



## The Bologna Process - Qualifications Frameworks in the Engineering Area

**Sebastião Feyo de Azevedo**

Professor of Chemical Engineering, Faculty of Engineering,  
University of Porto, Portugal  
National Vice-President, Ordem dos Engenheiros-Engineers Portugal  
Portuguese Delegate to the BFUG

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

<http://www.fe.up.pt/~sfeyo>

XXI Meeting - SPQ - Sociedade Portuguesa de Química  
FEUP, Porto  
12 June 2008

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

1



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



- ① The Bologna Process and the European Strategy for Development
  - ① Major issues and documents - parallel developments
- ② Qualifications Frameworks in Engineering
- ③ The Directive of Professional Recognitions and related Academic Degree Structures in Engineering
- ⑤ Closing Notes

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...

Qualifications Frameworks in Engineering ...

## The Bologna Process

### From birth, till Today, 2008

☞ **Genesis was...**



- ✓ ? The Magna Carta signed by Rectors in Bologna, 1988?
- ✓ ? The Sorbonne Declaration, signed by Ministers of 4 Countries, France, Germany, Italy and UK, in 1998 ?

☞ **Original objectives were... never mind...**

☞ **Something for sure very deep and sound led to the development of a movement that Today**

- ✓ Counts with 46 signatory Countries
- ✓ Involves over 5600 Higher Educations Institutions
- ✓ Involves over 16 million students
- ✓ Is receiving most serious attention from other main blocks in the Planet

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...

## The Bologna Process

### What needs to be understood?


☞ 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 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...


## European Strategy for Development

### 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

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt



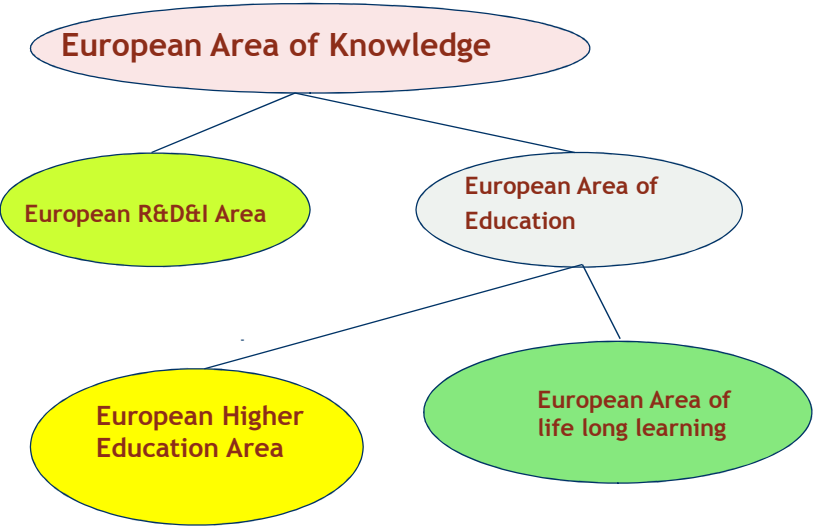
Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## The Bologna Process Revisited


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




```

graph TD
    EAK([European Area of Knowledge]) --> ERDI([European R&D&I Area])
    EAK --> EAE([European Area of Education])
    EAE --> EHEA([European Higher Education Area])
    EAE --> EALL([European Area of life long learning])
            
```

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...


## The Bologna Process Revisited

### II - 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...


## The Bologna Process Revisited

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


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

- ☞ Political / academic
  - ✓ Restructuring the offer of higher education - more attractive and nearer to the needs and interests of Society
- ☞ Academic
  - ✓ An evolution of teaching/learning paradigms - adapted to the concepts and perspectives of the modern society and to the available technical tools, projecting education to more adult phases of life

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

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


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

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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

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


### 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! “*

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## 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**

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## 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**

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**




Qualifications Frameworks in Engineering ...


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

- ① The Bologna Process and the European Strategy for Development
  - ① Major issues and documents - parallel developments
- ② **Qualifications Frameworks in Engineering**
- ③ The Directive of Professional Recognitions and related Academic Degree Structures in Engineering
- ⑤ Closing Notes

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**




Qualifications Frameworks in Engineering ...


## Qualifications Framework I - Requirements for QF definition

- ☞ A conceptual framework should define/identify (TU-3 proposals)
  - ✓ A system of competences - define areas of competences
  - ✓ Ways of characterizing those competences
    - Academic Dimensions
  - ✓ A system of grading the academic dimensions
- ☞ We should understand that a complete QF may involve up to 4 levels of descriptors in course documentation and in national, sectoral and European qualifications frameworks.

