

Engineering Education: Theoretical vs. Applied Approaches

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To say what I am going to say...

*Theoretically oriented vs. Applications oriented
profiles in Engineering Education*

- ① **Setting the Stage**
 - ① Discussions within FEANI, 2004-2005
- ② **Qualifications Frameworks and Engineering Education**
 - ② Meta frameworks; Sectoral frameworks - EUR-ACE; Branch level descriptors
 - ② Meta frameworks and the offer of Engineering Education
- ③ **General issues about quality assurance - global vs. field-specific systems**
 - ③ EUR-ACE as sectoral reference for field-specific quality assurance in Engineering
- ④ **Concluding Notes**

Setting the Stage I - A World of Coopetition

- ☞ A global World, 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**

Setting the Stage II - Keywords

- ☞ The name of the game is **BUILDING TRUST**
- ☞ **TRUST GOES WITH MOBILITY, COOPERATION, ACCREDITATION**
 - ✓ **MOBILITY AND COOPERATION** require professional recognition
 - ✓ Professional recognition requires **TRUST**
 - ✓ **TRUST** requires transparency and readability of structures and professional qualifications
- ☞ Such requires:
 - ✓ **COMPARABLE QUALIFICATIONS FRAMEWORKS**
 - And**
 - ✓ **RECOGNISED QUALITY ASSURANCE PROCEDURES**

Setting the Stage

III - Discussion within FEANI - 2003-2005 in the context of the making of the Directive on Professional Recognition

- ☞ **Two main lines in discussion**
 - The proposal for the recognition of a Common Platform, based on the 'famous' formula :
 - ✓ **B + 3U + 2(U/T/E) + 2E**
 - The views of the two level system, associated or not to different profiles of education
- ☞ **Ended up with the recognition of two main levels of engineering education and also two possible profiles as entry routes for the profession. Looking ahead:**
 - ✓ **In line with the Bologna Agreements**
 - ✓ **In line with the recommendations of the EQF-LLL - The European Qualifications Framework for Lifelong Learning**

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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 Consortia, 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

- ☞ **(Two plus One) major documents at High Level**
 - ✓ The QF-EHEA -Qualifications Framework for the European Higher Education Area - **An Agreement**
 - Adopted in Bergen 2005, within the Bologna Process
 - ✓ The EQF-LLL - European Qualifications Framework for Lifelong Learning - **A Recommendation**
 - 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 - **A Law within the Union**
 - National laws should have been passed in all EC Countries till the end of 2007....

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

- ☞ A degree structure with **three main cycles**, including, within national contexts, the possibility of intermediate qualifications
- ☞ 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

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...

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

- ☞ The Bergen QF-EHEA, the EQF-LLL and the Directive point out in the same direction
 - ✓ Recognition of different qualification levels
 - ✓ Recognition that qualifications can or may 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 accreditation systems

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 11° e)
First Cycles	Level 6	Art. 11° d)
Short Cycles Linked to or Within First Cycles	Level 5	Art. 11° c)

Academic Degree Structures in Engineering I - Concerning levels of qualification - (I) - Art. 11, c)

- ☞ **Level of Qualification: Short cycles, Level 5, Art. 11, c),**
 - **1 year of post-secondary course work + Professional Training \geq 1 year**
- ☞ **Not leading to a recognised competence group of Engineering, though they are vital as support to the 'Engineering Activities'**
 - **Let's identify them as Technicians**

