The Framework for Higher Education Qualifications in Poland

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Abstract *— The Bologna Process is an European-level process that was initiated by ministers responsible for higher education who signed in 1999 a document called the Bologna Declaration. The essence of this process is the transformation of system of higher education in the signatory countries and its ultimate goal is to create an European Higher Education Area. This goal is to be reached as a result of an agreement on principles in the organisation of education. The Bologna Process is both an opportunity and a challenge for the academic community. In the scenario of global educational world are those is transnational cooperation and mobility of students and professionals. Cooperation requires academic and professional recognition. Recognition requires trust. Trust requires transparency and readability of academic curricula and professional q\qualifications. Such can be achieved through transparent qualifications frameworks and quality assurance procedures. Qualifications framework is essentially, a systematic description of an education system, expressing the expected learning outcomes for a given qualification, that is expressing what a learner is expected to know, understood and be able to do after successful completion of a process of learning. Qualifications framework based of learning outcomes represent a cornerstone of the reforms proposed by within the Bologna Process. The European Qualifications Frameworks has been designed to act as a reference for different qualifications systems and frameworks in Europe and were intended that each country will reference its national qualifications (in terms of diplomas, certificates or awards) to the eight levels of European Qualifications Frameworks. Engineering is a good example of a sector that requires specific domain descriptors, related to the different disciples.*

Index terms *— Bologna Process, European Qualifications Framework, Qualifications Framework in the sector of engineering.*

1. Higher Education in Poland

For many decades the engineering profession was very attractive to young people and it was widely chosen. The national industry was developing in isolation from technical and technological cooperation with Europe due to the geopolitical conditions, but on the other side, relatively small number of universities resulted in strong competition for places. Until late 70s of the last century, the study programs were imposed by the authorities responsible for higher education. Seventeen technical programs were approved by the Ministry of Higher Education.

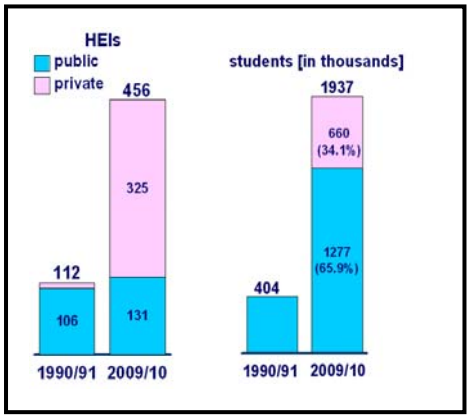

FIGURE 1
HIGHER EDUCATIONAL INSTITUTIONS AND STUDENTS IN POLAND

In the 1980s there was a liberalization of the study programs for engineers. Higher education institutions got a possibility to create different study programs as well as a the right to set limits for the number of the new entrants. At the beginning of 1990s, together with political changes, the universities in Poland received a lot of autonomy which resulted in a rapid creation of many private universities. Thus, the number of students grew from 400 thousand in 1990 to 2 million in 2010 (Fig.1). The biggest growth was in the field of humanities, which became the biggest part of the offer of more than 300 newly created private universities. The number of fields of study grew up to almost 120. Unfortunately the great efforts made by our universities combined with the development of infrastructure and research base which enable preparation of an attractive didactic offer were not visible enough for young people from the secondary schools and they were still more likely to choose education in humanities. At that time the first signals appeared showing the difference between the preferences of the candidates in the choice of a field of study and the needs of labour market.

2. COMMENTS ON THE SITUATION IN TECHNICAL STUDIES

Decreasing interest in engineering studies is a phenomenon widely observed in Europe. The decrease in the number of students in science and technology (below the 10% of total number) happened in the majority of European countries while in China or India hundreds of thousand graduate with engineering diplomas every year.
At the beginning, this phenomenon was not so obvious due to the crisis in Polish industry caused by the transformation of economy from a centrally planned to a liberal one. It was accompanied by the growth in the number of offered fields of studies and it led to the increase of the number of students and the number of candidates; the question of quality was overcome by a general optimism deriving from the higher rate of graduates.

Today there is no doubt that this situation requires decisive actions and public universities, which are naturally less flexible due to their traditions and size, need to be more aggressive and have to fight strongly for the minds and souls of the graduates of secondary schools. However, not only the number of candidates, but also their quality and level of knowledge must be taken into consideration.

