



## Engineering Education in this new Model of European Development

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## To say what I am going to say...


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

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## The Bologna Process

### What needs to be understood?

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- ☞ Understand the Bologna Process as one of the dimensions of the prevailing strategy for European development
- ☞ 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

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- ☞ 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

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## 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

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## European Strategy for Development

### III - 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” .
- ☞ Is being pursued with the Lisbon Treaty, 2007.....

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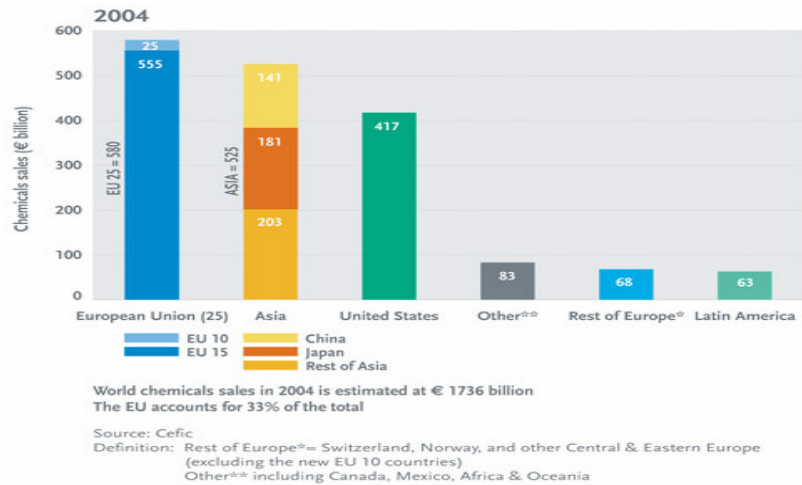
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## European Strategy for Development

### IV - Just an Example of World Competition

#### (A) Geographic breakdown of world chemicals sales



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## 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

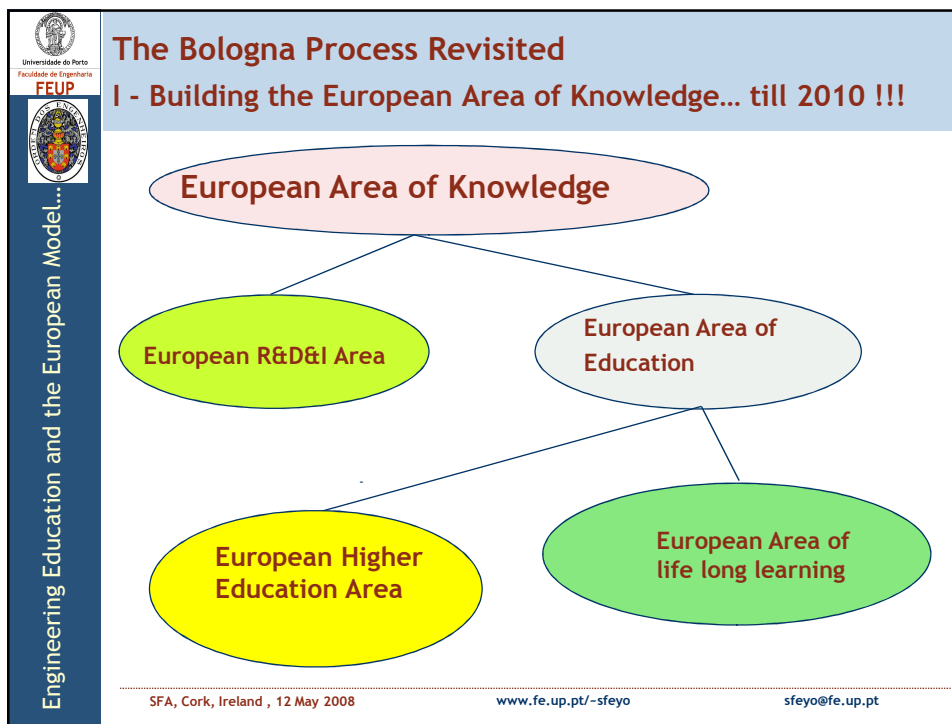
#### ✓ The Knowledge Society Dimension -


