

Essential qualifications of modern engineers in Europe and how the university provides for them: The Greek paradigm

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INTRODUCTION

At a time, when the mobility of engineers in Europe is heavily promoted, students from various engineering fields studying at the AUTh convened with academics and professional engineers in order to examine the ways that the university contributes in offering students all the skills needed to face the requirements of the European job market. Special attention was paid to the study cycles, given that in Greek universities, which have not yet complied with the Bologna Process, the educational system used is five years of integrated studies. Main topics tackled at first were the educational system and mobility, while after the evaluation of the most important skills needed, the impact on the quality of the educational process which offers these skills, after a potential separation of the integrated study cycle into two distinct ones was discussed.

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1 ENGINEERS, SKILLS AND JOB MARKET

1.1 Bologna Process and Greek Educational System

There has been a great effort for the Greek educational system to fulfill the requirements of the Bologna Process since it was signed. Only minor steps could be made at a time as no fundamental changes could be adopted in a short period of time. Also, there were a lot of harsh reactions against the process both from professors and students. While the process started on 1999, most of the changes on Greek legislation happened during 2005 and 2006. [1]

An important point to be discussed is the correlation of knowledge and skills earned through the structure of the Greek educational system and the recognition of the Greek engineering degrees in the European job market. On 06/03/10 the Technical Chamber of Greece, the main organization for the licensing of engineers, requested from the government to recognize 5-year degrees as equivalent to a master's degree, as European Universities recognize the 5-years Engineering Diploma to be equivalent to a MEng. [2] While this paper was under construction the Greek Minister of Education announced that there will be a government ordinance that will recognize 5-year degrees as equivalent to a master's degree. [3]

1.2 Skills: Inalienable assets for an engineer's career

According to A. Moropoulou [4], a high-quality educational system should offer to engineers ways of developing a plethora of skills, amongst them being innovation and provable craftsmanship. Young engineers should be able to exploit complex problem-solving techniques and to engage in professional activity in an ever-changing environment, demonstrating adaptivity and flexibility. Also, in order for them to become the cornerstone of National and European economic development, they should possess the spark of entrepreneurship.

Following Moropoulou's statement, Bourdonnaye and Malcorps [4] state that the modern engineer should possess the skill of staying informed of the latest progress in his field, being a self-directed learner. Likewise, for efficient engineering education the need for self development capabilities emerges. The skills needed by a modern engineer are put in different perspective by Fastenau [4], who addresses the need of a set of skills that aid the adjustment and integration of a young engineer in the reality of globalization: international spirit and interculturality.

Finally, Vyncke [4] stresses the need for interdisciplinary cooperation as means for efficient problem-solving. The Bologna Process is considered to be a great opportunity, as far as mobility and cooperation between engineers of various cultural backgrounds are concerned. Greek students are supported by European Commission's initiatives like Ploteus, a program which provides counseling about studying in Europe and Erasmus+, which funds mobility projects. [5]

1.3 Skills needed for engineers following academic career

An engineer can be employed not only as a freelance professional but also as an academic - researcher. Here, the case of a PhD candidate is examined [6], as it includes many of the aspects needed for an academic career.

The job market in which PhD students seek for employment usually consists of university research projects (either with non-commercial funding mechanisms such as government grants, European commission grants etc. either with commercial funding by the industry and/or private companies). Apart from the hard skill background which is necessary for someone who wants to pursue a PhD program, the candidate should be able to produce new knowledge and fresh ideas

which he should then share and spread with the academic and technological community. Equally important is, the ability to mentor and guide less specialized people into his field of work and the ability to find the resources necessary for the advancement and the sustainability of his work. [6]

1.4 Skills of engineers needed in Greek Job Market

In the case of technical education, according to the Greek Report for EQF [7], in order for a candidate to qualify for a position, he has to have the necessary technical background, the necessary communication skills (including specialized vocabulary), the analytical skills that help him understand technical documents and apply directions effectively and the flexibility to overcome unexpected technical difficulties in his area of expertise.

