

## HARMONISATION OF BME EDUCATION IN EUROPE

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**Abstract: In Europe, Biomedical Engineering (BME) is a relatively young engineering discipline. Harmonisation (NOT standardisation) of BME education programmes is required to accommodate the Bachelor/Master structure, to allow student mobility and to recognise BME degrees throughout Europe. Only recently, this process of harmonisation has started. In view of the diversity of BME programmes, it is important that core competencies and exit levels are defined. This has been discussed in several BIOMEDEA meetings in Europe. The outcomes of the first BIOMEDEA conference in Eindhoven, the Netherlands, are presented. This concerns common contents of Bachelor's and Master's programmes and admission criteria.**

### Introduction

The Bologna declaration in 1999 involved adoption of easily readable and comparable degrees in order to promote European citizens' employability and the international competitiveness of the European higher education system, and a credit system to allow student mobility. A system of two cycles was adopted. Student mobility requires international recognition of certain professional qualifications of BME graduates. The diversity of BME makes it very hard to bring it under one harmonising umbrella. However, this is a necessity for student mobility and recognition of degrees. Synchronisation and tuning in are required.

The BIOMEDEA project (Biomedical engineering preparing for the European higher education area) was initiated by Joachim Nagel and the education committees of EAMBES and IFMBE. Its objective is:

- To support harmonisation of educational programmes through cooperation and organisation of seminars for all partners involved in MBES education, training and continuing education (life-long learning), and

- To develop and establish consensus on European guidelines for harmonisation of high quality MBES programmes, their accreditation and for certification of professionals working in health care systems.

BIOMEDEA organised a series of 3 conferences in Eindhoven, the Netherlands (December 17-19, 2004; *MBES education and training*), Warsaw, Poland (April 15-17, 2005; *MBES accreditation*) and Stuttgart, Germany (September 23-25, 2005; *MBES certification, registration and continuing education*).

Outcomes of the first BIOMEDEA meeting in Eindhoven are presented in this paper.

### Biomedical Engineering Education in Europe

*BME*: Biomedical Engineering developed by integrating various disciplines; not by differentiation. BME utilises theories, instrumentation, methods, and organisation from other engineering areas. BME has interaction with engineering disciplines, medicine and life sciences.

In Europe, most BME education programmes started from a single parent discipline: Electrical Engineering, Mechanical Engineering and Physical Engineering. At a later stage, Life Sciences were added to the education programme. In many cases BME education is only present at the graduate level. Programmes at all levels are offered by more than 150 Universities, Universities of Applied Science, Polytechnic Schools and Academies. However, almost no coordination exists concerning contents and required outcome qualifications.

*Programmes*: should adopt a system of undergraduate and graduate level.

- First cycle of minimally 3 years with degree relevant to the European labour market.
- Second cycle requires completed first cycle. Master's or doctorate degree. Master's degree usually 2 years.

Some countries do not follow this scheme:

- Spain: 4+1 for engineering curricula.
- France:
  - License master Doctorate:=3+2+3
  - Grandes Ecoles: 5-year engineering degree

So, quite a variety of systems exists in Europe.

### Harmonisation

Definition of required BME education will depend on specific requirements of a job. Mathematics, physics, life sciences and (bio) chemistry may be involved. BME graduates cannot acquire knowledge in each of these disciplines at the level of engineers fully trained in the specified field. Therefore, choices have to be made. Remember that BME has become a discipline in itself. For jobs in research, a specific combination of courses may be excellent in one situation and insufficient in another. Qualifications suggested by the degree, e.g., patient safety knowledge, must be fully reliable for health care systems. Harmonise BME education; do

NOT standardise. Define core competencies and exit levels. It is suggested not to prescribe the individual courses. Harmonisation should allow for diversity between programmes. Mutual recognition of credits should stimulate student mobility which is still limited in Western Europe. Recognition of courses and degrees will promote student mobility, which allows students to design their own career by attending those education programmes that offer the desired education and research experience.

### Contents of BME Bachelor's programme in Europe

Average contents of programme: 180 ECTS (3 years)

- Life sciences: 17 ECTS
- Mathematical foundations: 25 ECTS
- Science and engineering foundations: 57 ECTS
- BME: 46 ECTS
- Languages: 5 ECTS
- General competencies: 14 ECTS
- Computer programming: 8 ECTS
- Lab practicals: 8 ECTS

Engineering is the key word. Context is the living material. Flexibility in proportions is desirable. Contents depend on track. Emphasis should be on the underlying concepts.

#### *Research in BME Bachelor education:*

- Involve research in the education process;
  - To be taught by researchers is stimulating,
  - Research compartment is growing.
- Learn to do research by doing research,
- Working in a research lab with advanced equipment is stimulating

*Do University Bachelors BME continue to BME Master's programmes?* This varies from 15-25% (UK) to almost 100% (Netherlands, Italy, and Poland). In Germany, limited admission is being discussed in some of its states.

#### *Admission to Master's:* Applicants with

- Backgrounds in BME or in areas related to BME can usually be directly admitted.

- Students with other backgrounds or students from abroad will usually need further preparation before admission.

Further preparation may be achieved through electives within BME programme, or from classes/modules in other programmes.

### BME Master's programmes in Europe

Average content: 120 ECTS (2 years).

- Lectures:
  - Mandatory: 39 ECTS
  - Elective: 37 ECTS; varies from none to all.
- Research projects: 15 ECTS
- Thesis: 29 ECTS, usually 30-40; extremes 3 and 60 ECTS.

Lectures reflect the heterogeneity of the various Master's programmes. If Master's degree is required for specific job, many BME degrees will not cover the right courses. There is a need for specific professional requirements. A student should choose the right programme.

*Comments:* Parent discipline sometimes dominates the type of courses. Entrance requirements usually "typical" of parent discipline. This seems reasonable if profession at which is aimed requires this.

### Future challenges for BME Education

Governmental agencies expect in the near future a variety of new disciplines to emerge, filling the gaps between highly specialised medicine and engineering. It is therefore recommended to diversify BME to accommodate such newly developing disciplines. This should lead to differentiation of BME after the long integrative process.

*The BIOMEDEA I meeting was co-sponsored by the IFMBE <http://www.ifmbe.org>, and the Eindhoven University of Technology <http://www.tue.nl>, which was also hosting the meeting, while EAMBES <http://www.eambes.org> endorsed the meeting.*