The boom for education in marketing and management led to the appearance on the labour market numerous graduates in these fields. However, there is a question. Who will be managed by these qualified people if this is not accompanied by the growth of the industry? The statistical data are really frightening - the engineering and technical students constitute only 13 % of all the students (see Fig.2). The owners of the companies complain about the lack of IT specialists, civil engineering specialists, electrotechnics and production engineers. The migration for financial reasons deteriorated the situation. Well educated graduates of Polish universities, mainly technical ones, find attractive and well paid jobs abroad. The Polish market alerts "
'it's time for engineers' and although the universities are ready for that, the young people from secondary schools are not likely to change their preferences.

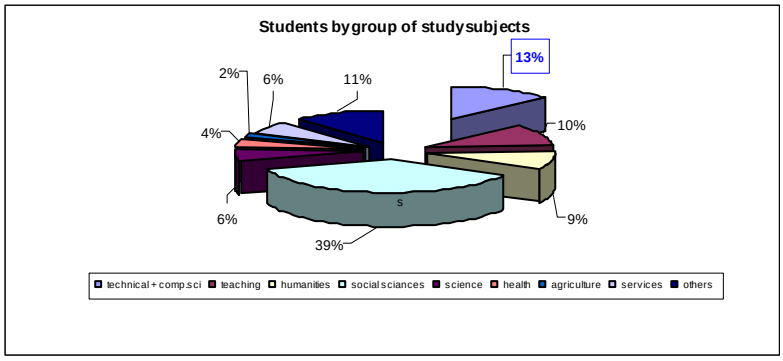

FIGURE 2
STUDENTS BY GROUP OF STUDY SUBJECTS.

3. DEVELOPMENTS IN BOLOGNA PROCESS

Since the late 1990s implementation of the Bologna Process has occurred. Polish higher education system started to solve the problems common in numerous European countries and the biggest emphasis was put on the adoption of the system of education that would address the needs of the European labour market and especially on harmony between the offered fields of study and employment possibilities for graduates.

The Bologna Process is an European-level process initiated by the ministers responsible for HE who signed in 1999 a document called Bologna Declaration. The essence of this process is the transformation of systems of higher education to create a European Higher Education Area (EHEA).

The Bologna Process is an attempt to find a common 'European answer' to challenges facing higher education in individual countries. The harmonisation of the national systems of higher education is aimed at:

- removing obstacles to the free movement of citizens,
- adjustment of higher education to the needs of the labour market thus improving the employability of graduates,
- enhancement of the activeness and competitiveness of higher education in Europe.

The immense reforms in Europe, under the codename 'Bologna Process' involve about 16 millions students, 5600 institutions in 46 countries. The most significant event that determines the progress of the Bologna Process are the meetings of European ministers responsible for higher education (Fig.3). During these meetings key agreements and decision are made. The conclusions are published in the form of policy documents – declarations and communiqués.

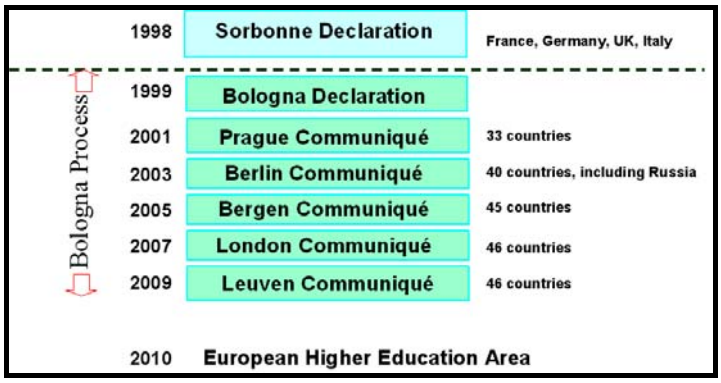

FIGURE 3
THE BOLOGNA PROCESS

4. OBJECTIVES OF THE BOLOGNA PROCESS

Objectives of the Bologna Process [9]:

- adoption of a system based on two (three) cycles
- establishment of a credit point system (ECTS),
- promotion of mobility of students, teachers, researches and administrators
- adoption of a system of easily readable and comparable degrees,
- promotion of European cooperation in quality assurance,
- promotion of an European dimension in higher education with regards to curricula development, inter-institutional cooperation, mobility schemes and integrated programmes of study, training and research
- implementation of the qualification frameworks in the EHEA based on learning outcomes.