- Identified with the Bologna Process and the creation of the European Higher Education Area

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## The Bologna Process Revisited


### II - From the Sorbonne 1998... To London 2007... and Beyond

- ☞ A movement of World Dimension - much wider than the EU
- ✓ Sorbonne, 1998 - 4 Countries within the EU
- ✓ Bologna 1999 - 29 Countries, 6 action lines
- ✓ Prague 2001 - 33 Countries , 9 action lines
- ✓ Berlin 2003 - 40 Countries, 10 action lines
- ✓ Bergen 2005 - 45 Countries
- ✓ London 2007 - 46 Countries
- ✓ .....
- ☞ Recognized Today and followed with significant attention in other parts of the Globe

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## The Bologna Process Revisited


### III - The 10 Action Lines

1. Adoption of a system of easily readable and comparable degrees
2. Adoption of a system essentially based on two cycles
3. Establishment of a system of credits
4. Promotion of mobility
5. Promotion of European co-operation in quality assurance
6. Promotion of the European dimension in Higher Education
7. Focus on Lifelong Learning
8. Inclusion of Higher Education Institutions and students
9. Promotion of the attractiveness of the European Higher Education Area
10. Doctoral Studies and the synergy between the European Higher Education Area and the European Research Area

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## The Bologna Process Revisited

### IV - Objectives... From another point of view

#### (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 guarantee the Social Dimension
  - ✓ To promote the External Dimension of the European model

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## The Bologna Process Revisited

### IV - Objectives... From another point of view

#### (B) Objectives of a more academic nature

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- ☞ **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

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## From Bologna ... to London... and beyond...

### I - Directions specifically expressed in the London Communiqué


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- ☞ **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

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## 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...
  - ✓ Developing student centred learning
  - ✓ Adopting Learning Outcomes, the ECTS System within NQF
  - ✓ Implementing the Quality Assurance System
  - ✓ ...

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## From Bologna ... to London... and beyond...

### III - The Global Dimension... A Recent Report


- ☞ Clifford Adelman, “Bologna is a process, not a processed meat”  
Institute for Higher Education Policy (IHEP), USA, Inside Higher Ed audio conference , February 26, 2008:

*“Prediction*

- ✓ *By 2030, what started as European will be global, providing transfer without borders.*
- ✓ *The US will either join or be left behind.*
- ✓ *It is a challenge unlike any other issued to our system of higher education, and we’ve been soundly asleep to date.*
- ✓ *We had better get started---and in more positive ways than simply rejecting degree equivalencies! “*

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## From Bologna ... to London... and beyond...

### IV - 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

☞ **All is achieved through:**

- ✓ **COMPARABLE QUALIFICATIONS FRAMEWORKS**
- And**
- ✓ **ACCEPTED QUALITY ASSURANCE PROCEDURES**

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## To say what I am going to say...

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

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## Still the European Strategy for Development - Qualifications Frameworks and the Directive for Recognition of Professional Qualifications

- ☞ Three major documents
  - ✓ The EQF-EHEA - European Qualifications Framework for the European Higher Education Area
    - Adopted in Bergen 2005, within the Bologna Process
  - ✓ The EQF-LLL - European Qualifications Framework for Lifelong Learning
    - Adopted by the EC - approved on April 23, 2008 by the Parliament and the Council of the European Union
  - ✓ The Directive for Recognition of Professional Qualifications, approved by the European Parliament and by the Council on September 7, 2005
    - National laws should have been passed in all EC Countries till the end of 2007

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## The EQF-EHEA - European Qualifications Framework for the European Higher Education Area

- ☞ A degree structure with three main cycles and a short cycle within or linked to the First Cycle (adopted in Bergen 2005)
- ☞ Adopts the Dublin Descriptors developed by the Joint Quality Initiative (2003) as the cycle descriptors, 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

