The Reforms of the Bologna Process - Recognition of Chemical Engineering Qualifications

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8th World Congress of Chemical Engineering - WCCE8

27 August 2009, Montréal, Quebec, Canada

Bologna and Recognition in Chemical Engineering

To say what I am going to say...

The Bologna Process, 10 Years On
What it is not... What it is…

- The Bologna Process is not…
  - ✓ Any criticism or defeating position relatively to the past of Higher Education
  - ✓ A magic solution to improve from night to day the system of Higher Education
- The Bologna Process is…
  - ✓ The perception of the present and the preparation of the future in a Global World of fast and deep changes
- The Bologna Process is indeed a major dimension of the European answer to the
  - ✓ CHALLENGES FOR A CHANGING WORLD

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Life Today
I - Driving forces for changes in Europe… and in the World

- 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, 20 years ago…
  - ✓ Expectations and demands of Society
    - Education for All - mass education policies
    - Quality requirements of a Society of "Comfort"

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Life Today
II – A Mix of Challenges, Threats and Opportunities

- The computer and communications era - dramatic changes of the concepts of time and space - globalisation
- The global market economy - driving today's Societies
  - Sharp increase in standards and competition Worldwide
  - Volatility of jobs
  - Job market and opportunities - wider than ever
- The increase of Expectation of Life vs. Social sustainability - work longer years
- The decrease of knowledge half-time - back to School
- Significant change in the concepts of individual career management, mainly for Young People

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Life Today
III – Preparing for the Future…
Essential instruments and policies

- A global World living in and with a new paradigm of coexistence
  - ✓ COOPETITION = COOPERATION + COMPETITION
- That requires
  - New management and transnational cooperation policies
  - A new cultural paradigm of Education - Lifelong Learning
  - Mobility of students and professionals
- Which in turn requires
  - Policies and Instruments for recognition of academic and professional qualifications
  - POLITICAL WILL

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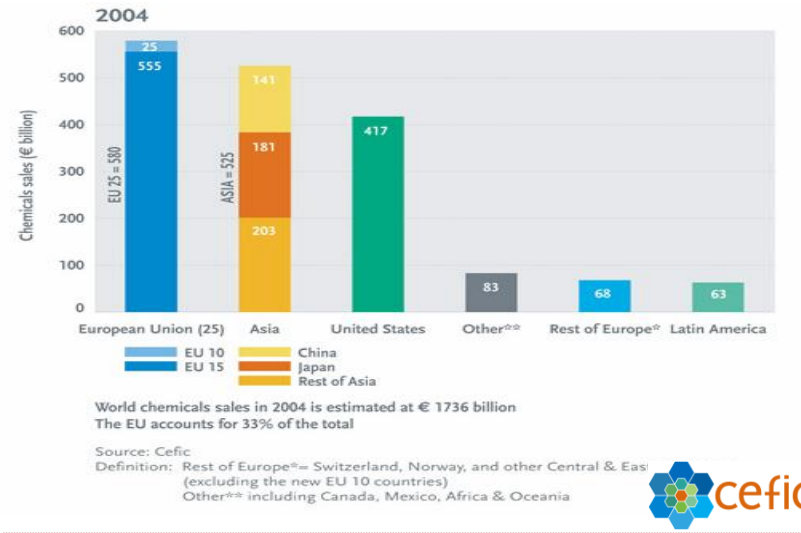
Life Today…
Just an Example of World Competition
Geographic breakdown of World chemicals sales, CEFIC F&F2004



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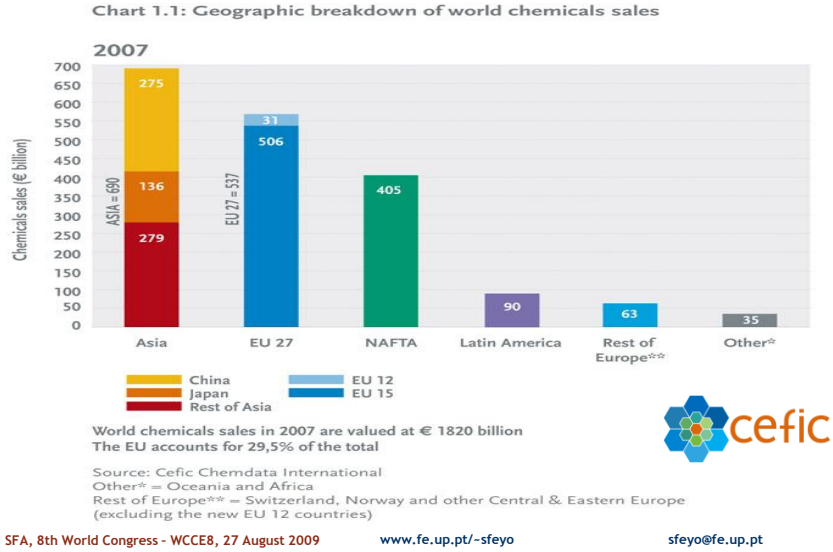