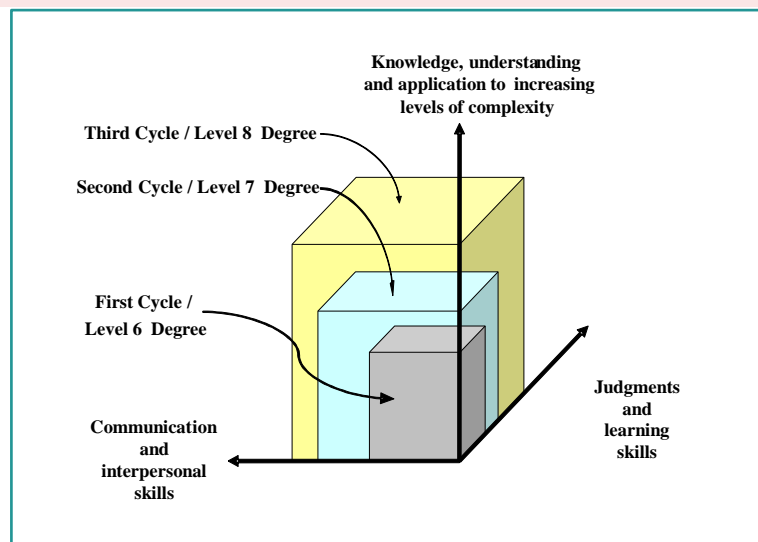
Academic Degree Structures in Engineering I - Concerning levels of qualification - (II) - Art. 11, d), e)

- ☞ **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 entry routes for achieving the qualification of Technical (or Associate) Engineers, whatever the European designation**
 - **2nd Cycle, Level 7, Art. 11, e): \geq 4U**
 - ✓ **Second Cycle Degrees are entry routes for achieving the qualification of Engineers, or equivalent European designation**

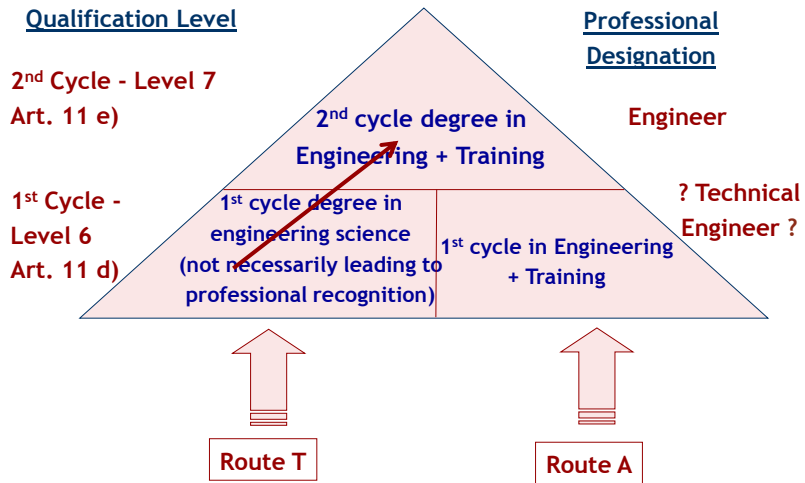
Academic Degree Structures in Engineering II - Concerning Profiles

- ☞ 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
 - ✓ Hopefully for more theoretically oriented minds...!
 - **More Applications oriented**
 - ✓ Designed to qualify after First Cycle, independently of pursuit of studies through Second Cycles, be it directly or through bridging programmes
 - ✓ Hopefully for more applications oriented minds...!

Academic Degree Structures in Engineering III - A single route for the different qualification levels



Academic Degree Structures in Engineering IV - Two routes for the different qualification levels (I)

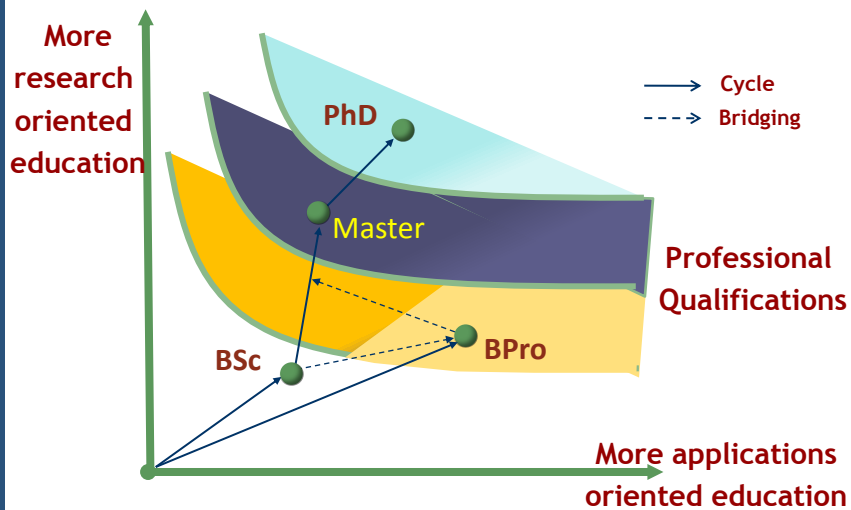


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Academic Degree Structures in Engineering IV - Two routes for the different qualification levels (II)

