

# Introducing Quality Indicators in Doctoral Engineering Education



Prof. Dr.-Eng. Aris Avdelas  
Faculty of Engineering  
Aristotle University of Thessaloniki, Greece

## Dublin Descriptors

Shared “Dublin” descriptors for Short Cycle,  
First Cycle, Second Cycle and Third Cycle

Awards

(2004)

## Dublin descriptors

Qualifications that signify completion of the third cycle

- **Knowledge and understanding:**  
[include] a systematic understanding of their field of study and mastery of the methods of research associated with that field..
- **Applying knowledge and understanding:**  
[are demonstrated by the] ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity ..  
[is proved in the context of] a contribution that extends the frontier of knowledge by developing a substantial body of work some of which merits national or international refereed publication ..

## Dublin descriptors (cont'd)

- **Making judgements:**  
[requires being] capable of critical analysis, evaluation and synthesis of new and complex ideas..
- **Communication:**  
with their peers, the larger scholarly community and with society in general (dialogue) about their areas of expertise (broad scope)..
- **Learning skills:**  
[they are] expected to be able to promote, within academic and professional contexts, technological, social or cultural advancement ..

## Dublin descriptors (cont'd)

The Dublin descriptors have also been adopted  
by the framework of qualifications for the  
European Higher Education Area

(2005)

## European Qualifications Framework

In the European Qualifications Framework-  
EQF, the learning outcomes for EQF level 8  
correspond to the descriptor for the doctorate  
(Third Cycle)

(2008)

# European Qualifications Framework

The learning outcomes relevant to  
Level 8 are:

- **Knowledge:**

knowledge at the most advanced frontier  
of a field of work or study and at the  
interface between fields

- **Skills:**

# European Qualifications Framework (cont'd)

- **Competence:**

demonstrate substantial authority, innovation,  
autonomy, scholarly and professional integrity and  
sustained commitment to the development of new  
ideas or processes at the forefront of work or study  
contexts including research.

# Salzburg Recommendations

(2005)

- i. **The core component of doctoral training** is the advancement of knowledge through original research. Doctoral training must increasingly meet the needs of an employment market that is wider than academia.
- ii. **Embedding in institutional strategies and policies:** doctoral programmes and research training to meet new challenges and include appropriate professional career development opportunities.
- iii. **The importance of diversity:** the rich diversity of doctoral programmes in Europe is a strength which has to be underpinned by quality and sound practice.
- iv. **Doctoral candidates as early stage researchers:** should be recognized as professionals – with commensurate rights – who make a key contribution to the creation of new knowledge.

# Salzburg Recommendations

- v. **The crucial role of supervision and assessment:** arrangements for supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners)
- vi. **Achieving critical mass:** doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that **different solutions** may be appropriate to different contexts. These range from graduate schools in major universities to international, national and regional collaboration between universities.

## Salzburg Recommendations

- vii. **Duration:** doctoral programmes should operate within an appropriate time duration (3-4 years fulltime).
- viii. **The promotion of innovative structures:** to meet the challenge of interdisciplinary training and the development of transferable skills.
- ix. **Increasing mobility:** doctoral programmes should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of cooperation between universities and other partners.
- x. **Ensuring appropriate funding:** the development of quality doctoral programmes and the successful completion by doctoral candidates requires appropriate and sustainable funding.

## The “SEFI Position on the Doctorate in Engineering” (2007)

*Influenced by the Salzburg Recommendations*

1. A Doctorate in engineering must be the result of individual research work
2. The Doctorate is regarded as the third cycle of qualification within the Bologna Process
3. Diversity in Doctoral careers must remain possible
4. Quality of mentoring must be enhanced
5. Clear entrance qualifications must be defined
6. The doctoral degree program should not take the form of a formal curriculum

## CESAER's "Corner Stones for a Doctorate in Engineering" (2007)

Issued six months later, follow in the same path and elaborate further on the **generic skills** necessary for the doctoral candidate:

- Ability to communicate in an international academic, scientific and industrial environment
- Ability to acquire information and synthesize knowledge, multidisciplinary experiences, cross-cultural experiences
- Ability to deal with uncertainty
- Ability to handle conflicts, to solve problems and to manage failure, leadership, teamwork
- Ability to manage research, creativity, ethics.