European search for a new, more competitive, model for development, with three visible dimensions

- 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 Area of Knowledge

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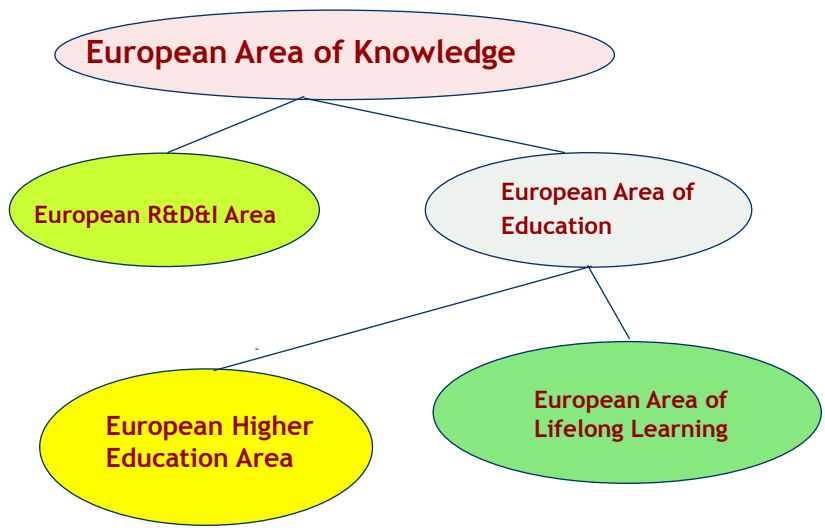
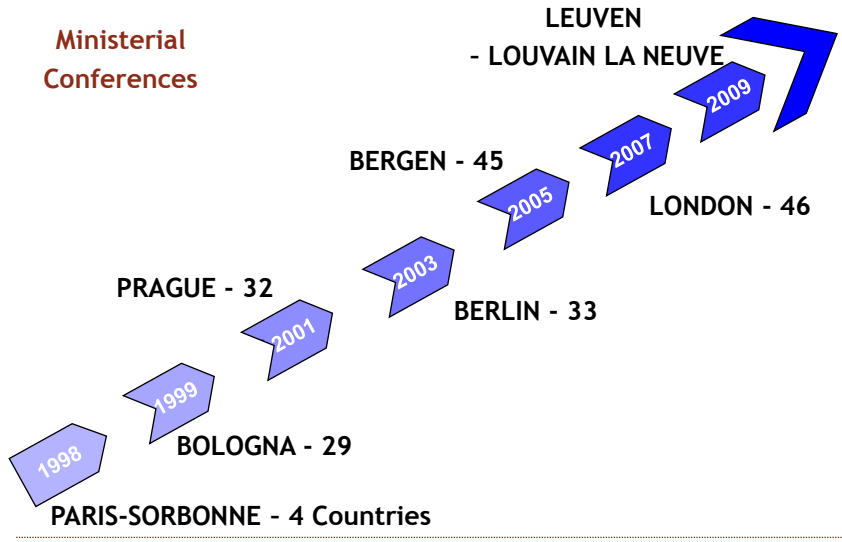
The Bologna Process
Building the European Area of Knowledge… till 2010 !!!



The Bologna Process, 10 Years On
How it developed politically



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The Core of the Bologna Reforms
Keywords characterizing Structural and Political Objectives

- MOBILITY, COOPERATION, TRUST, ACCREDITATION
  - ✓ MOBILITY AND COOPERATION require both academic and professional recognition
  - ✓ Academic and Professional recognition require TRUST
  - ✓ TRUST requires transparency and readability of structures and professional qualifications
- All requiring as main action tools
  - ✓ COMPARABLE QUALIFICATIONS FRAMEWORKS

  And
  - ✓ RECOGNISED QUALITY ASSURANCE PROCEDURES

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To say what I am going to say...