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## The EQF-LLL

### European Qualifications Framework for Lifelong Learning

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- ☞ Approved by the Parliament and the Council of the European Union on April 23, 2008
- ☞ Adopts 8 levels of qualifications characterized in terms of
  - *Knowledge*
  - *Skills*
  - *Competences*
- ☞ Adopts common principles for Quality Assurance in Higher Education and Vocational Education and Training in the context of the European Qualifications Frameworks
- ☞ Establishes a link of compatibility with the Framework for Qualifications of the European Higher Education Area

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## Bringing Qualifications Framework into Practice

### The different layers - from general to specific...


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- ☞ EQF-EHEA or EQF-LLL - High Level Descriptors
  - ✓ Characterize high level groups of competences
  - ✓ Note the link with the Directive for Professional Recognition
- ☞ Sectoral Descriptors at the different levels of qualifications
  - ✓ Ideally resulting from wide transnational agreements
  - ✓ The TUNING methodology - The E\$ application to Engineering
  - ✓ CDIO, EUR-ACE in Engineering
- ☞ Specific Descriptors
  - ✓ For each discipline, thus depending on the sector
  - ✓ 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

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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

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## 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

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## The Directive for Recognition of Professional Qualifications (III)


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- ☞ 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...

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## The EQF-EHEA and the Directive A striking coincidence or concerted action?


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- ☞ The EQF-EHEA and the Directive point out in the same direction
  - ✓ Recognition of different qualification levels and profiles
  - ✓ Recognition that qualifications can be attained through routes in two different subsystems
- ☞ They fit remarkably well in the world of engineering and the offer of engineering education in Europe
- ☞ They should obviously be translated into our professional accreditation systems

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## Academic Degree Structures


### I - Concerning level of qualification - (I) - Art. 11, c)

- ☞ **Level of Qualification: Art. 11, c)**
  - 1 year of post-secondary course work + Professional Training  $\geq Z$ , with  $Z=1$
- ☞ **At least for the time being, in most countries, not leading to a recognised competence group of Engineering, though they are vital for the 'Engineering Act'...**
- ☞ **Let's identify them as Technicians**

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## Academic Degree Structures


### I - Concerning levels of qualification - (II) - 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  $\geq Y$ , 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):  $\geq 4U$  + Professional Training  $\geq X$ , with  $X=?$** 
  - **Second Cycle Degrees are the basis for achieving the qualification of Engineers, or equivalent European designation**


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## 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