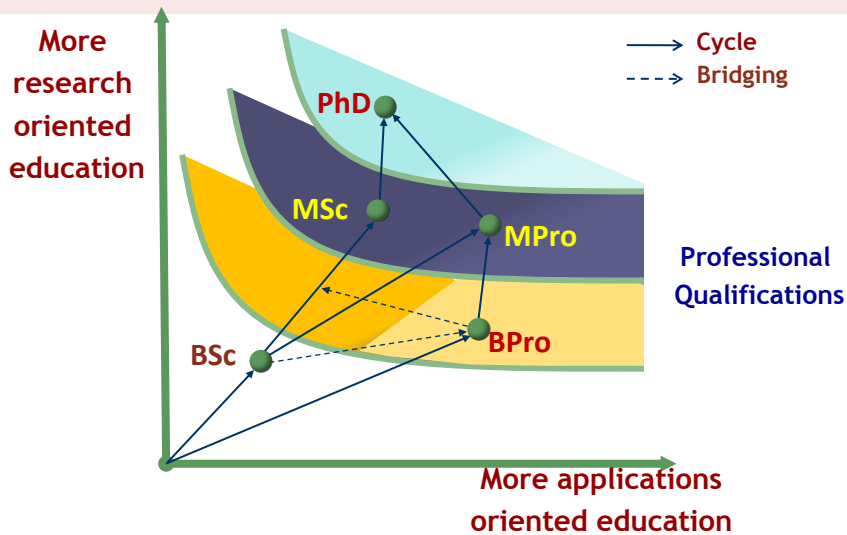


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Academic Degree Structures in Engineering IV - Two routes for the different qualification levels (II)



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Academic Degree Structures in Engineering V - Understanding fundamental 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 First and Second Cycle Degrees in Engineering, and for the different subsets of Programme Outcomes, 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

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Academic Degree Structures in Engineering VI - Accumulated long education (I)

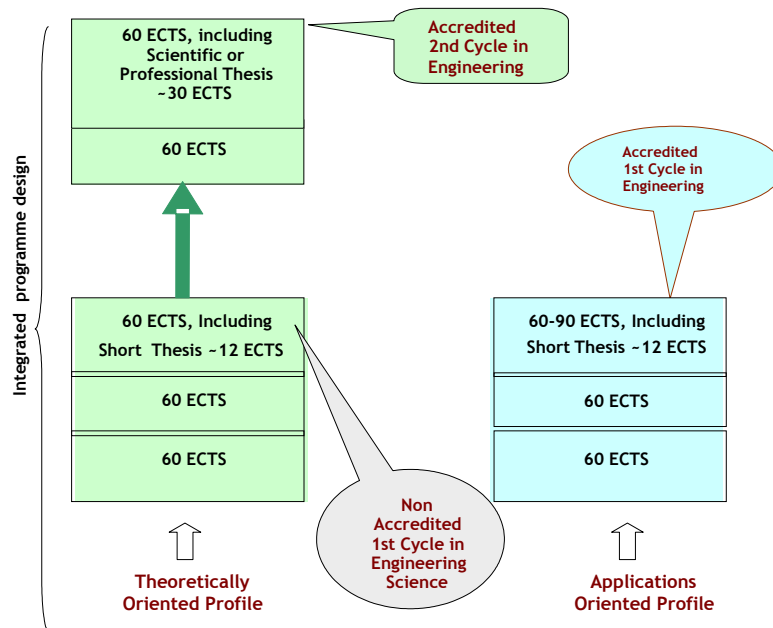
- ☞ In the engineering profession, qualifications for a significant number of activities require accumulated long education at higher education level.
 - In most countries this means the equivalent to 300 ECTS, but it is known that this is not the generalized situation.
- ☞ 'Musts' of Today's life
 - We must open to new publics
 - We must bring in the concept of accumulated credits through lifelong learning
 - We must bring in the 'delicate' issue of recognition of experiential learning