4.1 Model of three-cycle studies

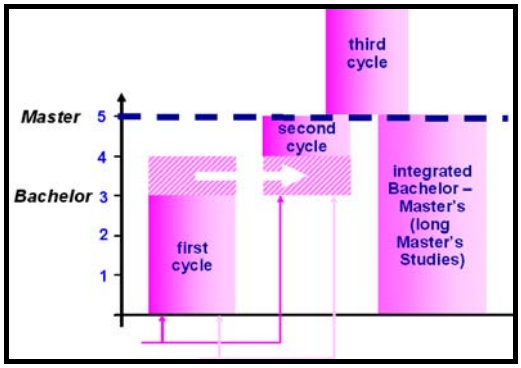

FIGURE 4
A MODEL OF THE THREE CYCLE STUDIES

The model of the three-cycle system is viewed in the way shown in Figure 4:

- a Bachelor degree requires 3-4 years of full-time study,
- a Mater's degree requires 5 years of full-time study, from the beginning of the First Cycle, including at least one full year on the graduate level,
- a doctorate studies.

4.2 ECTS – the credit and accumulation point system

The European Credit Transfer and Accumulation System is not a goal of the Bologna Process. ECTS is a tool supporting:

- the students mobility,
- recognition of education,
- flexibility of study programs,
- quality of education.

4.3 Promotion of the mobility of students and staff

Student and staff mobility play a significant role in the development of a European Higher Education Area. As stated in the London Communiqué (2007), 'mobility of staff, students and graduates is one of the core elements of the Bologna Process, creating opportunities for personal growth, developing international cooperation between individuals and institutions, enhancing the quality of higher education and research, and giving substance to the European dimension'.

International mobility contributes to the personal fulfilment and the development of competences, such as languages and intercultural understanding. Such skills are becoming more valued on an increasingly global labour market, and therefore can substantially enhance the employability of those students.

Pursuing a part of the first or second cycle degree programme in other education institution, especially abroad, is referred to as horizontal mobility (Fig.5). Designing and individual education path is an alternative form of mobility – vertical mobility. Such a transfer to another education institution, sometime associated with a change of a field of study, takes place after the completion of the first cycle studies.

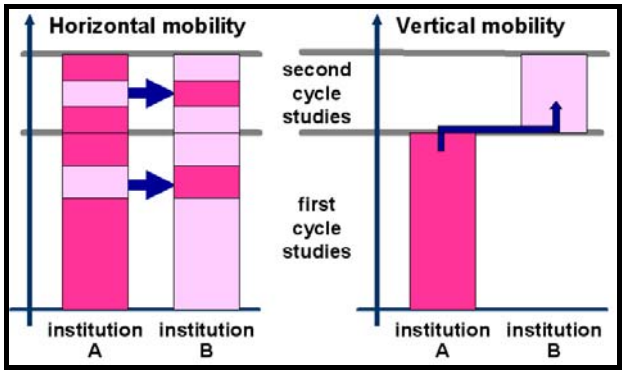

FIGURE 5
STUDENTS MOBILITY

4.4 Adoption of a system of easily readable and comparable degrees

The basic mechanism aimed at improving the readability of degrees is the Diploma Supplement, a document that is issued together with a diploma.
A Diploma Supplement contains:

- a general description of a study programme,
- a record of the individual achievements of the student (courses, credits, grades),
- a summary of the national higher education system.

To improve readability and comparability of degrees it is necessary to describe a degree in a precise manner. A degree has to confirm the qualifications of a graduate. Degrees and diplomas have to be defined by learning outcomes based on qualification framework. The adoption of a system of easily readable and comparable degrees is related to the issue of the recognition of qualifications awarded in other countries.

4.5 Promotion of European co-operation in quality assurance

The great progress has been made in developing internal and external quality assurance procedures and national quality assurance systems since ministers stated in Berlin in 2003 that 'quality of higher education has proven to be at the heart of the setting up of a European Higher Education Area', and since they adopted the Standards and Guidelines for Quality Assurance in the European Higher Education Area in Bergen in 2005 [5].

In the context of the Bologna Process, the European Quality Assurance Register for Higher Education (EQAR) was founded in March 2008 to enhance transparency and trust in quality assurance. It enables all relevant stakeholders to identify credible and legitimate agencies that perform quality reviews of higher education institutions or programmes in the European Higher Education Area.

Inclusion on EQAR is voluntary. Quality assurance agencies that wish to be included have to undergo an external review by independent experts in order to demonstrate their substantial compliance with the European Standards and Guidelines for Quality Assurance [5].

5. Qualifications Framework

Cooperation and mobility require academic and professional recognition. Such recognition has to based on trust. Trust requires transparency and readability of academic curricula and professional qualifications. This can be achieved through transparent qualifications frameworks and appropriate quality assurance procedures recognized and accepted by all partners and stakeholders.