### III - Offer of Programmes

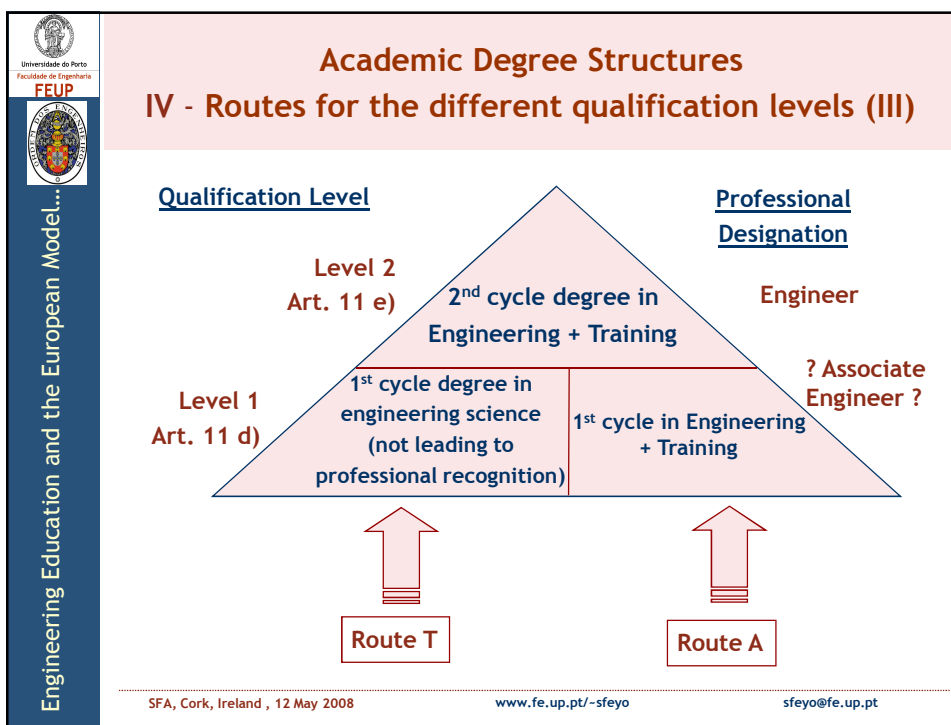
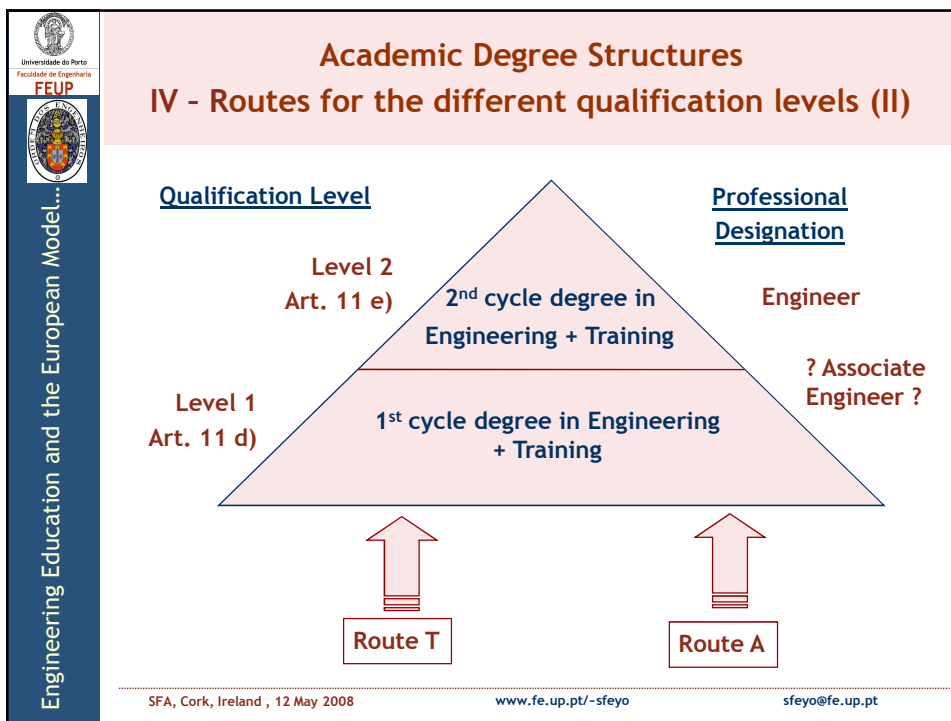
☞ **Three main offers of Programmes in Engineering Education**

- The offer of **First-cycle programmes**, aiming at fulfilling the level of requirements for accreditation and professional recognition of **LEVEL 1**
- The offer of **Second-cycle programmes**, aiming at fulfilling the level of requirements for accreditation and professional recognition of **LEVEL 2**
- The offer of **two-cycle programmes**, within a philosophy of integrated studies, aiming mainly at fulfilling the requirements of accreditation and professional recognition at **LEVEL 2**


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## Academic Degree Structures


### V - Prevailing 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 programs**
- ☛ More attractive offer in order to bring into the system students with different backgrounds and interests
- ☛ Promotion of a true offer for lifelong learning through
  - Complementary modules of (advanced) specialization courses
  - Implementing the concept of ‘accumulated credits’ for recognition of studies


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## Academic Degree Structures