The 10 Salzburg Recommendations of 2005  
have been further elaborated five years later  
(2010) in what is known as the Salzburg II  
Recommendations

## The Salzburg II Recommendations

- **Confirm** that the doctorate, based on the realisation of an original research project, is different from the first and the second cycles: *Research as the basis and the difference*
- **Identify** ways by which universities as well as those providing the legal frameworks for doctoral education might help improve doctoral education: *Critical mass and critical diversity, Recruitment, admission and status, Supervision, Outcomes, Career development, Credits, Quality and accountability, Internationalisation*
- **Raise issues** related to the institutional autonomy and sustainable funding of doctoral schools and are aimed mostly at non-university stakeholders such as political decision makers and funding organisations: *Funding, Autonomy, Legal framework, Intersectoral collaboration.*

## Comment

It is interesting that the authors of the 2010 Salzburg II Recommendations deemed it necessary to elaborate on "the meaning of structure" explaining that "*structuring doctoral education is to create a supportive environment*" and that "*structures must give support to individual development and not produce uniformity or predictability*".

The introduction of structured doctoral programs had been discussed a lot in SEFI and this can be seen in its 2007 statement:



## Comment II

*"SEFI acknowledges the necessity of a continuous process of optimization of PhD projects, e.g. by offering integrated and structured PhD programs. Nonetheless, this must not turn them into educational programs. Any **credit system** should be used only in order to enhance the mobility of Doctoral candidates and the internationalisation of Doctoral Programs, but not lead to formal accreditation. It is the intrinsic the fundamental character of a PhD project that the related study and research environment remains within the autonomy of the universities".*

## Comment III

You might have noticed that another issue is already raised in the 2007 SEFI position: the introduction of a credit system in the doctorate. The Salzburg II Recommendations elaborate also in this, pointing out that *"applying the credit system developed for cohorts of students in the first and second cycles is not a necessary precondition for establishing successful doctoral programmes"* and that *"Applied wrongly, rigid credit requirements can be detrimental to the development of independent research professionals. High quality doctoral education needs a stimulating research environment driven by research enthusiasm, curiosity and creativity, not motivated by the collection of credits"*

# The LLP/Erasmus Academic Network “EUGENE-European and Global ENgineering Education” (October 2009 to September 2012)

## EUGENE

EUGENE, coordinated by the University of Florence (Prof. Claudio Borri) has five Activity Lines and three Transversal Activities:

**Line A:** Structure and Bologna follow-up in the competitiveness issues of PhD studies

**Line B:** Promoting EE in Europe as a true research field

**Line C:** Improving transnational mobility of engineering students, graduates and professionals

**Line D:** Life Long Learning & continuing education as a tool to improve competitiveness and innovation of European engineers

**Line E:** Increase attractiveness of studies in science and engineering and to the European Higher Education Area

## EUGENE

**TA 1:** Direct involvement of industrial stakeholders

**TA 2:** Promote the establishment of the standing European Engineering Deans Council

**TA 3:** Identify and put in practice sustainability tools beyond the 3 years of life of the project.

---

78 Partners

32 countries

6 associate partners from 4 other countries

Partners are not only higher education institutions but also engineering societies and associations like IFEES, SEFI, CESAER, EUCEET, SEII and APE, quality assurance institutions like ASIIN, ENAEE and CTI and companies like Dassault Systèmes and Hewlett-Packard.

## EUGENE-Line A

EUGENE Line A focuses on two Actions:

### *Action A1*

*Coordinated by Prof. J. Berlamont from K.U. Leuven*

"To try to identify institutions where doctoral schools with structured PhD programs have been introduced and to establish the influence they have on the level, quality and employability of PhD graduates

### *Action A2*

*Coordinated by Prof. A. Avdelas from Aristotle University*

"To try to identify indicators for the quality measurement in doctoral training"

## EUGENE-Line A1

### Summary of provisional outcomes of Action A1

*(Obtained through a series of interviews/questionnaires with PhD employees and PhD employers)*

- Whether a formal PhD programme is needed to acquire the skills that PhD alumni should possess to be successful and contributing to the Lisbon objectives, depends on the *preceding undergraduate and graduate education*. Therefore there may be a difference between graduates from UK or USA and from continental Europe.
- The PhD training cannot be discussed without considering the two preceding tiers.
- There are “cultural differences” in engineering curriculum development throughout Europe
- Because of big differences in background (2nd cycle) of PhD candidates, in their character and talent, in the subjects, in research groups, in advisors, in aspiration for the future career etc, PhD programs should be individualized

## EUGENE-Line A1

- Requirement of e.g. 30 ECTS (as “time measure”) seems reasonable to widen the knowledge and interests (“soft skills”) through seminars, teaching assignments, attending conferences and presenting papers, introduction to entrepreneurship, economy, how to innovate, how to start a company etc, temporary placements in industry, participation in European or industrial research projects
- The doctoral program should support and facilitate the PhD work, and not be an extra burden
- No formal “lectured” courses with exams. PhD candidates have had enough of that, they should be able to acquire new knowledge individually
- A research project closely related to industry is a plus
- A stay in another university is strongly advised
- Doctoral candidates learn most in an informal way from their advisor and from each other. The added value of a PhD is the learning process, not the acquired knowledge.
- Working in a good research group of supercritical size, where excellence is fostered and having good relations with industry and with an international profile is the best “PhD program”.