Academic Degree Structures in Engineering VI - Accumulated long education (II)

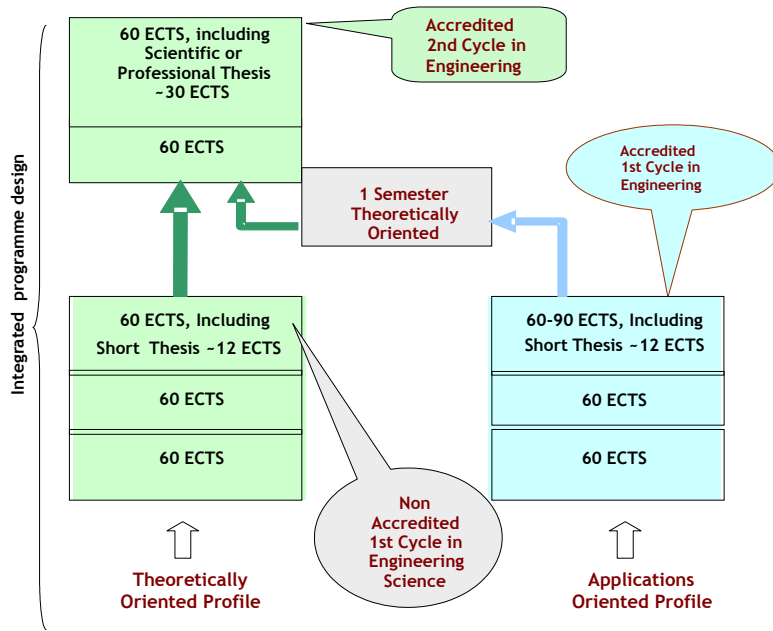
- ☞ What is in discussion is whether such education should be achieved through long cycle degrees, or if it can be achieved through accumulated two-cycle studies.
 - The question of the type of offer is more and more a political issue of educational policies
 - In fact, most European countries are adopting the two-cycle system, independently of the qualifications associated to First Cycle degrees

Academic Degree Structures in Engineering VII - Prevailing concepts in the design of the Degree System

- ☞ **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**
 - **Implementation of the concept of ‘accumulated credits’ for recognition of studies**



Theoretically oriented vs. Applications oriented profiles in Engineering Education