### V - Prevailing concepts in the design of the Degree System (II)

- ☛ Recognizing the need for personal and inter-personal competences or skills
 

<b>Dublin...</b>	<i>Making judgements, communication, Learning skills...</i>
<b>TU-3...</b>	<i>Competence in co-operating, communicating and taking account of the temporal and the social contexts</i>
<b>E4...</b>	<i>Personal requirements</i>
<b>CDIO -</b>	<i>Multi-disciplinary teamwork, communications, understanding external, societal, enterprise and business contexts</i>
<b>EUR-ACE</b>	<i>Transferable (personal) skills</i>


*Or, employing terms more often heard at professional and industrial level:*

**Time-scales, market, costs, quality, management, leadership, communication, sustainable, ethical...**

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## Qualifications Frameworks and Quality Assurance I - The EUR-ACE Project and ENAEE (I)

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- ☞ 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 *Engineers Portugal*
- ✓ FEANI, SEFI, CESAER, EUROCADRES, ENQHEEI, ASIIN, CTI, IEI, CoPI, UNIFI, OE, UAICR, RAEE, EC-UK
- ☞ SEE FULL DETAILS IN [www.enaee.eu](http://www.enaee.eu)

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## Qualifications Frameworks and Quality Assurance

### I - The EUR-ACE Project and ENAEE (II)

- ☞ EUR-ACE developed Framework Standards, that were compiled as a “synthesis” between existing National Standards
- ☞ An European accreditation system that should
  - ✓ Ensure consistency between existing national “engineering” accreditation systems;
  - ✓ Add an European “quality label” to accreditation;
  - ✓ Introduce “accreditation” in other European and third countries;
- ☞ and thus
  - ✓ Improve quality of education
  - ✓ Facilitate transnational recognition
  - ✓ Facilitate (physical and virtual) mobility

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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance

### I - The EUR-ACE Project and ENAEE (III)

- ☞ The Standards developed:
  - ✓ Specify the **Programme Outcomes** that must be satisfied
  - ✓ Accredite programmes, not Departments or Universities
  - ✓ Accredite 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 Qualification 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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## Qualifications Frameworks and Quality Assurance

### I - The EUR-ACE Project and ENAEE (IV)

Engineering Education and the European Model...

- ☞ **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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## Qualifications Frameworks and Quality Assurance

### I - The EUR-ACE Project and ENAEE (V)

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- ☞ **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**
- ☞ **6 European Agencies are currently accredited for awarding the EUR-ACE Label**
  - ✓ **Institution of Engineers, Portugal is one such Agency and is now preparing its accreditations**

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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance

### I - The EUR-ACE Project and ENAEE (VI)


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

<b>FEANI</b> ( <i>acting Secretariat</i> )	<b>RAEE</b> (RU)
<b>SEFI</b>	<b>CoPI</b> (IT)
<b>UNIFI/TREE</b>	<b>IEI-Engineers Ireland</b>
<b>EUROCADRES</b>	<b>OE</b> (Ordem...) (PT)
<b>EC</b> (UK)	<b>UAICR</b> (RO)
<b>CTI</b> (FR)	<b>IDA</b> (DK)
<b>ASIIN</b> (DE)	<b>FOTEP/BBT</b> (CH)

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

<b>CLAIU</b>	<b>MÜDEK</b>
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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance


### I- The EUR-ACE Project and ENAEE (VII)

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


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

☞ The representatives of these Agencies sit in the **EUR-ACE Label Committee**

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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance


### II - 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


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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance


### III - 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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## National Qualifications Frameworks Bringing Bologna into Practice


Engineering Education and the European Model...

- ☞ 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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## Qualifications Frameworks and Quality Assurance IV - EUR-ACE vs. the ABET System - ABET 07-08 Criterion 3 - Outcomes and Assessment


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- 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.