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP




Qualifications Frameworks in Engineering ...

## Qualifications Framework


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

- ☞ **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
  - ✓ In Engineering - TU-3 descriptors, CDIO, EUR-ACE, ABET...
- ☞ **Specific Descriptors**
  - ✓ For each discipline, thus depending on the sector
  - ✓ Including, if applicable, 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...


## Qualifications Frameworks

### III - 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**
- ☞ **Adopts the Dublin Descriptors developed by the Joint Quality 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**

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)





Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...


## Qualifications Frameworks

### IV - 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*
- ☞ 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**




Qualifications Frameworks in Engineering ...

## Qualifications Frameworks


### V - The CDIO Syllabus (Chalmers, Linköping, KTH, MIT) (I)

- ☞ CDIO - Conceive - Design - Implement - Operate
- ☞ Building Blocks
  - 1 TECHNICAL KNOWLEDGE AND REASONING**
    - 1.1 KNOWLEDGE OF UNDERLYING SCIENCE [a]
    - 1.2 CORE ENGINEERING FUNDAMENTAL KNOWLEDGE [a]
    - 1.3 ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE [k]
  - 2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES**
    - 2.1 ENGINEERING REASONING AND PROBLEM SOLVING [e]
    - 2.2 EXPERIMENTATION AND KNOWLEDGE DISCOVERY [b]
    - 2.3 SYSTEM THINKING
    - 2.4 PERSONAL SKILLS AND ATTITUDES
    - 2.5 PROFESSIONAL SKILLS AND ATTITUDE

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...


## Qualifications Frameworks

### V - The CDIO Syllabus (II)


☞ **Building Blocks (Cont.)**

- 3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION**
  - 3.1 MULTI-DISCIPLINARY TEAMWORK [d]
  - 3.2 COMMUNICATIONS [g]
  - 3.3 COMMUNICATIONS IN FOREIGN LANGUAGES
- 4 CONCEIVING, DESIGNING, IMPLEMENTING, AND OPERATING SYSTEMS IN THE INTERPRISE AND SOCIETAL CONTEXT [h]**
  - 4.1 EXTERNAL AND SOCIETAL CONTEXT
  - 4.2 ENTERPRISE AND BUSINESS CONTEXT
  - 4.3 CONCEIVING AND ENGINEERING SYSTEMS [c]
  - 4.4 DESIGNING [c]
  - 4.5 IMPLEMENTING [c]
  - 4.6 OPERATING [c]

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## Qualifications Frameworks for Quality Assurance

### I - The EUR-ACE Project

☞ **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 the Portuguese Institution of Engineers**

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


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

☞ **Concluded in 2005**

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

## Qualifications Frameworks for Quality Assurance II - The EUR-ACE Standards (I)


☞ **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


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

## Qualifications Frameworks for Quality Assurance II - The EUR-ACE Standards (II)

☞ **Programme Outcomes that must be satisfied**


- **6 areas of competences are defined**
  - ✓ Knowledge and Understanding
  - ✓ Engineering Analysis
  - ✓ Engineering Design
  - ✓ Investigations
  - ✓ Engineering Practice
  - ✓ Transferable (personal) Skills
- **For each category, the EUR-ACE Framework Standards list the expected Programme Outcomes of First Cycle and Second Cycle Studies**

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...



## Qualifications Frameworks for Quality Assurance


### III - The ABET System -

#### ABET 07-08 Criterion 3 - Outcomes and Assessment

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

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt

Qualifications Frameworks in Engineering ...



## Quality Assurance and Qualifications Frameworks



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

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

CDIO		Dublin - Master					EUR-ACE						ABET											
		a)	b)	c)	d)	e)	1	2	3	4	5	6	a	b	c	d	e	f	g	h	i	j	k	
1	Technical knowledge and reasoning	1.1 Knowledge of underlying sciences	1					1						1										
	1.2 Core engineering fundamental knowledge	1					1						1											
	1.3 Advanced engineering fundamental knowledge	1					1																1	
2	Personal and professional skills and attributes	2.1 Engineering reasoning and problem solving	1	1	1			1	1									1						
		2.2 Experimentation and knowledge discovery	1	1				1	1	1							1							
		2.3 System thinking	1					1	1	1	1													
		2.4 Personal skills and attitudes		1			1	1	1	1	1	1										1		
		2.5 Professional skills and attitudes		1	1		1			1	1	1							1					
3	Interpersonal skills: Teamwork and communication	3.1 Teamwork									1							1						
		3.2 Communications				1					1									1				
		3.3 Communications in foreign languages				1					1													
4	Conceiving, Designing, Implementing and Operating systems in the enterprise and societal context	4.1 External and societal context		1						1	1	1									1		1	
		4.2 Enterprise and business context		1						1	1	1									1			
		4.3 Conceiving and engineering systems		1														1						
		4.4 Designing		1						1								1						
		4.5 Implementing		1														1						
		4.6 Operating																1						