Qualifications Framework (QF) is a systematic description of an education system, that express the expected learning outcomes for a given qualification, that is stating what learners are expected to know, understand and be able to do after successful completion of the process of learning. Qualifications Framework should describe all the qualifications in a higher education system

It is an important reference point for providers of higher education. Together with the associated guidance for implementation, it will assist them to maintain academic standards; to inform international comparability of academic standards, especially in the European context; to ensure international competitiveness; and to facilitate student and graduate mobility

The fundamental premise of a Qualifications Framework is that qualifications should be awarded on the basis of achievement outcomes and attainment rather that years of study. Qualification descriptors set out the generic outcomes and attributes for the award of the individual qualifications. The qualification descriptors contained in the Qualifications Framework exemplify the outcomes and attributes expected of learning that results in the award of higher education qualifications. These outcomes represent the integration of various learning experiences resulting from designated and coherent programmes of study. These qualifications, which develop graduates with high-level analytical skills and a broad range of competences, are therefore distinct from training or solely the acquisition of higher level skills.

The main features of the Qualifications Framework are:

- to provide important points of reference for setting and assessing academic standards to higher education providers,
- to assist in the identification of potential progression routes, particularly in the context of lifelong learning,
- to promote a shared and common and understanding of the expectations associated with typical qualifications by facilitating a consistent use of qualifications titles across the higher education sector.

The Qualifications Framework should enable higher education providers to communicate to employers; schools; parents; prospective students; professional, statutory and regulatory bodies; and other stakeholders and achievements and attributes represented by the typical higher education qualification titles.

The Qualifications Framework based on Learning Outcomes represent a cornerstone of the reforms proposed within the Bologna Process – they play a major role in basically all main structural areas of the reform:

- in developing degree systems and study programmes at higher education institutions,
- in the recognition of qualifications, by all stakeholders,
- as a pre-requirement, in the implementation of Quality Assurance systems.

The understanding by all stakeholders of academic degrees and related specific knowledge, skills and competences of the graduates is essential also for both internal and external evaluation and recognition.

Qualification frameworks may be seen at three major levels of descriptors;

1. high level descriptors of competences, of a general nature, describing global qualifications associated to degrees,
2. sectoral descriptors grouped in scientific and technological areas, with direct relations to the professions,
3. content descriptors, characterizing main or core curricula contents and methods.

5.1 Meta Qualification Frameworks and related high level descriptors

These characterize high level groups of qualifications. They are generally developed at institutional level of governments and stakeholders. They may differ in background and objectives. A such, different frameworks may arise, employing different sets of descriptors, or grouping such descriptors in different clusters of outcomes.
At European level, two main frameworks are currently in place [10]:

1. The Qualification Framework for the construction of the European Higher Education Area [4], has been formed since 1999 approved by the 47 signatories to the Bologna Process. The QF_EHEA focus of the post-secondary education system and in 2005 adopts the well known Dublin Descriptors that identify four cycles of higher education (three main cycles plus short cycles within or linked to First Cycle).
2. The development of European Qualifications Framework for Lifelong Learning started in 2005. The Recommendation of the European Parliament and of the Council was approved on April 23, 2008. The EQF-LLL aims at describing the entire education system, recommending eight levels of qualification, each identified by descriptors grouped in the three main clusters of outcomes.

The two frameworks have similarities and overlapping area, both are meta-frameworks, cover a broad scope of learning and are designed to improve transparency with regard to qualifications within Europe. Comparison of the levels is shown on Figure 6.

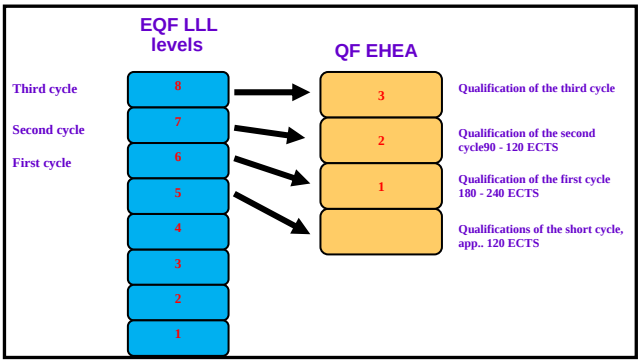

FIGURE 6
COMPARISON OF THE QF EHEA AND EQF LLL LEVELS.

The learning outcomes of certain EQF LLL levels correspond to the cycle descriptors of the QF EHEA. The QF EHEA descriptors refer to the five dimensions and EQF to the three as shown in Table 1. Although the descriptors defining levels in the EQF and the Dublin descriptors differ, the EQF level descriptors fully integrate the Bologna descriptors and are thus compatible to these [10].