① The Bologna Process - Why and What
- ① Life Today
- ① European Strategy for Development
- ① The Bologna Process, 10 Years on

② Qualifications Frameworks and Qualifications Recognition
- ② Meta Qualifications Frameworks and Academic Degree Structures
- ② Sectoral and branch level Frameworks
- ② Recognition of Engineering Qualifications - a Worldwide issue

③ Chemical Engineering Education in and for the future
- ③ Qualifications Frameworks and Chemical Engineering Programes
- ③ Main directions for Chemical Engineering Education

④ Concluding Notes

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Qualifications Frameworks
The different layers - Who does what...

☞ High level descriptors - Meta Frameworks
- ✓ Characterized at institutional level of governments and stakeholders
- ✓ They represent the 'legal crust'

☞ Complemented by Sectoral descriptors
- ✓ By area and specialty
- ✓ In close cooperation with higher education institutions and professional associations
- ✓ In transnational cooperation
- ✓ They represent Bologna in practice

☞ Complemented by descriptors at branch level
- ✓ Typically developed in Education Working parties and Academic Consortiuns, at European Level, or within regulatory bodies at national level
- ✓ They are the basis for credibility of the whole system

Meta Qualifications Frameworks and the Directive for Recognition of Professional Qualifications

- High Level Framework within the Bologna Universe of 46 Countries
  - ✓ The QF-EHEA - Qualifications Framework for the European Higher Education Area - An Agreement
    - Adopted in Bergen 2005, within the Bologna Process
- High Level Framework and a High Level legal instrument within the European Union 27
  - ✓ The EQF-LLL - European Qualifications Framework for Lifelong Learning - A Recommendation 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 - A Law within each of the Union Countries

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QF-EHEA - Qualifications Framework for the European Higher Education Area (Bergen, 2005)

- A degree structure with three main cycles and a short cycle within or linked to the First Cycle
- Adopts the Dublin Descriptors developed by the Joint Quality Initiative Group 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

EQF-LLL - The European Qualifications Framework for Lifelong Learning

- 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*
- Establishes a link of compatibility with the Framework for Qualifications of the European Higher Education Area

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A major Legal Document - the Directive for Recognition of Professional Qualifications (I)

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

A major Legal Document - the Directive for Recognition of professional Qualifications (II)

- Art. 11, e) - higher level

  ...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) - intermediate level

  ...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) - lower level

  ...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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Qualifications Frameworks and the Directive
A striking coincidence or concerted action?

Bologna EQF-EHEA CYCLES	European Union EQF-LLL LEVELS	EU-Directive of Professional Recognition Art. 11 - LEVELS
Third Cycles	Level 8	
Second Cycles	**Level 7**	**Art 11º e)**
First Cycles	**Level 6**	**Art. 11º d)**
Short Cycles Linked to or Within First Cycles	Level 5	Art. 11º c)

Academic Degree Structures in Engineering
Concerning levels of qualification

- Two levels of qualifications associated to those levels approved in the Directive of Professional Recognition and recognized in the QF-EHEA and the EQF-LLL
  - 1st Cycle, Level 6, Art. 11, d): (3-4)U
    - ✓ First Cycle Degrees are the basis for achieving the qualification of Technical (or Associate) Engineers, whatever the European designation
  - 2nd Cycle, Level 7, Art. 11, e): >= 4U
    - ✓ Second Cycle Degrees are the basis for achieving the qualification of Engineers, or equivalent European designation

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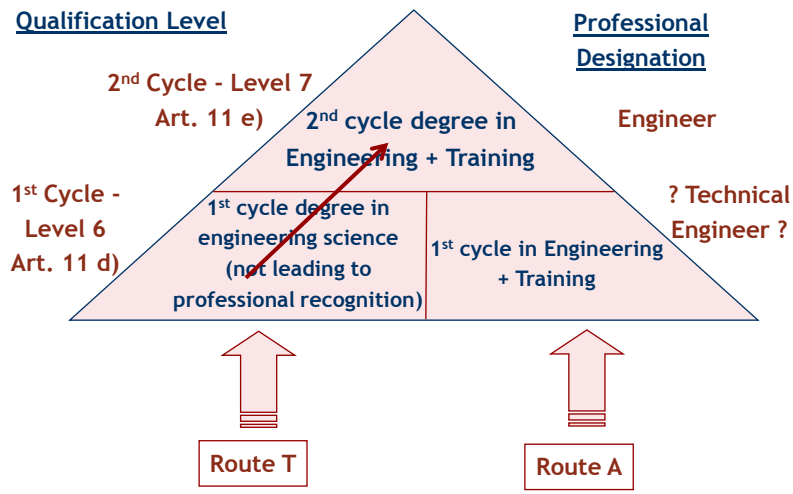
Academic Degree Structures in Engineering
Concerning Profiles