## EUGENE-Line A2

The Salzburg II Recommendations focus also on the very important issue of the **quality of doctoral training**, pointing out that it is important to develop specific systems for quality assurance in doctoral education and that "in order to be accountable for the quality of doctoral programmes, institutions should develop indicators based on institutional priorities".

This is exactly what we are trying to do in Line A2

## EUGENE-Line A2

We have been working on the identification of indicators to be used in order to assess and enhance quality in doctoral education. The list of indicators is shown in the following table, where the connection with the Salzburg II Recommendations is also depicted.

# EUGENE-Line A2

## 1. Organisational Models

Do you:

1.1 Have a Doctoral School or equivalent	SRII.vi
1.2 If yes, does it cover more than one discipline	SRII.vi
1.3 Try to create a critical mass of young and expert researchers in order to encourage innovation	SRII.vi

# EUGENE-Line A2

## 2. Entrance Qualifications

Do you:

2.1 Have clear and transparent entrance rules	SRII.2.2
2.2 Make public the results of the selection and its reasoning	SRII.2.2
2.3 Have a committee responsible for selection and admissions procedures	SRII.2.2
2.4 Recognise the diversity and different needs of doctoral applicants	SRII.2.2
2.5 Admit domestic and foreign doctoral applicants competitively and on the basis of transparent criteria	SRII.2.2

## EUGENE-Line A2

### 3. Supervision, Mentoring, Performance

Do you:

3.1 Have rules for the selection/composition of the supervising committee	SRII.2.3
3.2 Include in the supervising committee members from other universities	
3.3 Include in the supervising committee at least one member with prior experience of supervision	SRII.2.3
3.4 Include in the supervising committee faculty members that represent a diversity of backgrounds and intellectual perspectives	SRII.2.3

## EUGENE-Line A2

3.5 Select as members of the supervising committee scientists that are aware of the research priorities within the specific field	SRII.2.3
3.6 Apply inter-disciplinarity in the selection of the supervising committee	
3.7 Monitor, at least once every year, the progress of the doctoral candidates	SRII.2.7
3.8 Appoint external examiners who are members of the academic staff of other higher education institutions	
3.9 Appoint the principal supervisor and the members of the supervising committee as members of the examination board	

## EUGENE-Line A2

3.10 Demand the Doctoral Thesis to be submitted in written form and defended in a public session	SRII.2.7
3.11 Take steps for the Doctoral Thesis to be accessible to the public on web	SRII.2.7
3.12 Select as members of the supervising committee experienced researchers in the appropriate discipline	SRII.2.3
3.13 Ensure that the members of the supervising committee are fully aware of their role and responsibilities	SRII.2.3
3.14 Explain to PhD candidates the role of the principal supervisor and of the other members of the supervising committee	SRII.2.3

## EUGENE-Line A2

3.15 Help PhD candidates to understand the value of programs of research that continue over time and build upon previous work	SRII.2.3
3.16 Keep a record of the meetings of the supervisor and the supervising committee with the PhD candidate	SRII.2.7
3.17 Use external reviewers to assess the overall quality of the PhD program	SRII.2.7
3.18 Discuss with PhD candidates their progress through the program, and work to ensure that their experiences prepare them for the career they plan to enter	SRII.2.5



## EUGENE-Line A2

3.19 Discuss ethically complex issues with doctoral candidates, ask candidates about their experiences and listen to their responses	SRII.2.5
3.20 Encourage PhD candidates to have a number of Peer-reviewed publications and to present papers in conferences before they obtain their Doctorate	SRII.2.7
3.21 Recognize PhD candidates as early stage researchers	SRII.iv SRII.2.2
3.22 Offer transferable skills training to the doctoral candidates	SRII.viii SRII.2.5
3.23 Promote interdisciplinary exchange between PhD candidates from related disciplines	SRII.viii