	Bologna, QF-EHEA		EU, EQF-LLL
A	Knowledge and understanding	1	Knowledge
B	Applying knowledge and understanding	2	Skills
C	Making judgments	3	Competences
D	Communication skills		
E	Learning skills		

TABLE 1
CLUSTERING OF QUALIFICATIONS DESCRIPTORS IN DIFFERENT FRAMEWORKS

National Qualifications Framework

The National Qualifications Frameworks are a key instrument for the implementation of the European Qualifications Framework. National Qualifications Frameworks are seen as instruments:

- for referring national qualifications to the EQF and thus increase international transparency,
- to make national qualifications systems easier to understand and overview – for citizens, employers and other users,
- to create a platform for cooperation and dialogue,
- to reinforce the learning outcome orientation,

- to support LLL learning by making learning pathways visible and thus facilitate access, progression and participation,
- to facilitate the recognition of a broader range of learning (including non-formal and informal learning),
- to provide a reference point for quality assurance,
- to strengthen the link to the labour market.

National Qualifications Frameworks are to be based on learning outcomes and their developments reinforce the shift to learning outcomes.

National Qualifications Frameworks have generic qualification descriptors for each cycle and are build on but differ from the European Qualifications Framework descriptors (Dublin descriptors) since they need to be more detailed and contextualised. The differences in nature of level descriptors reflect national context.

The shift to learning outcomes is a condition for success but is also a major challenge faced at all levels of implementation.

The development of the National Qualifications Frameworks is essentially a political, process and hence should be carried out on the ministerial level and require broad stakeholders involvement and dialogue - the lack of such involvement may undermine good technical proposals.

Polish Qualifications Framework (preliminary approved):

- 7 or 8 levels,
- defined by the level descriptors in three categories:
  - knowledge,
  - skills,
  - competences
- level can be also defined by profiles.

National qualifications frameworks constitutes an instrument for the classification of qualifications according to a set of criteria for specified levels of learning achieved, which aims to integrate and coordinate national qualifications subsystems and improve the transparency, access, progression and quality of qualifications in relation to the labour market and civil society.

5.2 Sectoral Frameworks

Sectoral frameworks are concerned with specific discipline descriptors and ideally result from wide transnational co-operation and agreements between stakeholders, namely higher education institutions and professional associations. Sectoral frameworks should naturally relate to and be identified within the wide descriptors of the meta-frameworks, but they quite clearly are expected to be more detailed in the descriptions. Depending on the sector of knowledge, they may be further subdivided in sub-sectors characterized by specific domain descriptors, including, if applicable, the good example of a sector that requires specific domain descriptors, related to different specialties.

A major concerted effort aiming at developing subject area frameworks is in the TUNNING Project [7]. As written by its coordinators, it aims at contributing to the elaboration of a framework of comparable qualifications in such of the (potential) signatory countries of the Bologna Process, which should be described in terms of workload, level learning outcomes, competences and profile.

In Poland eight sectors were defined, and levels' and profiles' descriptors in the three categories: knowledge, skills and competences were prepared by the groups of experts also on ministerial level (preliminary approved).

5.3 Descriptors at syllabus level – core curricula

The aim is to bring in substance to the qualifications, namely through the identification of core contents and the identification of scope, depth and breadth of the programmes, a major issue in the engineering area when comparing the programmes. This part has to be prepared by the educational institutions themselves.

Higher education providers have to assure the public that the achievements represented by qualifications are appropriate and represented consistently. Higher education providers are responsible for demonstrating that each of their qualifications is allocated to the appropriate level of the Qualifications Framework. In considering the appropriate level for a qualification, higher education providers consider:

- the relationship between the intended outcomes of the programme and the expectations set out in the qualification descriptors,
- whether there is a sufficient volume of assessed study that will demonstrate that the learning outcomes have been achieved,
- whether the design of the curriculum and assessments is such, that all students following the programme have the opportunity to achieve and demonstrate the intended outcomes.

Qualification descriptors are in two parts. The first part is a statement of outcomes, the achievement of which is assessed and which a student should be able to demonstrate for the award of the qualification. This part will be of particular relevance to higher education providers in designing, approving and reviewing academic programmes. They will need to be satisfied and that, for many programmes, the curriculum and assessments provide all students with the opportunity to achieve, and to demonstrate achievements of, the intended outcomes.

The second part is a statement of the wider abilities that the typical student could be expected to have developed. It will be of assistance to higher education providers during discussion with employers, and others with interest in the general capabilities of holders of the qualification.

6. QUALIFICATION DESCRIPTORS – ENGINEERING (SECTORAL BENCHMARK)

Main assumptions:

1. use of existing solutions
2. fit with international standards
3. wide discussion with the stakeholders

Our learning outcomes descriptors have to fit together with qualification descriptors describe in European and national documents like:

1. Qualifications Framework for EHEA (Dublin Descriptors) [4].
2. Qualifications Framework for Long Life Learning [3].
3. National Qualifications Framework (for Poland).

