQHEEI, ASIIN, CTI, IEI, CoPI, UNIFI, OE, UAICR, RAEE, EC-UK

- EUR-ACE has been supported by the European Commission (DG EaC) within SOCRATES and TEMPUS programmes

- Concluded in 2005

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Quality Assurance
II - The EUR-ACE Project and ENAEE (II)

Programme Outcomes that must be satisfied

- 6 areas of competences are defined
  - Knowledge and Understanding
  - Engineering Analysis
  - Engineering Design
  - Investigations
  - Engineering Practice
  - Transferable (personal) Skills

- For each category, the EUR-ACE Framework Standards list the expected Programme Outcomes of First Cycle and Second Cycle Studies

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Quality Assurance
II - The EUR-ACE Project and ENAEE (III)

The Standards developed:

- Specify the Programme Outcomes that must be satisfied
- Accredit programmes, not Departments or Universities
- Accredit education, not whole formation
- Are valid for all branches of engineering and all profiles
- Distinguish between First and Second Cycle programmes, as defined in the European Qualifications Framework
- Are applicable also to “integrated programmes”, i.e. programmes that lead directly to a Second Cycle degree
- Describe what is to be achieved but not how
  - As such it can accommodate national differences of educational and accreditation practice

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www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt

Quality Assurance
II - The EUR-ACE Project and ENAEE (IV)

- The EUR-ACE project has lead to the creation in 8 February 2006 of an European Association
- The ENAEE - European Network for Accreditation of Engineering Education
- The ENAEE is responsible for maintaining and awarding the EUR-ACE label

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sfeyo@fe.up.pt

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Quality Assurance
II - The EUR-ACE Project and ENAEE (V)

ENAEE was born on February 8, 2006, with Founding Members:

- FEANI (acting Secretariat)
- SEFI
- UNIFI/TREE
- EUROCADRES
- EC (UK)
- CTI (FR)
- ASINI (DE)

RAEE (RU)
CoP1 (IT)
IEI-Engineers Ireland
OE (Ordem...) (PT)
UAICR (RO)
IDA (DK)
FOTEP/BBT (CH)

- New Members (admitted at the Second General Assembly, 17 November 2006)

CLAII
MÜDEK

Quality Assurance
II - The EUR-ACE Project and ENAEE (VI)

The EUR-ACE system is now being implemented by six Agencies, that form its initial “core”:

- ASIN (DE)
- EC (UK)
- IEI-EngineersIreland
- CTI (FR)
- OE (PT)
- RAEE (RU)

‘Engineers Portugal’ is thus one of such Agency and is now preparing its quality assurance procedures
Quality Assurance

III - EUR-ACE vs. Other existing global ‘accords’ [W-S-D] (I)

- **Different “accords” involving also American and Asian organisations:**
  - Washington Accord for Professional Engineers (1st Cycle studies)
  - Sydney Accord for Engineering Technologists
  - Dublin Accord for Engineering Technicians

- **Different “registers”:**
  - Engineers Mobility Forum - International Register of Professional Engineers
  - ETMF International Register of Engineering Technologists
  - APEC Register of Professional Engineers (Asian-Pacific Economical Cooperation)

Quality Assurance

IV - EUR-ACE vs. other existing global ‘accords’ [W-S-D] (II)

- Firstly, fundamental differentiation/barrier between
  - “Professional Engineers” and “Engineering Technologist”

- Also, define all recognized (accredited) “Engineers’ “ degrees as “Bachelor”.

- These features are not in the spirit of the EQF nor of EU Directive 2005/36

- So, issues concerning recognition of standards will have to be overcome - Indeed some discussion is currently in the air...
Quality Assurance
V - Agreements? Changes may well occur elsewhere...

What Should Be the First Professional Degree in Engineering?
BY MOSHE KAM & ARNOLD PESKIN

We'd like your opinion. Should the first professional degree in engineering be at the Bachelor of Master level? The IEEE is considering whether to follow the recommendations of several professional bodies and declare that a Master of Science or Master of Engineering (rather than Bachelor level degree) should be an engineer's first professional degree in engineering in the customary degree needed for the practice of engineering. Practice is understood to be carried out in an industrial setting, and does not require much additional training. However, it is widely accepted that in a field as large and diverse as engineering, some specialties require more training. For example, researchers and academicians is the Bachelor of Science or Bachelor of Engineering. In the last decade, many educational programs that required some additional training before being awarded a title such as "Diploma engineering" have reduced their requirements to conform to the U.S. ABET "state related." Nevertheless, the increasing complexity of engineering tasks motivates educators to add new topics and subdisciplines to

<table>
<thead>
<tr>
<th>Question</th>
<th>Current Practice</th>
<th>Proposed</th>
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<tbody>
<tr>
<td>What should be the minimum requirement?</td>
<td>A Bachelor of Science in engineering (or equivalent)</td>
<td>A Master of Science in engineering (or equivalent)</td>
</tr>
<tr>
<td>What additional training would be required?</td>
<td>None</td>
<td>Masters of Science, as well as industrial engineer training and knowledge of the field</td>
</tr>
<tr>
<td>What changes in engineering education would be needed?</td>
<td>None</td>
<td>New accreditation procedures for engineering programs, consistent minimum of new graduate credit, changed emphasis in course requirements and elsewhere</td>
</tr>
<tr>
<td>Who supports each position?</td>
<td>The IEEE, several sections, including the Applied Power Section Researcher of Science and the US National Council for Engineering and Surveying</td>
<td>The IEEE, several sections, including the American Society of Civil Engineers and the US National Council for Engineering and Surveying, plus the newly developed Bologna Process</td>
</tr>
</tbody>
</table>

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www.1e.up.pt/uleyo
aley@fe.up.pt
To say what I am going to say…

1. The Bologna Process and the European Strategy for Development
2. Paradigm shifts in engineering education
3. Qualifications Frameworks
4. The Directive for Recognition of Professional Qualifications and Academic Degree Structures
5. Quality Assurance issues
6. Quality Assurance and Qualifications Frameworks - what is equal, what is different

Closing Notes

Bologna and Routes for Professional Qualification and Transnational Cooperation (I)

- The Bologna Process fosters positive developments and new directions for engineering education
- Technical Education (the Engineering Profession) requires different qualification levels and education profiles that should be guaranteed and identified through transparent Quality Assurance Procedures
- The framework being developed and put in practice within the Bologna agreements seem to serve adequately the needs of industry and society in general
  - Short vocational studies, first cycle studies and second cycle studies (stand-alone or integrated) constitute the basis of such framework
- The concept of Credit Accumulation, together with Lifelong Learning, is of utmost relevance in this new paradigm of building professional qualifications
**Bologna and Routes for Professional Qualification and Transnational Cooperation (II)**

- **Second Cycle Programmes** should be evaluated in terms of integrated outcomes
  - They should meet the requirements for professional recognition of the highest engineering level (Engineer or equivalent designation at European level)

- Professionally oriented **First Cycle Degrees** should offer relevant competences to the Society in the engineering profession

- At a more academic level - the real challenge is to bring in new more efficient methods, student-centred methods for learning

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**Bologna and Routes for Professional Qualification and Transnational Cooperation (III)**

- **TRUST** is the basis, the necessary condition for progress, for professional mobility, for transnational cooperation

- The mechanisms to build and consolidate such TRUST are indeed slowly, but steadily, being implemented in the European Area of Knowledge, particularly in our Higher Education Institutions... to the advantage of European Progress