## EUGENE-Line A2

3.24 Monitor the performance of PhD candidates by:	SRII.vii
1 Time to degree	SRII.2.7
2 Grades	
3 Discontinuation rate	
3.25 Assign additional tasks (e.g. teaching) to your PhD candidates	

## EUGENE-Line A2

### 4. Monitoring the Outcomes-Career Development

Do you:

4.1 Collect opinions of the related stakeholders (e.g. industrial and governmental establishments, scientific societies, professional associations etc) for the improvement of doctoral education and of the abilities of doctoral graduates	SR11.3.4
4.2 Monitor the career development of your doctoral graduates	SR11.2.5
4.3 Develop attractive research career perspectives for early stage researchers, including opportunities outside academia and industry	SR11.2.5

## EUGENE-Line A2

4.4 Expose PhD candidates to various career paths by encouraging formal and informal collaboration with industry, inviting alumni to speak to candidates, and encouraging candidates who seek positions outside academia	SR11.2.5
4.5 Have a support structure for the creation of spin-off companies by your PhD graduates	SR11.2.5

## EUGENE-Line A2

### 5. Internationalisation

Do you:

5.1 Develop joint and co-supervised Doctoral programs both in national and international level	SRII.2.8 SRII.3.2
5.2 Foster the international mobility of doctoral candidates by their participation in: a. Conferences      b. Summer schools c. Short term stays abroad (less than 3 months) d. Long term stays abroad (more than 3 months)	SRII.2.8
5.3 Create fair conditions for international doctoral candidates in your institution (e.g. financing, accommodation etc)	SRII.3.1
Have in your institution Erasmus-Mundus PhDs in engineering	

## EUGENE-Line A2

### 6. Financing

Do you:

6.1 Provide doctoral candidates with a scholarship • above young researcher's average salary • comparable with young researcher's average salary • below young researcher's average salary	SRII.2.2
6.2 Finance doctoral research from following sources 1. state budget 2. projects, grants 3. other sources of the university 4. industry 5. private sources 6. other	SRII.3.1
<b>What do you think is your strong point and/or best practice example that might be of interest to other people?</b>	

3. Supervision, Mentoring, Performance			
Do you:			
3.1 Have rules for the selection/composition of the supervising committee	IMI	YES <input type="checkbox"/>	NO <input type="checkbox"/> N/A <input type="checkbox"/>
3.2 Include in the supervising committee members from other universities	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.3 Include in the supervising committee at least one member with prior experience of supervision	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.4 Include in the supervising committee faculty members that represent a diversity of backgrounds and intellectual perspectives	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.5 Select as members of the supervising committee scientists that are aware of the research priorities within the specific field	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.6 Apply inter-disciplinarity in the selection of the supervising committee	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.7 Monitor, at least once every year, the progress of the doctoral candidates	IMI	YES <input type="checkbox"/>	NO <input type="checkbox"/> N/A <input type="checkbox"/>
3.8 Appoint external examiners who are members of the academic staff of other higher education institutions	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.9 Appoint the (principal) supervisor and the members of the supervising committee as members of the examination board	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.10 Demand the Doctoral Thesis to be submitted in written form and defended in a public session	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/> SOMETIMES <input type="checkbox"/> NEVER <input type="checkbox"/> N/A <input type="checkbox"/>	
3.11 Take steps for the Doctoral Thesis to be	IMI	ALWAYS <input type="checkbox"/> OFTEN <input type="checkbox"/>	

Part of the actual Questionnaire

## EUGENE-Line A2

As it can be seen, the majority of the questions are within the Salzburg II principles. A small number of them go beyond these principles, asking from the engineering faculties to go one step further in the quest for quality. It must be pointed out that our aim is not only to get replies to the questions but also to ask the respondents to give a weight to each one of them. Questions that are considered most important for Quality get IMI=1, the ones considered least important get IMI=5.

## EUGENE-Line A2

By this Questionnaire we try to identify **Indicators** by which different models of PhD training will be compared, in order to produce a common set of excellence standards and principles. **Each one of the questions is a specific Indicator related to one or more Quality Actions** . Some of the indicators are related to Quality Actions that most of the institutions apply and some others to ones that only a few institutions do.

## EUGENE-Line A2

We can say that both of these are **Key Indicators**; the first ones because of their global application and the second ones because they are connected to good practice. In-between there are the simple Indicators. What we will do, with the help of the respondents will be to group the Indicators in three categories: Common Indicators, Key Indicators and Good Practice Indicators. In this way, we hope to have a strong tool to use as a first step in the measurement of quality of doctoral training in engineering.