Speaking in the wide Engineering Sector, we can identify a number of relevant initiatives, again driven by different objectives, hence with somewhat different structures:

1. EUR-ACE (EURopean ACcredited Engineer project) framework for accreditation of engineering programmes [2,8].
2. ABET (Accreditation Board for Engineering and Technology, USA) [1].
3. CDIO (Conceive-Design-Implement-Operate initiative) [6].
4. JABEE (Japan Accreditation Board for Engineering Education) [12].
5. IEA (International Engineering Alliance) [11].

For us the most useful material was placed in the EUR-ACE because they are strictly based on the ideas of Bologna Process.

In the Table 2 there are the references to above mentioned initiatives in comparison with our First Cycle knowledge descriptors (the numbers in column 1 refer to the table 3a).

	generic descriptors			engineering descriptors				
	NQF 2010)	QF_LLL	QF_EHEA (Dublin)	EUR-ACE	ABET	JABEE	IEA	CDIO
1	K1	VI.1	1	I.1	A	C	KP1, KP2	1.1
2	K1	V.1	1	II.pre	A	A	KP3, PS4	1.2
3	K1	VI.1	1	I.2, I.3	A	D	KP3, PS1, PS4	1.2, 1.3
4	K2	V.1	1	I.3	A	D	KP4	1.2, 1.3
5	K2	V.1	1	I.3	J	D		2.5.4
6	K2, K3	V.1	1	V.3	A, K		KP5, KP6, PS4	1.2
7			3, 4	I.4, V.4, VI.3	H, C, D	B, A, E	KP7	2.3, 4.1
8				VI.4	H	H	GA11	2.4, 4.2, 4.3.4

TABLE 2
ANALYSIS BETWEEN DIFFERENT LEARNING OUTCOMES DESCRIPTORS

in column NQF - K# means outcomes in knowledge,
in column QF_LLL - V/VI means level, and 1 position on the list
in column EQF_EHEA - numbers refer to position in the Dublin Descriptors list
in column EUR-ACE - I..VI means group, #1 means in the group
in column ABET - numbers refer to the list
in column JABEE - letters refer to the list
in column IEA - KP# refers to Knowledge Profile, PS# refers to Problem Solving, GA# refers to Graduate Attribute, # means position in a table
in column CDIO - #.%.@ refers to number on the list

Speaking of the engineering sector, in several countries there has been significant discussion about levels and profiles of required education in engineering. There are different views, but all countries agree on two levels of engineering, and not all about the types of profiles, relevant to the profession. Figure 7 shows profiles and possible trajectories proposed for Poland.

The levels are directly related to the expected qualifications evaluated in direct relation to relevant technical, scientific and social aspects. It is also clear that differences in outcomes for First and Second Cycle should be related with scope, depth and extent.

Another relevant decision was taken that the First Cycle needs two profiles - one more theoretically oriented (called general or academic) and more professional (called vocational). It creates the problem of communication between profiles connected with the possibility of continuation of studies. The qualification on both First Cycle profiles creates route for Second Cycle. Second Cycle will be again with two profiles - general eligible for everybody and research entitled mostly of the holders of First Cycle diploma after general profile. But this problem is still under discussion.
The Third Cycle by nature has to be by research but we called it general (Figure 8).

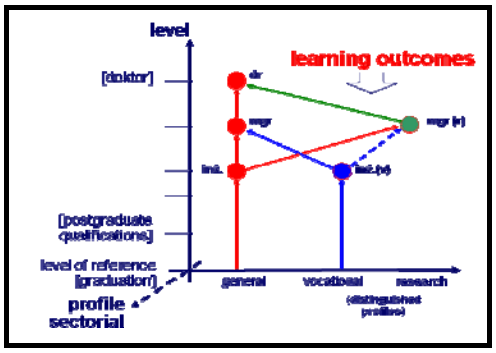

FIGURE 7
DIFFERENT TRAJECTORIES IN ENGINEERING EDUCATION

	vocational profile	general profile	research profile
First Cycle (inżynier)	+	+	
Second Cycle (magister)		+	+
Third Cycle (doktor)		+	

FIGURE 8
DIFFERENT PROFILES IN ENGINEERING EDUCATION

The other relevant issues should be decided:
1. Qualifications require to be precisely defined at each higher education level. It means
- 210-240 credits for the First Cycle Degree,
- 90-120 credits for the Second Cycle Degree (totally at least 300 credits).