- Two main profiles in Engineering
  - 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

Academic Degree Structures in Engineering
Routes for the different qualification levels



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Academic Degrees in Engineering
Understanding fundamental differences between levels of qualifications for professional purposes

- Programme Outcomes must be evaluated in relation with the level of intervention in the Engineering Activity
  - Social responsability (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 in Engineering, the differences in outcomes are mostly related with
  - scope, depth and breadth
- For the Master degree, developing the right ATTITUDE to use knowledge or skills in a given situation is a major outcome (TU3 Booklet)

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To say what I am going to say...

① The Bologna Process - Why and What
- ① Life Today
- ① European Strategy for Development
- ① The Bologna Process, 10 Years on

② **Qualifications Frameworks and Qualifications Recognition**
- ② Meta Qualifications Frameworks and Academic Degree Structures
- ② **Sectoral and branch level Frameworks**
- ② **Recognition of Engineering Qualifications - a Worldwide issue**

③ Chemical Engineering Education in and for the future
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Relevance of Sectoral and/or Curriculum Frameworks Taken from the Leuven/Louvain-la-Neuve Communique 29 April 2009

"...

Curricular reform will thus be an ongoing process leading to high quality, flexible and more individually tailored education paths.

Academics, in close cooperation with student and employer representatives, will continue to develop learning outcomes and international reference points for a growing number of subject areas

..."

Bringing Qualifications Frameworks into Practice
Sectoral Frameworks

What we have...

- **TUNING Project** - a methodology designed to understand curricula and to make them comparable
  - ✓ E4 proposals for Engineering
- TU3 proposals - Delft, Eindhoven e Twente
- CDIO - Conceive-Design-Implement-Operate - MIT, Swedish U.
- EUR-ACE standards for professional quality assurance
- ABET EC 2000 standards for professional quality assurance
- The TUNING-AHELO conceptual framework of expected/desired Learning Outcomes in engineering
  - ✓ A major initiative from the OECD, 2009

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Bringing Qualifications Frameworks into Practice
The EUR-ACE Framework and Accreditation System

- European Project that aimed at establishing an European System for Qualification of Engineering Education programmes
  - ✓ 14 European Institutions, among them "Ordem dos Engenheiros - Engineers Portugal"
  - ✓ FEANI, SEFI, CESAER, EUROCADRES, ENQHEEI, ASIIN, CTI, IEI, CoPI, UNIFI, OE, UAICR, RAEE, EC-UK
- First Phase for setting the standards, supported by the European Commission (DG EaC) within SOCRATES and TEMPUS programmes; Concluded in 2005
- Second Phase for implementation, supported by the European Commission (DG EaC) within SOCRATES and TEMPUS programmes; concluded in 2008

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The EUR-ACE Framework and Accreditation System
I - Background

- **EUR-ACE developed Framework Standards, that were compiled as a "synthesis" between existing National Standards**

- **An European accreditation system that aims at**
  - ✓ **Ensuring consistency between existing national "engineering" accreditation systems;**
  - ✓ **Adding an European "quality label" to accreditation;**
  - ✓ **Introducing "accreditation" in other European and third countries;**

and thus

- ✓ **Improving quality of education**
- ✓ **Facilitating transnational recognition**
- ✓ **Facilitating (physical and virtual) mobility**

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The EUR-ACE Framework and Accreditation System
II - System Characterization

- **Programme Assessment Procedures should include clear information and evidence on the following components:**
  - ✓ Needs, objectives and outcomes
  - ✓ Educational process
  - ✓ Resources
  - ✓ Assessment of the educational process
  - ✓ Management system

- **In this context 'the criteria to be assessed' and the associated 'requirements' in the form of questions, valid for both FC and SC programmes should be addressed when assessing an engineering programme on education**

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The EUR-ACE Framework and Accreditation System
III - Standards Characterization

☞ **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 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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The EUR-ACE Framework and Accreditation System
IV - Knowledge and Competence areas

☞ **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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EUR-ACE Implementation
I - Creation of the ENAEE (I)