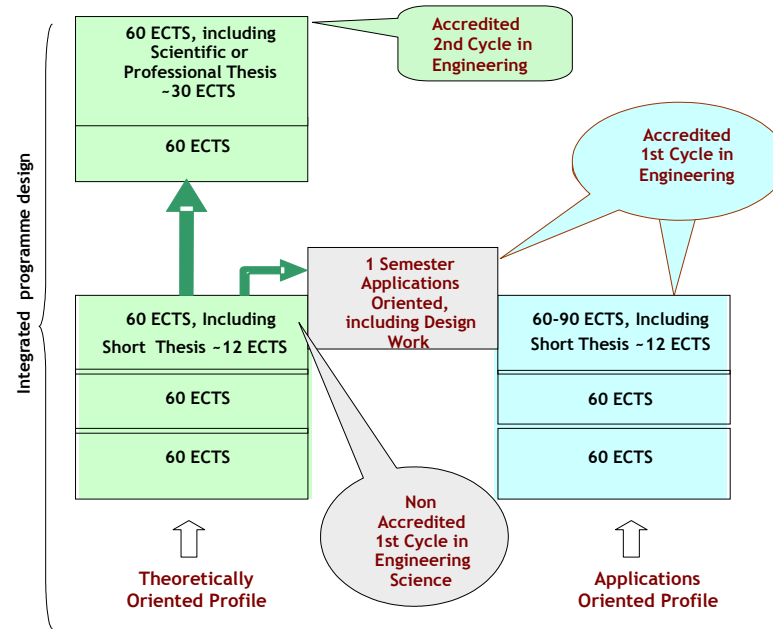


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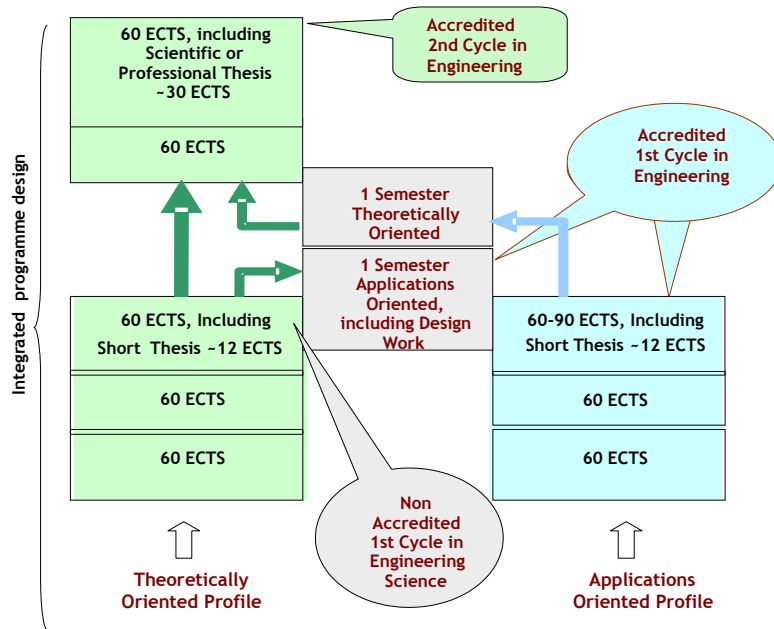
Theoretically oriented vs. Applications oriented profiles in Engineering Education



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General Quality Assurance Strategy at European Level Main Documents and Milestones

- ☞ Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), Bergen 2005
- ☞ The European Quality Assurance Register (EQAR), London 2007,
 - Formally set on March 4, 2008
- ☞ The on-going process led by the Council of Europe, catalysing the approval of National Qualifications Frameworks
- ☞ The on-going process of creation of National Accreditation Agencies that are expected to register with EQAR
- ☞ The wide recognition and the creation of field-specific quality assurance systems (Eg. EUR-ACE in Engineering, 2008)

Quality Assurance in Engineering I - Issues leading to Field-Specific QA Systems

- ☞ Quality Assurance systems should include clear and measurable objectives and standards, associated to an accepted Qualifications Framework (QF)
- ☞ The understanding by all stakeholders of specific knowledge, competences and skills of their graduates is essential for both internal and external evaluation and for recognition
- ☞ This means that we have to develop and implement field-specific QA systems that must be supported by sectoral and branch specific descriptors of qualifications

Quality Assurance in Engineering II - Global vs. Field Specific Systems

- ☞ The issue is not to abandon “general” QA approaches, that lead to a relevant evaluation of the educational process, but rather to understand the relevance of “field-specific” QA systems
- ☞ “Field-specific” QA systems accentuate the need for aligning the goals of educational programmes with the expectations of the relevant stakeholders, in order to be comparable and ensure their relevance for the labour market
- ☞ “Field-specific” QA systems give credibility and concreteness to the whole “Bologna”/EHEA system

Relevance of Sectoral and/or Curriculum Frameworks Taken from the Leuven/Louvain-la-Neuve Communiqué 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 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**

The EUR-ACE Framework and Accreditation System Standards Characterization

- ☞ **The Standards developed:**
 - ✓ Specify the **Programme Outcomes** that must be satisfied
 - ✓ 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**

The EUR-ACE Framework and Accreditation System 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**

Qualifications Frameworks and Quality Assurance - What is equal, what is different? I - Clustering of qualifications descriptors

Table 1 - Clustering of qualifications descriptors in different frameworks

Bologna, QF-EHEA	EU, EQF-LLL	EUR-ACE
A. Knowledge and understanding	1. Knowledge	I. Knowledge and understanding
B. Applying knowledge and understanding	2. Skills	II. Engineering analysis
C. Making Judgments	3. Competences	III. Engineering design
D. Communications skills		IV. Investigations
E. Learning skills		V. Engineering practice
		VI. Transferable skills