To qualify for even more specialized positions a candidate must be able to use specialized methods and techniques, conduct experiments and record results and observations in a systematic manner, This proves that he is careful and observing. He should be able to develop simple strategies and tactics to deal with everyday problems, proving that he is resourceful, and finally, communicate on technical subjects with accuracy and clarity.

Jobs that contain a bachelor's degree in the list of required qualifications usually have as prerequisite a wide variety of skills. Analytic and synthetic skills are required, so the acquired knowledge can be applied and tailored to the needs of each task [7]. Additionally, the correct, fast and precise usage of the correct tools for complex problem-solving with creative or innovative methods are highly valued, especially when combined with their scientific justification. Candidates should be precise, innovative, creative and technically and theoretical well founded to defend their views. Furthermore, critical thinking is also important, as it enables the utilization and cross-referencing of many diverse sources of information. This offers the advantage of being able to communicate with experts from diverse fields in order to provide solutions to specialized problems [7]

In the case of research work [7], the candidates should have the skills to evaluate and to integrate recent scientific propositions. Originality of thinking and innovative solutions are key. For a researcher, it is also necessary to have wide understanding of social and economic factors that can affect his work and vice-versa, and to be able to take under consideration the cultural hues and ethics of their working environment. Moreover, he should be able to correctly document his working methods, as this is usually equally important with the scientific results.

Finally, presentation skills are of great usefulness [7], as it is not always easy to present fresh specialized information thoroughly and clearly, even if the audience is well informed on the subject. Interestingly, presentation skills can help present ideas to investors and thus attract funds, giving a new perspective to the usefulness and value of this skill.

2 METHODOLOGY

2.1 Preparation and structure of Local Event on Education

In order to collect the data for this essay, a special procedure was followed. Specifically, a working team from Local BEST Group of ATh, with the support of a responsible professor, took care of the content preparation, organization and facilitation of an event during which representatives of the relevant parties (students, academics, and professionals) had the ability to express their view on the subject.

Among the participants were people from the academic world (university professors), job market (full time engineers from medium and big companies), and students of different levels and engineering departments of ATh.

Due to the complex nature of the topic, the participants' composition was evaluated to allow sufficient knowledge and opinion sharing. Efforts were made to involve all relevant to the topic parties, to enhance interaction and knowledge sharing and to dynamically communicate the different perspectives.

The event consisted of 4 parts:

- Part One established a minimum common knowledge ground. It consisted of conventional, one-to-many presentations on both the European and the National Qualifications Framework and on regulations and licensure in engineering.
- Part Two and Part Three consisted of plenary sessions, discussion on the current situation (work and study-wise) related to skills (Part Two) and focusing on key skills and mobility (Part Three). The procedural modifications that allowed the efficient facilitation of our heterogeneous crowd will be described in sections 2.2, 2.3 and 2.4.
- Part Four consisted of two parallel discussion groups on the same subject: the skills and qualifications of the modern engineer and how the different educational systems provide for them.

2.2 Dynamic Content and Agenda

Since the event was targeted to students and aimed to enhance their understanding of the topic, their expectations were collected and taken into account in several phases. Firstly, an online survey was sent to students of ATh, announcing the general topic prior to the event, researching the aspects of the topic that students are more interested in. Through this process the "key concerns" of students were revealed and the awareness level on the topic was indirectly identified, allowing a better design of the prematerials and the first introductory part of the event. Secondly, during the event and after the first introductory part, when the participants were more aware of the aspects of the topic at least in a basic level, the expectations were collected once more and were adjusted on the dynamic agenda of the plenary sessions.