SFA, SPQ, FEUP-Porto, 12 June 2008
www.fe.up.pt/~sfeyo
sfeyo@fe.up.pt

Qualifications Frameworks in Engineering ...



### Example of Standards at Discipline Level

#### Contributions in Chemical Engineering Education

- ☞ Very many contributions addressing scientific, academic and political issues of the required reform or adapting of the degree structures and contents
  - ☞ US National Research Council Report (2003)
  - ☞ The proposals of E4 Thematic Network (2003)
  - ☞ The CHEMEPASS Project (2007)
  - ☞ The recommendations of WPE-EFCE- the Working Party on Education - European Federation of Chemical Engineers (2005)

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...


### Example of Standards at Discipline level

#### Contributions in Chemical Engineering Education


#### The CHEMEPASS Project (I)

- ☞ A consortium 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, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

### Example of Standards at Discipline level

#### Contributions in Chemical Engineering Education

#### The CHEMEPASS Project (II)

☞ A project financed by the European Commission within the Erasmus Mundus Programme - Action 4: “Enhancing Attractiveness”. Started: November 2006. E.U. grant for 3 years.

- ✓ Co-ordinated by Sebastien Gagneur, CPE Lyon


☞ **Milestones**

- ✓ Identification of relevant general and specific Learning Outcomes for Chemical Engineering Programmes
- ✓ Identification of knowledge to be tested among Chemical Engineering core subjects
- ✓ Development of a database with test questions


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

### Example of Standards at Discipline level

#### Contributions in Chemical Engineering Education

#### The WPE-EFCE Recommendations

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

☞ These recommendations cover


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

☞ The core curriculum proposed covers only approx. two thirds of a first and a second level degree study


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## Qualifications Frameworks


### V - 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


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## National Qualifications Frameworks

### Bringing Bologna into Practice

- ☞ National Qualifications Frameworks will have to articulate with European Qualifications Framework
- ☞ For some countries, the most difficult bit of the Bologna Reform
  - ✓ Defining NQF compatible with EQF
  - ✓ Characterizing the programmes through ECTS - Workload plus Outcomes
  - ✓ Re-doing of all modules within this new framework
  - ✓ Giving evidence that approved Learning Outcomes are achieved
- ☞ Or simply, bringing Bologna into practice...

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

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

- ① The Bologna Process and the European Strategy for Development
  - ① Major issues and documents - parallel developments
- ② Qualifications Frameworks in Engineering
- ③ The Directive of Professional Recognitions and related Academic Degree Structures in Engineering
- ⑤ Closing Notes

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)





Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## 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

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

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

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

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

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

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## The EQF-EHEA and the Directive


### A striking coincidence or concerted action?

- ☞ 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


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP



Qualifications Frameworks in Engineering ...

## 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


SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP




Qualifications Frameworks in Engineering ...

## 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**

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP




Qualifications Frameworks in Engineering ...

## 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
FEUP




Qualifications Frameworks in Engineering ...

## 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**

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



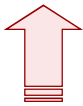
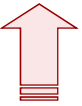
Universidade do Porto  
Faculdade de Engenharia  
FEUP



