

The Engineering direction of the Technological Educational Institutes in Greece

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ABSTRACT: It is the policy of most countries to direct their educational system according to their needs, which, may arise from historical, socio-economic and commercial reasons. The Greek engineering educational system is comprised of various engineering fields most of which are offered by the Universities, and Technological and Educational Institutes (TEI) of the Country. The engineering curriculum at a TEI is structured to offer an applied knowledge of engineering technology. The paper addresses the content of engineering studies at a TEI. The curriculum of studies is also compared to the respective curricula of other engineering departments in Europe. Recent changes in Greek legislation allow TEIs to organise postgraduate studies in co-operation with Universities. The significance of this alteration in improving engineering education at TEIs is also discussed. Some findings on the curriculum, which is poor in courses from the fundamental sciences of physics, math and chemistry are discussed, especially with respect to the impact they have on the student's ability to understand applied technology and pursue a postgraduate degree. Also the needs of the Greek market for engineering graduates are discussed both in the private and governmental section.

INTRODUCTION

Education in Greece [1] is provided in three stages. First, second and third degree, each one offering an education which is either general or general technical-vocational, taking care, in parallel, of the edification, polish and socialization of young people.

The compulsory education is comprised of the primary school, belonging to the first degree and the high school, which belongs to the second degree of education. One of the main aims of the compulsory education is to promote a full-scale-developing of students in relation with the abilities they present in this age and the corresponding challenges of life. The universal lyceum and the Technical Vocational Schools belong to the non-compulsory second-degree-education.

The Universities, Technical Universities and Technological Educational Institutes (TEI), are on the highest level of Greek education, aiming to:

a. Generate and transmit knowledge through teaching and research or foster the arts.
b. Contribute in modulating responsible people with social, scientific, cultural and political awareness, providing the necessary outfit, which ensure their perfect training for a scientific and vocational career.
c. Promote a personal polish along with confrontation of social problems.

Graduates of the secondary education, who do not wish to attend higher education, have the opportunity to attend the Institutions of Vocational Training (IVT). These Institutions aim at providing vocational knowledge and skills. They address to people who:

- Have not obtained vocational specialization
- Want to improve or refresh their vocational knowledge
- Wish to change vocational specialization.

The IVTs do not belong to the second or third degree of education. They correspond to European Institutes of the so-called "past-second-degree" of vocational training and provide a certified training of national level, which is recognised by the European countries through the 92/51 directives. Their target is to:

- Provide vocational training of whichever type, either initial or supplementary
- Secure a corresponding qualification to the people under training through a scientific, technical, vocational and practical knowledge
- Provide the possibility of developing corresponding skills in order to facilitate their vocational incorporation in the society
- Ensure their adoption in the various needs of the procreative procedure.

COURSE CURRICULUM AT TEIs

The curriculum of the three engineering departments at TEIs, i.e., Electrical, Mechanical and Civil Engineering, emphasizes heavily the applied side of engineering technology instead of more theoretical engineering which is taught at the corresponding departments at the Universities [2]. As a result, the comprehensive mathematical modeling taught in engineering departments at Universities is absent from the course curriculum at TEIs, although computer skills for programming and arithmetic analysis such as the finite element method are taught.

Almost all modules in TEIs carry a heavy load of laboratory exercise and training. The modules are structured in such a way that the student will spend from 60% to 80% of the time in the laboratory and from 20% to 40% in the class (theory). For example in a module of heat transfer, while they are taught no simulation techniques, in the laboratory there is several prototype equipment for heat transfer (by conduction, natural convection, forced convection, condensation and boiling), which the student operates and gathers data which he analyzes. He uses the fundamental laws of mass, energy and momentum conservation but also relies heavily on empirical equation and therefore avoids the use of simulation. In the mechanical engineering department the students are trained in the laboratory, apart from the basic theoretical training and knowledge of the basic principles, the constitution of most internal combustion engines, their operation and how to fix them and troubleshoot most problems. These last elements are absent from engineering University curriculum, which, in the past few years they have moved in a more theoretical training of their respective students. As a result the outcome of this training at TEIs is that the students are trained to address everyday problems, which are encountered in a typical production line.