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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance

### V - EUR-ACE vs. other existing global 'accords' [W-S-D] (I)

☞ **Different “accords”:**

- Washington Accord
- Sydney Accord
- Dublin Accord


☞ **Different “registers”:**

- EMF International Register of Professional Engineers
- ETMF International Register of Engineering Technologists
- APEC Register of Professional Engineers

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## Qualifications Frameworks and Quality Assurance

### V - 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...**

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## Qualifications Frameworks and Quality Assurance

### VI - Agreements? Changes may well occur elsewhere...

M. Kam & A. Peskin, "What Should be the First Professional Degree in Engineering?", IEEE, p.10-11, September 2007, [www.ieee.org/theinstitute](http://www.ieee.org/theinstitute)

#### EDUCATION

## What Should Be the First Professional Degree in Engineering?

BY MOSHE KAM & ARNOLD PESKIN

**W**e'd like your opinion. Should the first professional degree in engineering be at the Bachelor or Master level?

The IEEE is considering whether to follow the recommendations of several other professional bodies and declare that a Master of Science or Master of Engineering (rather than Bachelor-level degrees) should be an engi-

first professional degree in engineering is 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 academ-

engineering is the Bachelor of Science or Bachelor of Engineering. In the last decade, some educational programs that required more schooling or practice (and awarded a title such as Diplom-engineer) have reduced their requirements to conform to the B.Sc./B.Eng. "standard." Nevertheless, the increasing complexity of engineering tasks motivated educators to add new topics and subdisciplines to

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## Qualifications Frameworks and Quality Assurance

### VI - Agreements? Changes may well occur elsewhere...

M. Kam & A. Peskin, "What Should be the First Professional Degree in Engineering?", IEEE

#### EDUCATION

normally require two additional years of study and a dissertation.

In the United States, the National Academy

of Engineering and the American Society of Civil Engineers have advocated that the Master of Science be declared the first profes-

sional degree in engineering. The U.S. National Council of Examiners for Engineering and Surveying recently discussed changes to its Model

Law requiring a Bachelor of Science degree plus 30 semester credits as a prerequisite for candidacy for licensure. The tables presented here


### The First Professional Degree in Engineering

Question	Current Practice	Proposed
What should be the minimum requirement?	A Bachelor of Science in engineering (or equivalent)	A Master of Science in engineering or a Bachelor of Science in engineering plus 30 additional semester credits
What additional training would be required?	None	Holders of a B.Sc. or B.Eng. would have to acquire additional educational credentials such as a M.Sc. or M.Eng.
What changes in engineering education would be needed?	None	New accreditation procedures for graduate programs; development of new graduate curricula; changes in licensure procedures and laws.
Who supports each position?	Inside the IEEE, several sections, including the Alaska Section. In the United States, several representatives of state licensing boards that do not intend to adopt new guidelines.	Several engineering associations including the American Society of Civil Engineers. In the United States, the National Academy of Engineering and National Council of Examiners for Engineering and Surveying. In Europe, the developers of the Bologna Process.


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Engineering Education and the European Model...

## Qualifications Frameworks and Quality Assurance VI - and changes may well occur elsewhere...

☞ In [www.ieee.org/theinstitute](http://www.ieee.org/theinstitute)

M. Kam & A. Peskin, “What Should be the First Professional Degree in Engineering?, p.10-11, September 2007

We can read  
 “....In the United States the National Academy of Engineering and the American Society of Civil Engineers have advocated that the Master of Science be declared the first professional degree in Engineering” .


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Engineering Education and the European Model...

## To say what I am going to say...


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

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## A little bit of History

### Paradigm shifts in Engineering Education

- ☞ 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...

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Engineering Education and the European Model...



## New Directions for Engineering Education


### I - Methods and contents for ...

- ☞ Of course directed to **technical 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..

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## New Directions for Engineering Education

### II - Methods - What to change and how to change?

Engineering Education and the European Model...

- ☞ Which new methods and tools for teaching and how to induce self-learning?
- ☞ 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
- ☞ How to induce holistic thinking and concepts of integrated development?
- ☞ Which mechanisms to promote changes ?