2.3 Creation of an environment of equality and interactivity

As mentioned above, the structure and the content of this meeting were carefully designed, since the heterogeneity of the participants (age-wise, professionally etc.) could block the essential production of ideas. However, taking into account that interactivity drastically declines when people with different levels of prestige meet the facilitation of the plenary sessions was designed to provide a sense of equality between the participants. This interactivity decline is very apparent in professor-students meetings, where the conversation is almost always carried out in a one-to-many rather than a peer-to-peer fashion, with since the students believe that the

professor has authority over them. The mixed positioning of students, professionals and academics in a U-shape, the conversation's rules and the facilitation techniques were also devised to encourage the feeling of equality among the participants and to encourage students to participate and share actively their opinions. Finally, the natively interactive discussion groups facilitated the productive and parallel thinking and expression of ideas.

2.4 Support of processes that enhance productive thinking

With respect to productive thinking, Part Three began with a brainstorming session on the skills needed by a modern engineer. These crowdsourced skills were written down and functioned as the core content of the parallel discussion groups. In Part Four, each skill was briefly examined by the participants in order to reach a (leaning, not strong) conclusion on whether the skill under questioning could be better provided by a 5-year integrated study cycle, a 4+1 two-cycle educational system, or if none of the two systems help its development.

3 DATA PRESENTATION / FINDINGS

As a result of the participants' selection process, all interested parties were present and contributed in this event. It should be underlined that the majority of the participants had mostly national background of experiences, especially those coming from the job market's side. Some academics and students of higher levels (master or PhD year) had experienced European environment as well. According to the short survey which was sent to students of ATh, some of the key aspects of the topic that pointed out by the students were: the modification of educational methods in order to allow the development of certain skills they feel they lack (eg. team work, presentation skills, etc.), the way university prepares students for job market, the availability of research opportunities, the way university and academics support students to decide better for their career path, the impact of lectures-practice balance on skills that students end up to develop, skills developed through postgraduate studies, skills provided by university compared to skills required from job market, and many more. These topics were taken into account and were adjusted to the core agenda of the event. Participants had still the opportunity to propose new topics throughout the plenary sessions, and facilitators' team was evaluating the relevance of the proposed topic and the option to include it on the ongoing or following activities.

During the first plenary session, discussions were oriented around the practical issues that students and graduates of engineering schools of Greece are dealing with when they want to study and work abroad or in Greece. These issues were examined through the scope of skills, by discussing the opportunities and barriers that students and graduates have, due to the set of skills officially acknowledged to them through the degree, and as they are defined in National Qualifications Framework of Greece. Regarding the part of studying abroad, Greek graduates are depended on whether the host university will recognize their degree as equivalent to master or bachelor level. This uncertainty is rather crucial when they apply for PhD studies, since they are likely to be requested to follow further master studies in order to be considered as eligible applicants. According to testimonies of the participants, the positive image of ATh created by previous students who complied PhD studies in foreign universities worked as a positive factor for such universities to perceive the skills of the applicants as sufficient, despite the discontinuity among the actual skills and the ones defined from NQF of Greece. Concerning the part of working abroad, skills of Greek graduates of the 5-year curriculum are uncommonly yet likely to be insufficiently certified for specific positions in countries that link the rights of engineers with the

NQF. In the majority of cases however they appear to be properly qualified and adoptable. Engineering graduates from Greek universities have difficulty to define the skills they gained and therefore lack in self-presentation. This factor makes it more difficult for them to fight inequality in working environment and to negotiate their salary. At national level, the Technical Chamber of Greece is dealing with preserving rights for Engineering graduates of higher institutions, however due to the lack of interaction between them and Universities related to this topic, there is no common strategy on skills' issue. During the second plenary session the focus shifted towards some key needed skills, evaluated by the participants, and their opinion about how university provides them. Some of the mentioned key skills were: teamwork, leadership, critical thinking, fast learning, adoptability, time management and flexibility to perform tasks that require "engineering" logic.