2. Definition of the relationship in the learning outcomes for First, Second and Third Cycle. This problem comes from opposite postulates:
- 'logic' of NQF i.e. entering higher level demands 'increase' of competences,
- 'openness' of the Second Cycle for candidates with different character of competences as a result of different First Cycle programmes (vertical mobility).

The WG proposed that learning outcomes for the 'higher' cycle will be more in depth and extent (more advanced knowledge and skills), but they can be in narrower area.
For the First and Second Cycle it means that the learning outcomes of the Second Cycle are based on the competences derived from the First Cycle, but not necessarily all of them.
3. Some Quantitative targets for the First and Second Cycle programs:
- knowledge of mathematics, physics, chemistry and other area of engineering necessary to formulate and solve problems in the discipline – at least 42 credits (20% credits for general profile), including mathematics – at least 18 credits, and physics – 12 credits,

- knowledge and skills connected to non-technical aspects of engineering profession and other non-technical general skills and competences – at least 32 credits (app. 15% credits for general profile), including ability of communicate effectively in foreign languages – at least 12 credits,
- fundamental knowledge and skills connected with engineering sciences and engineering design appropriate to the student's field of study – at least 50% credits of a program.

4. Ability to communicate in foreign languages
   - after the First Cycle:
     - the English language at least on the level A1,
     - one foreign language at least on the level B2 (if it is English - it fulfil the demand).
   - after the Second Cycle two languages including English language
     - one language at least on the level B2
     - second foreign language at least on the level A2
5. Practical placement
   - First Cycle
     - 4-8 weeks for the general profile program,
     - one semester (30 credits) for the vocational profile.
   - Second Cycle
     - higher educational institution decision.

The Working Group prepared the learning outcomes descriptors for these three levels and proposed profiles. In the Table 3 (a-e) one can find the learning outcomes for the First Cycle of general profile.

	KNOWLEDGE
1	Knowledge and understanding of the scientific, mathematical and physical principles useful to formulate and solve simple engineering problems of their branch of engineering
	Elementary knowledge in the wide spectrum of engineering connected with their branch of engineering
3	A systematic understanding of the key aspects and concepts of their branch of engineering
4	Coherent knowledge of their branch of engineering
5	Basic knowledge on the forefront of the branch
6	Knowledge on applicable techniques, methods and materials and an ability to identify, formulate, and solve simple engineering problems
7	An awareness of the impact of engineering solutions in a global, economic, environmental, and societal context
8	Basic knowledge of project management and business practice

TABLE 3A
KNOWLEDGE

GENERAL SKILLS
The ability to conduct searches of literature, to use data bases and other sources of information as well as to analyze and interpret data
The ability to function as an individual and as a member of a team
The ability to communicate effectively within the engineering and non-engineering community, also in English or other language recognized as a communication tolls
A recognition of the need for, and an ability to engage in life-long learning

TABLE 3b
GENERAL SKILLS

BASIC ENGINEERING SKILLS
The ability to use ICT to carry out tasks common engineering activities
The ability to design and conduct experiments and computer simulations, interpret the data and draw conclusions
The ability to use analytic, experimental and modelling methods to formulate and solve engineering problems
The ability when designing and solving engineering problems to be aware of their non-technical implications
The ability to function in industrial environments and knowledge of health and safety policies associated with that work
The ability to perform economic analysis of engineering practice

TABLE 3c
BASIC ENGINEERING SKILLS

SKILLS DIRECTLY CONNECTED TO ENGINEERING PROBLEM SOLVING
The ability to apply their knowledge and understanding to analyse engineering products, processes and methods
The ability to apply their knowledge and understanding to identify and formulate engineering problems typical in the discipline
The ability to select and use appropriate equipment, tools and methods
The ability - according to given specification – to design and realise designs, object, system or process typical for their branch of engineering

TABLE 3d
SKILLS DIRECTLY CONNECTED TO ENGINEERING PROBLEM SOLVING

OTHER COMPETENCES
Recognize the need for managing professional development
Recognize the importance and understanding of non-technical aspects of engineering practice, their impact on environment, and responsibilities for the decision taken
Recognise the importance of being professional and ethical
Demonstrate the awareness of responsibility for managing professional development in multi-disciplinary teamwork
Able to think and work in an innovative way
Recognise the need for effective communication with society—including methodical writing, verbal presentation and debate abilities – on new technical achievements and other aspects of engineering work

TABLE 3e
OTHER COMPETENCES

In Table 4 (a-b) one can find comparison of selected learning outcomes of general profile. Shadings indicate differences between levels (cycles).