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## New Directions for Engineering Education

### III - Lifelong Learning

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- ☞ Lifelong learning is the key for ensuring progress
  - ✓ It is the only way to avoid obsolescence
  - ✓ 1st degrees for sure do not cover all relevant technical topics
  - ✓ Complementary offer - formal courses, 'hands-on' and 'on-the-job' training, distance and interactive courses...obviously the Internet...
- ☞ Paradox - employers, promoting short-term jobs and forced mobility, are reluctant to educate staff - **SOMETHING TO FIGHT AGAINST**
- ✓ In a number of countries there is pro-active legislation with incentives for innovation

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## New Directions for Engineering Education


### IV - Profiles - diversity required

- ☞ To what extent should EE approach (or combine with) immediate societal needs and concerns and industrial practice?
- ☞ Should EE rather be research oriented?

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Engineering Education and the European Model...

## Directions for Engineering Education

### IV - Questions... at social and political level

- ☞ What role and distinction of education at the tertiary stage (Higher Education)?
  - Education for all - where to draw the massification line?
- ☞ What should be the structure and the core content of engineering curricula for first degrees?
  - What, what depth, when, how, which teaching aids
- ☞ Is it feasible a two-year learning process?
  - The system should be ready to accommodate exceptions

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Engineering Education and the European Model...

## New Directions for Engineering Education


### VI - Guidelines... not a single degree structure...

- ☞ **University First Degrees in Engineering (not the first degree of integrated studies)**, though strong in fundamentals and depositing the seeds for research, will have to be directed to the more basic and practical requirements of industry and of the society
- ☞ **It is appropriate to leave for second cycles the effort for growing and developing new concepts**, with formal courses, with compulsory and elective subjects, for a longer research oriented horizon
- ☞ **It is important to keep a database, at European level, that provide (to Industry) coherent and regularly updated information on the extremely wide range of curricula available.**

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Engineering Education and the European Model...

## New Directions for Engineering Education


### VII - Third Paradigm? Is it so?

- ☞ **If there is, it is of a different nature of the second paradigm**
- ☞ **Still fuzzy, can we see it?**
  - **Student centred learning methods**
  - **Skills and competencies**
  - **Cultural interchanges - base on transnational cooperation**
  - **Inducing pro-active attitude for lifelong learning as the key for individual career management**
  - **.....**

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Engineering Education and the European Model...


## New Directions for Chemical Engineering Education VIII - Third Paradigm ? Prospectively...

☞ If this is not a paradigm shift, it is at least an extension of the concepts of the second paradigm that, as fifty years ago, will help in pushing the frontiers of engineering beyond its present limits.

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Engineering Education and the European Model...

## 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’

\* Landau, R. (1997), "Education: Moving from Chemistry to Chemical Engineering and Beyond," Chemical Engineering Progress, AIChE, pp. 52-65

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## The Bologna Process as part of the paradigm shift

### Mechanisms for inducing changes

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- ☞ **Main concepts for promoting changes**
  - ✓ **A Credit System based on Learning Outcomes and on the required Workload**
    - **If well defined, they will have clear influence on learning methods**
- ☞ **Transparent National Qualifications Frameworks**
  - ✓ **Including descriptors at the required differentiated levels**
- ☞ **Quality Assurance Systems with criteria that are taken from the NQF**
- ☞ **We should understand the complementarity of concepts and mechanisms in discussion**

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## To say what I am going to say...

Engineering Education and the European Model...


- 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**
- ⑤ **Quality Assurance and Qualifications Frameworks - what is equal, what is different**
- ⑥ **Closing Notes**

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Engineering Education and the European Model...


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

- ☞ 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

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Engineering Education and the European Model...

## 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 offer relevant competences to the Society in the engineering profession (those of qualified Associate Engineer or equivalent designation at European level)
- ☞ First Cycle Degrees offered within theoretically oriented profiles may not meet immediately the requirements for professional recognition of First Cycles

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

- ☞ Transnational cooperation and professional mobility require **TRUST**
- ☞ The mechanisms to build and consolidate such TRUST are indeed slowly, but steadily, being implemented in our Higher Education Institutions...