Regarding the skills that an engineering student develops in a Greek university, participants supported that students develop a lot their logical thinking, making them comfortable in working on fields unknown to them. The 5-year integrated studies provide a wide yet strong background of technical skills that allows the student graduate to efficiently adopt on many different sub-fields. On the contrary, the lack of soft skills development, technical English terminology and interdepartmental cooperation were identified as some of the drawbacks of the Greek university. On the matter of mobility, it was commonly expressed that it can partially work as a tool to help students obtain skills that they lack in their curriculum, and also provide them with useful experience of getting familiar with different mindsets, cultures, working methods, and so on.

During Discussion groups, participants were separated in two groups which worked individually on the topic. Their aim was, having considered the relevant parameters discussed in the previous parts, to identify which skills are boosted through the different systems: one cycle 5 year integrated versus 2 cycle studies (in case of Greece the 4 plus 1 year case was examined).

The first discussion group started by pros and cons of the two different scenarios of systems and continued by placing around 30 skills (provided in post-its) to the system they believed it supported more their development. According to students' opinion 5-year integrated studies lead to a deeper understanding of the scientific subject and due to the stable working environment (colleagues and academic environment) they are able to observe better how long term cooperations work and put more energy in advancing their studying and working. On the other hand, two cycles provide the students with the opportunity of mobility which challenges them to adjust in different environments, cultures, languages and working methods, enhancing a set of different skills. The shorter duration of studies and the more often change of teams, allows them to develop a lot of their social skills and possibly optimize their organization and time management skills.

The second discussion group started by selecting a set of skills identified as more important and discussing how the different systems help students to develop them. According to their evaluation, 5-year integrated studies allow students to focus more on details as the requirements in this duration can be higher. The workload is considered as rather high, therefore they believe that time-management is essentially developed. Moreover, they believe that the variety of topics they go through, enhances their ability to adopt efficiently and develop a "can-do" philosophy. However they are missing practical training and skills related to it. They also consider that high number of students and insufficient facilities and equipment degrade the quality of their studies and don't allow them to have experience in applied projects. Lastly, they are missing the development of soft skills and self-presentation skills.

4 RESULTS

Even though the Bologna Process is a controversial issue in Greek Educational community, due to recognition problems of the Greek diplomas in other European countries, it gave a great boost to mobility opportunities for Greek students, supporting the development of essential skills for a successful engineer. Such skills are more or less needed to engineering students according to the career path they are willing to follow. Therefore, modifications of the current educational system are discussable due to the different needs that modern engineers have and the way mobility supports their development.

Being innovative, ready to face unexpected problems and having the flexibility to adapt in various working and cultural environments are considered to be important skills for a successful engineer's career. Moreover, having an entrepreneur's spirit, combined with analytic, synthetic and critical thinking is basic to chase such a career. Finally, understanding the value of interdisciplinary cooperation, being able to lead a team and to present clearly ideas and results of a project is fundamental.

With this meeting and its original structure, the following results were obtained: a) The initial knowledge level was elevated by the Part One sessions; b) Students participated actively and were not afraid to express their own opinion; c) Valuable knowledge and data on skills, qualifications, mobility and the job market was extracted from the verbatim proceedings of the meeting.

Some of the noticed dysfunctional aspects of Greek educational system itself and its cooperating relations with other universities of abroad, were worthy of excellent discussion and brought outcomes. These could be numbered as a) the problematic curriculum b) the examination system c) the big number of new entries each year which eliminates any chance of an efficient and interactive educational procedure d) the lack of correct orientation and information flow to the students about the culture of mobility and the opportunities it bears and e) the bureaucracy which prevents many students from applying for Erasmus+ programs because of the difficulty in acknowledging subjects between the host and home (Greek) university.

To come to a conclusion, students decided that despite the advantages that the 5 years integrated educational system might have, a two-cycle structure is desirable as well in order to comply with the European mobility culture. As a result, a new need arises, this of a substantial change of the current educational system, leading to a new one; combining the advantages of the two structures.

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