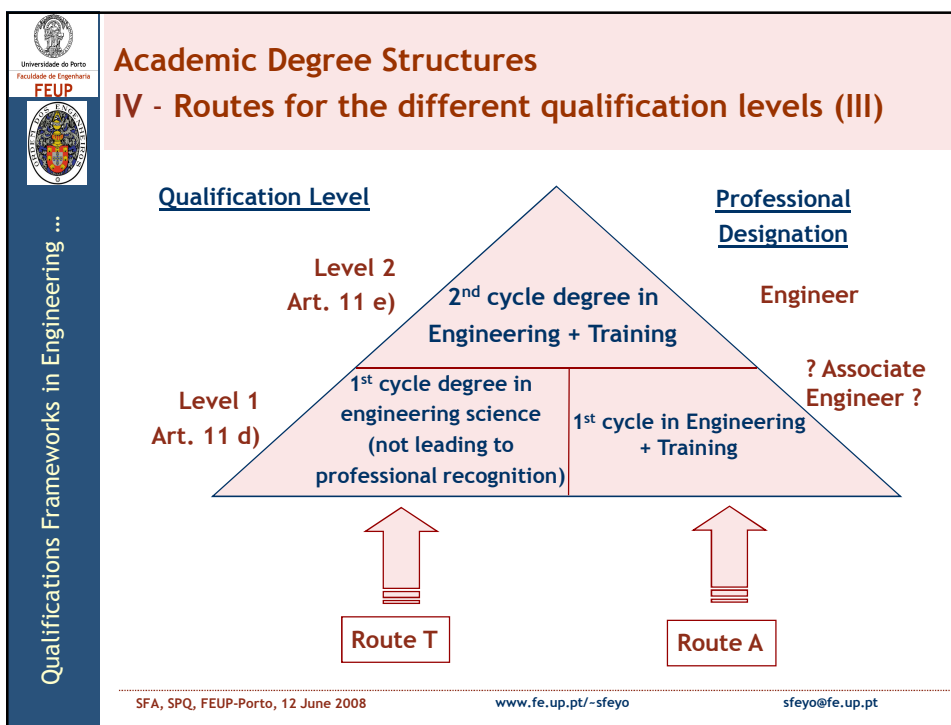
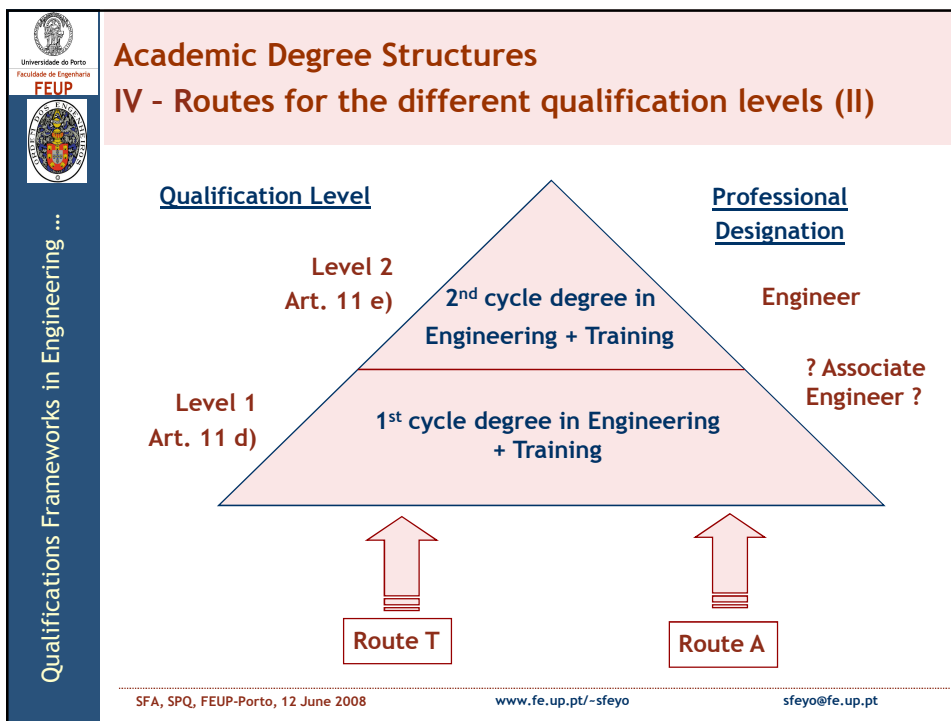
Qualifications Frameworks in Engineering ...


## Academic Degree Structures

### IV - Routes for the different qualification levels (I) (Not in the spirit of the Bologna Process)

<u>Qualification Level</u>		<u>Professional Designation in Portugal</u>
<p>Level 2 Art. 11 e)</p>	<p>2<sup>nd</sup> cycle degree in Engineering + Training</p>	<p>Engineer</p>
<p>Level 1 Art. 11 d)</p>	<p>Direct route</p>	<p>? Associate Engineer ?</p>
	<div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;">  <div style="border: 1px solid black; padding: 2px 5px; margin-top: 5px;">Route T</div> </div> <div style="text-align: center;">  <div style="border: 1px solid black; padding: 2px 5px; margin-top: 5px;">Route A</div> </div> </div>	

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)





Qualifications Frameworks in Engineering ...