- The EUR-ACE project has lead to the creation on 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
- 7 European Agencies are currently accredited for awarding the EUR-ACE Label
  - ✓ Ordem dos Engenheiros - Engineers Portugal, is one such Agency and is now preparing its accreditations

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EUR-ACE Implementation
I - Creation of the ENAEE (II)

- Founding Members of ENAEE:

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

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

CLAIU	**MÜDEK**

EUR-ACE Implementation
II – Seven accredited national agencies

- The EUR-ACE system is now being implemented by seven Agencies, that formed its initial "core":
  - ASIIN (DE)
  - EC (UK)
  - MÜDEK, Turkey
  - RAEE (RU)
  - CTI (FR)
  - IEI-EngineersIreland
  - OE (PT)
- The representatives of these Agencies sit in the EUR-ACE Label Committee
- A review process of the procedures of such Agencies is taking place during 2008 to decide on the autghorization for future activity of such Agencies in the EUR-ACE system

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Qualifications Frameworks and Quality Assurance – What is equal, what is different
QFs, the Directive and the EUR-ACE System

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Bringing Qualifications Frameworks into Practice
The OECD Initiative – AHELO – Assessment of HE Learning Outcomes

- Potentially the largest, most comprehensive assessment of universities yet devised
  - A feasibility study for assessing student Learning Outcomes
- 10 Countries involved in the start-up, on May 2008
  - Australia, Belgium (Flanders), Finland, Italy, Japan, Korea, Mexico, The Netherlands, Norway, Sweden
- Composed of four strand of work
  - Assessment of generic skills
  - Assessment of discipline - specific skills in Engineering
  - Assessment of discipline - specific skills in Economics
  - Research-based value-added strand – assessing the "value-added" factors of Higher Education Institutions

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Bringing Qualifications Frameworks into Practice
The TUNING-AHELO Conceptual Framework of Expected/Desired Learning Outcomes in Engineering

- Report published on 23 June 2009
- Proposes a framework of Learning Outcomes for FIRST CYCLE (BACHELOR) Degrees, that resulted from synthesizing two sets of Learning Outcomes
  - The ABET EC 2000 criteria and
  - The EUR-ACE FIRST CYCLE Learning Outcomes
- Goes one step further, proposing branch specific Learning Outcomes for a first group of three engineering branches - Civil, Electrical and Mechanical Engineering

Recognition of Qualifications
A Worldwide Issue - A global Accord required

- The Washington Accord defines all recognized (accredited) Engineers' degrees as Bachelor, or related to Bachelor level
- The Washington Accord considers a Fundamental differentiation/barrier between
  - "Professional Engineers" and
  - "Engineering Technologist"
- These features are neither in the spirit of the EQF, nor of EU Directive 2005/36, nor of the EUR-ACE Standards
- Indeed some discussion is currently going on, concerning recognition of standards and this difference is a major issue

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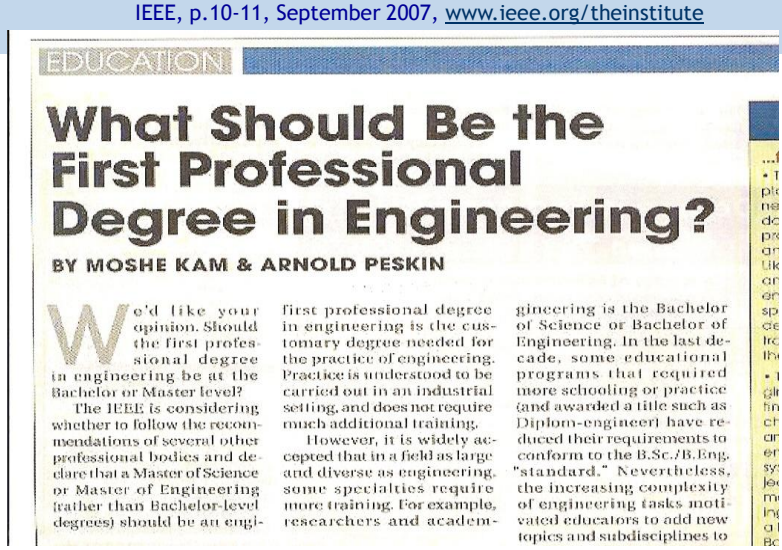
Recognition of Qualifications - a Worldwide Issue
Agreements? Changes may well occur elsewhere…