KNOWLEDGE	
First Cycle	Second Cycle
Knowledge and understanding of the scientific, mathematical and physical principles useful to formulate and solve simple engineering problems of their branch of engineering	Depth and systematic knowledge and understanding of the scientific, mathematical and physical principles useful to formulate and solve complex engineering problems of their branch of engineering
Elementary knowledge in the wide spectrum of engineering connected with their branch of engineering	Elementary knowledge in the wide spectrum of engineering connected with their main and other branches of engineering
A systematic understanding of the key aspects and concepts of their branch of engineering	A systematic understanding of the key aspects and concepts of their branch of engineering
Coherent knowledge of their branch of engineering	Theoretically based and coherent knowledge of their branch of engineering
Basic knowledge on the forefront of the branch	Knowledge on the forefront and contemporary achievements of the branch
Knowledge on applicable techniques, methods and materials and an ability to identify, formulate, and solve simple engineering problems	Knowledge on applicable techniques, methods and materials and an ability to identify, formulate, and solve complex engineering problems
An awareness of the impact of engineering solutions in a global, economic, environmental, and societal context	Knowledge of the impact of engineering solutions in a global, economic, environmental, and societal context and their use in engineering practice
Basic knowledge of project management and business practice	Basic knowledge of project management and business practice

TABLE 4a
COMPARISON OF KNOWLEDGE FROM THE FIRST AND SECOND CYCLE GENERAL PROFILE

SKILLS		
First Cycle	Second Cycle	Third Cycle
The ability to function as an individual and as a member of a team	The ability to function as an individual and as a member of a team	The ability to function as an individual and as a member of a team that may be composed of different disciplines, level and nationalities
The ability when designing and solving engineering problems be aware of their non-technical implications	The ability when designing and solving engineering problems integrate knowledge from different branches and systematically approach being aware of their non-technical implications	The ability when design and solve engineering problems integrate knowledge from different branches and handle systematically approach taking into consideration their non-technical implications
A recognition of the need for, and an ability to engage in life-long learning	The ability to identify personal need for further knowledge and to perform the self-learning process	The ability to identify personal need for further knowledge and to take responsibility for ongoing individual learning
The ability to apply their knowledge and understanding to identify and formulate typical engineering problems, in the discipline	The ability to apply their knowledge and understanding to identify and formulate complex engineering problems, in the discipline taking into consideration their non-technical implications	The ability to apply their knowledge and understanding to identify and formulate complex and new engineering research problems, in the emerging areas scientific discipline leading to innovative technical solutions

TABLE 4b
COMPARISON OF SKILLS FROM THE FIRST, SECOND AND THIRD CYCLE (GENERAL PROFILE)

7. REFERENCES

1. ABET (2009), "The ABET criteria for accrediting engineering programmes", available at "*www.abet.org*".
2. Augusti, G., "Accreditation of engineering programmes : European perspective and challenges in a global context", *European Journal of Engineering Education*, 43, 3, 2007, pp. 273-283.
3. "The European Qualifications Framework for Lifelong Learning, Recommendation of the European Parliament and of the Council", 23 April 2008, available at "*ec.europa.eu/education/lifelong-learning-policy/*"
4. "A Framework for Qualification of the European Higher Education Area, Bologna working Group on Qualification Frameworks", Ministry of Science, Technology and Innovation, Denmark, available at "*www.ond.vlaandern.be/hogeronderwijs/bologna/documents*".
5. "Standards and Guidelines for Quality Assurance in EHEA", European Association for Quality Assurance in Higher Education, Helsinki 2005, available at "*www.enga.eu/files/BergenReport210205.pdf*".
6. Crawley, E.F. "The CDIO Syllabus A Statement of Goals for Undergraduate Engineering Education", MIT 2001, available at "*www.cdio.org*"
7. "TUNNING Educational structures in Europe", available at "*tunning.unideusto.org/tuningeu*".
8. Azevedo, S.Feyo de, "High Level Qualifications Frameworks and the EUR-ACE Frameworks Standards - do they fit together?", Workshop EBAEE, Brussels, 2009.
9. Kraśniewski, A. "Bologna Process: A Challenge to the Academic Community of the Warsaw University of Technology, WUT 2004.
10. European Commission "Explaining the European Qualifications Framework for Lifelong Learning", available at "*ec.europa.eu/dgs/education_culture*".
11. "International Engineering Alliance: Graduate Attributes and Professional Competencies", available at "*www.washingtonaccord.org*".
12. "Criteria for Accrediting Japanese Engineering Education Program Leading to Bachelor's (Master's) Degree", available at "*www.jabee.org/english/*"