## Academic Degree Structures


### V - 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

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Qualifications Frameworks in Engineering ...

## Academic Degree Structures

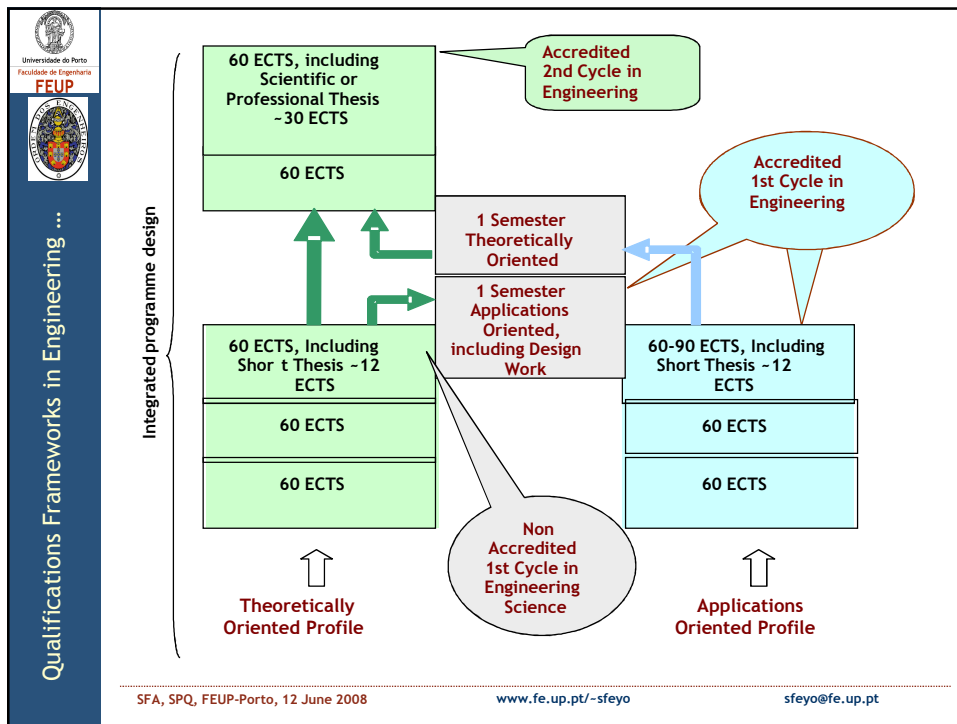
### VI - Prevailing concepts in the design of the Degree System (I)

- ☞ 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

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Qualifications Frameworks in Engineering ...

## Major issues left out in this talk


- ① Quality Assurance issues
- ② Paradigms shift in Engineering Education

SFA, SPQ, FEUP-Porto, 12 June 2008


[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**




## New Directions for Engineering Education

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


- ☞ 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 ?

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



## 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)





Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

## The Bologna Process as part of the paradigm shift

### Mechanisms for inducing changes

- ☞ **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**

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



Qualifications Frameworks in Engineering ...

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



- ① **The Bologna Process and the European Strategy for Development**
  - ① **Major issues and documents - parallel developments**
- ② **Qualifications Frameworks in Engineering**
- ③ **The Directive of Professional Recognitions and related Academic Degree Structures in Engineering**
- ⑤ **Closing Notes**

SFA, SPQ, FEUP-Porto, 12 June 2008

[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)

[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...






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

- ☞ The Bologna Process is a relevant dimension of the current European model of development
- A system promoting cohesion and Transnational Cooperation, through readable Qualifications Frameworks and recognized Quality Assurance Procedures
- ☞ New methods of Teaching/Learning adapted to Today's stage of development
- ☞ New offer of studies within a philosophy of Lifelong Learning
- ☞ Not all the action lines of the Bologna Process will have been completed by 2010

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

Qualifications Frameworks in Engineering ...

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

- ☞ 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

SFA, SPQ, FEUP-Porto, 12 June 2008
[www.fe.up.pt/~sfeyo](http://www.fe.up.pt/~sfeyo)
[sfeyo@fe.up.pt](mailto:sfeyo@fe.up.pt)

## 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...

The Bologna Process is indeed a major dimension of the European Strategy for Development in the political, social and economical concepts of this beginning of the XXI Century