Qualifications Frameworks and Quality Assurance

Comparing qualifications descriptors

(a) - First Cycles - Level 6

		EUR-ACE - First Cycles																					
		I.1	I.2	I.3	I.4	II.1	II.2	II.3	III.1	III.2	IV.1	IV.2	IV.3	V.1	V.2	V.3	V.4	VI.1	VI.2	VI.3	VI.4	VI.5	
QF - EHEA	FC-A	■	■	■	■																		
	FC-B					■	■	■	■	■	■	■	■	■	■	■	■				■	■	
	FC-C					■		■	■	■	■	■	■	■			■		■	■			
	FC-D																	■	■				
	FC-E														■	■	■	■					■
EQF-LLL	L6.1	■	■	■	■										■	■	■						
	L6.2		■	■	■	■	■	■	■	■	■	■	■	■	■	■							
	L6.3.1																	■			■	■	
	L6.3.2																	■		■			■

Qualifications Frameworks and Quality Assurance

Comparing qualifications descriptors

(b) - Second Cycles - Level 7

		EUR-ACE - Second Cycles																				
		I.1	I.2	II.1	II.2	II.3	II.4	III.1	III.2	III.3	IV.1	IV.2	IV.3	IV.4	V.1	V.2	V.3	VI.1	VI.2	VI.3		
QF - EHEA	SC-A	■	■																			
	SC-B			■	■	■	■	■	■	■	■	■	■	■		■	■					
	SC-C					■	■	■	■	■	■	■	■	■								
	SC-D																		■	■	■	■
	SC-E				■							■	■	■	■							
EQF-LLL	L7.1.1	■	■																			
	L7.1.2	■	■																			
	L7.2			■	■	■	■	■	■	■	■	■	■	■								
	L7.3.1															■				■	■	
	L7.3.2																	■		■		■

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

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

Towards Comprehensive Field-Specific QA Systems Branch level Recommendations compatible with Sectoral Frameworks

- ☞ Branch level initiatives are required to close the loop and build robust and transparent field-specific quality assurance systems
- ☞ EUR-ACE has already served as reference for relevant initiatives at branch level, that are expected to have significant follow-up in the near future -
 - ☞ The VDI-GVC Recommendations for Chemical and Processing Engineering (2008)
 - ☞ The branch level recommendations of the European Federation of Chemical Engineering (2010)
- ☞ Field-specific QA systems should include a comprehensive set of reference outcomes, coherent at all levels

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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 at European level 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**
- ☞ **Second-cycle studies, whatever the trajectory to pursue them, are requirements of quality and trust of the Society for the Engineering activity**

Routes for Professional Qualification and Transnational Cooperation (II)

- ☞ The concept of **Credit Accumulation**, together with **Lifelong Learning**, is of utmost relevance in this new paradigm of building professional qualifications
- ☞ Transnational cooperation is indissociable from mobility , recognition of qualifications and qualifications frameworks
 - ✓ Mobility is a distinctive need of Today's Global World
 - ✓ Recognition of professional qualifications is a major task ahead...
 - ✓ Mobility and Recognition require transparent and compatible Frameworks at different complementary layers

The relevance of Comprehensive Field-Specific Quality Assurance Systems The Case of EUR-ACE

- ☞ At sectoral and branch level, recommendations, descriptors, reference points and tools for characterizing degree programmes should be developed through institutional co-operation
- ☞ EUR-ACE is not the first effort, at European level, to develop sectoral descriptors, BUT it is up to this stage the most comprehensive in the way it brings together academics and professional , universities and professional associations
- ☞ Possibly for that reason, EUR-ACE has been praised and has received significant support from the Commission, in different occasions.

Engineering Education The Future

- ☞ **Within diversity, curricula should be designed with reference to such agreed recommendations or descriptors of learning outcomes at high level, sectoral level and branch level**
- ☞ **The aim is to guarantee quality and increase transparency in order to**
 - ✓ **increase academic and professional mobility**
 - ✓ **promote academic co-operation, namely through joint degrees**
 - ✓ **throw down barriers of recognition**

This is the way to walk to the future...