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



EDUCATION

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 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 engineering's 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- 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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New Programmes in Chemical Engineering Education
I - General guidelines on how to proceed (I)

- Revisit and modernize the programme
  - Bring in new topics
  - Incorporate new Knowledge, Competences and Skills
- Bring in new methods for learning
- Develop within the institution an International Dimension (not only European) and Culture of Quality through mobility and academic cooperation and interchange
  - Prepare programmes for cooperation - Joint Degrees
- Prepare programmes to attract new publics - Lifelong Learning

New Programmes in Chemical Engineering Education
I - General guidelines on how to proceed (II)

- Make recognition of qualifications easy
  - Re-design curricula with reference to agreed reccomendations or descriptors of learning outcomes at high level, sectoral level and branch level
  - Perform internal quality assurance exercises, following agreed guidelines
  - Submit the programme to recognized external quality assurance agencies

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Chemical Engineering Education in and for the future
Contributions in the XXI Century

- Chemical Product Design (E. Cussler and G. Moggeridge,2001)
- Chemical Engineering, Visions of the World (R. Darton et al., 2003)
- New Frontiers for ChE Education (R. Armstrong,2003)
- Beyond the Molecular Frontier. Challenges for Chemistry and Chemical Engineering, US NRC Report (2003)
- The proposals of TUNING-E4 Thematic Network (2003)
- The Recommendations of WPE-EFCE (2005)
- The CHEMEPASS Project (2007-2009)
- The VDI-GVC qualifications frameworks for degree course for Process Engineering, Chemical Engineering and Biomolecular or Bioprocess Engineering (2008)

Descriptors at programme level
I - Recommendations of the WPE-EFCE (I)

- WPE-EFCE – Working Party on Education – European Federation of Chemical Engineering
  - ✓ Currently with 41 members, representing 26 Countries
  - ✓ Developed between 2003 and 2005 an exercise of identification of core curriculum for chemical engineering – contents and methodologies
  - ✓ See EFCE Site and Bologna Recommendations (2005) at

    http://www.efce.info/wpe.html

    http://www.efce.info/Bologna_Recommendation.html

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Descriptors at programme level
I - Recommendations of the WPE-EFCE (II)

- 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

Descriptors at programme level
I - Recommendations of the WPE-EFCE (III)

- Using as reference accumulated knowledge, competences and skills after a Second Cycle in Chemical Engineering

⇩

- A minimum dimension is proposed to
  - ✓ Basic sciences, enlarged with life sciences
  - ✓ Chemical engineering sciences
  - ✓ Chemical engineering core
    - ➢ With engineering design,
    - ➢ With a dissertation for training R&D&I,
    - ➢ With diverse profiles through electives and external training.

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Descriptors at programme level
II - The CHEMEPASS Project (2006-2009) (I)

- Financed by the European Commission within the Erasmus Mundus Programme – Action 4: "Enhancing Attractiveness". Started: November 2006. E.U. grant for 3 years.

- Composed of 13 Higher Education Institutions of 9 European countries and 1 of South Africa:

  CPE Lyon (France) (Coordinator), **Institut Quimic de Sarrià** (Spain), **Universidade do Porto** (Portugal), **Politecnico di Torino** (Italy), **INPL-ENSIC Nancy** (France), **INPT-ENSIACET Toulouse** (France), **Technische Universiteit Delft** (The Netherlands), **University College Dublin** (Ireland), **Technische Universität München** (Germany), **UCTM Sofia** (Bulgaria), **Jagiellonian University** (Poland), **Lappeenranta University of Technology** (Finland), **Durban University of Technology** (South Africa).

SFA, 8th World Congress - WCCE8, 27 August 2009 www.fe.up.pt/~sfeyo sfeyo@fe.up.pt

Descriptors at programme level
II - The CHEMEPASS Project (2006-2009) (II)

- 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

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The VDI-GVC Recommendation for Chemical and Processing Engineering (2008) (I)

- VDI-GVC approved qualifications frameworks for degree course for Process Engineering, Chemical Engineering and Biomolecular or Bioprocess Engineering
- Recommendations cover both 'more theoretically oriented' and 'more vocationally oriented' profiles
- Recommendations apply to consecutive Bachelor's and Master's degree courses

The VDI-GVC Recommendation for Chemical and Processing Engineering (2008) (II)

- Recommendations are structured in:
  - ✓ Professional profile and qualification framework
  - ✓ Qualifications for admission to the course
  - ✓ Structure of the degree course
  - ✓ Contents of the degree course
- The Professional profile and qualification framework is organized in the six main outcomes adopted by EUR-ACE

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New Directions for Chemical Engineering Education I - Address problems, answer demands

- New concerns on energy and environment problems and generally on sustainability
- Sharp demand for 'performance products' - specialties, food, personal care products...
- Process and product development times came down sharply (3 to 5 fold) - risk management...
- Technological and scientific developments - new paradigms on Unit Operations open for discussion - micro-systems, process intensification…
- .....

New Directions for Chemical Engineering Education
II - Incorporate new knowledge, competences and skills

- Programmes are of course directed to scientific and technical knowledge (depending on the discipline)

BUT

- Should include developing of attitude, 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, self-management, achievement of objectives..

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New Directions for Chemical Engineering Education
III - Today and for the future, we have to…

- Speak of
  - ✓ Life sciences and of biology as one of the four basic sciences,
  - ✓ Environmental issues and sustainability
  - ✓ (Nano) structures and material science issues
- Speak of ENERGY and OPTIMAL Operation
  - ✓ An economy based on alternative energy resources
  - ✓ Systems engineering and knowledge based methods for optimised, safe, simple to operate systems
- Give an answer to the demand of Society for specificity and quality
  - ✓ New products - competencies in product design

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New Directions for Chemical Engineering Education
IV - Guidelines… not a single degree structure… (II)

☞ A decision has to be made on appropriate dosage of depth and scale of phenomena analysis

- Molecular modelling and microscopic scale
  - ✓ Polymer properties, microporous materials, vapour-liquid equilibria...
- Macrocospic scale
  - ✓ Process modelling and process synthesis, full plant models for optimisation, computer-aided process operations
  - ✓ Modelling through knowledge integration

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New Directions for Chemical Engineering Education
IV - Guidelines… not a single degree structure… (III)

- Teach and induce sustainability through everyday work
- Bring students nearer to the practice of chemical engineering
- Give sufficient practical experience, both in the laboratory, pilot plant and industry in the core curriculum
- Promote holistic thinking through integrated case-studies and strengthening of horizontal issues

To say what I am going to say...

① The Bologna Process - Why and What
- ① Life Today
- ① European Strategy for Development
- ① The Bologna Process, 10 Years on

② Qualifications Frameworks and Qualifications Recognition
- ② Meta Qualifications Frameworks and Academic Degree Structures
- ② Sectoral and branch level Frameworks
- ② Recognition of Engineering Qualifications - a Worldwide issue

③ Chemical Engineering Education in and for the future
- ③ Main directions for Chemical Engineering Education
- ③ Qualifications Frameworks and Chemical Engineering Programes

④ **Concluding Notes - Really, to say what I have said**

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Bologna and Routes for Professional Qualification and Transnational Cooperation

- 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

New Directions for Chemical Engineering Education Prospectively…

- A core group of topics, concerning basics and engineering, and of skills and competencies, should be part of the programmes
- A complementary group of elective modules should lead the student to work on frontier topics of chemical engineering and/or new relevant issues
- External training, more practical 'hands-on' training is required, mainly for vocational first-degrees
- Academia and Industry should co-operate, offering each other aided-value, by accepting students for training (the Industry), by jointly designing pilot case studies, by providing theoretical background through courses
- Lifelong learning is the key concept to have the edge

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New Directions for Chemical Engineering Education Paradigm shifts

- 1st Paradigm(s)
  - In general terms - First quarter of the XX Century - Education close to industrial operations - Unit 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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New Directions for Chemical Engineering Education
Third Paradigm? Is it so?

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

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Inspiring words about 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

Qualifications Frameworks, Quality Assurance and Recognition of Professional Qualifications (I)

- Curricula and module syllabus must be designed with reference to agreed reccomendations or descriptors of learning outcomes at high level, sectoral level and branch level

- Quality Assurance procedures should
  - ✓ Be in substantial conformity with Standards and Guidelines for Quality Assurance accepted by all stakeholders
    - ↳ Accomodating the recognition of descriptors developed at sectoral and branch level

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Qualifications Frameworks, Quality Assurance and Recognition of Professional Qualifications (II)

- Mobility is a distinctive need of Today's Global World

- Recognition of professional qualifications is a major task ahead…

- Mobility and Recognition of Qualifications are not an illusion, a dream, an objective or a target…

They are a MUST…

Required for Peace and Progress on Earth