Another characteristic of the curriculum at the engineering TEIs which, is absent from the respective engineering departments at Universities, is the successful completion of a 6-month training period in Industry. This training is mandatory and it strengthens and compliments the on-campus training. Also mandatory is the completion of a dissertation, which is defended, provided that all modules and the practical training have been successfully completed. The module work is thus spread in six semesters plus one semester, which is required for the practical training and another for the dissertation. In a country where basic research and development projects are totally absent from most industries, the aim of the Technological Educational Institutes is to supply the market with engineers who are highly skilled with applied knowledge of engineering. As a result graduates from the departments of civil engineering and civil works along with those of mechanical engineering are absorbed by the local private sector from 80% to 92% in their first year after graduation.

MODULE STRUCTURE

All curriculum at engineering departments at TEIs allocate courses from the following three categories:

1. Mandatory - Fundamental Sciences (Chemistry, Physics, Math)
2. Mandatory - Main Engineering Modules
3. Electives and
4. Other, Non - Technical Modules.

Basic math, physics and chemical technology are found in the category of Fundamental Science and are mandatory (M-FSc). Engineering modules such as thermodynamics, fluid mechanics, material science and strength of materials, construction engineering, electronics, electrical engines, industrial antipollution technologies, CAD/CAM, etc., are found in the Main Engineering Modules and are all mandatory (M-MEM). Most foreign language courses and some computer programming modules are found in the electives. Also some technical modules of lesser interest can be found in the electives (EL). The 4th category (other, non-technical modules) contains modules such as technical English terminology, modules on economics, business administration, etc.

Table 1 below [3] summarizes some of the findings of this study with respect to the fundamental science modules and the basic Material Science modules for each one of the three engineering departments. The numbers in the boxes indicate the amount of modules offered in each of the categories presented in the table. Also shown is the percent of the Fundamental Science Modules and Main Engineering Modules of the entire number of modules.

Table 1. Allocation of Modules for the four module categories, of the electrical, mechanical and civil engineering departments.

Department	M	P	CT-ET	MS	MEM	EL	OM	% FSc	% MEM
Electrical Eng.	3	1	0,5	0,5	25	3	6	11,5	64,1
Mechanical Eng	3	1	0	2	33	6	7	7,7	63,5
Civil Eng.	4	2	1	1	32	6	4	14	64,0

Key: M = Math, P = Physics, CT = Chemical Technology, ET = Electrochemical Technology, MS = Materials Science, MEM = Main Engineering Modules, EL = Electives, OM = Other, Non-Technical Modules, FSc = Fundamental Science.

It is to be noted that one chemical technology module is offered in the department of civil engineering; only half a module of electrochemical technology is taken by the students of electrical engineering, while no basic chemistry modules are offered in the department of mechanical engineering.

Highlighted in the table is also the percentage of modules offered in fundamental sciences, which ranges from 7,7% to 14%, mostly due to the math. The respective percentage in US universities ranges from 20% to 25%. It seems therefore, that fundamental sciences are not adequately taught in TEIs. It also seems that no pure chemistry modules are taught. For example, students who are taught modules on corrosion and combustion do not understand the fundamental chemical processes that are taking place. It is also to be noted that only one module of physics is taught in each of the departments of electrical and mechanical engineering. This single course is good enough to cover classical mechanics, but nothing more. There are no modules offered in physical chemistry, while in the department of electrical engineering there is only half a course where one material science is taught; the other half of the module covers electrochemical technology.

RECENT LEGISLATION CHANGES. POSTGRADUATE STUDIES

Recent changes in Greek legislature (in June 2001) [4] have brought the following opportunities to the TEIs:

1. They have upped their former status from a Higher Educational Technological Institution to a Highest Educational Technological Institution, status held until recently only by Universities and
2. They make it possible for TEIs, in collaboration with Universities, to offer postgraduate studies at the MSc or MA level. The Universities confer the postgraduate title having the overall responsibility and both the

modules and dissertation are offered either by both parties (the University and the TEI) or only by the TEI. Several TEIs have already begun postgraduate programs in various disciplines with domestic and European Universities.

3. They give to the Faculty members, who are not PhD holders, an opportunity to pursue a PhD in a domestic or foreign University.
4. According to the new law there are four grades of faculty members: Professors, Associate Professors, Assistant Professors and Lecturers. For the first three grades a PhD plus a significant professional (non-teaching) experience is required. Also for the first two grades significant research experience is required along with several publications in well-known scientific journals. For the fourth grade, a MSc is required along with significant knowledge in the application of technology. The faculty members of the fourth grade are therefore designated only for the conduction of laboratory exercises. The qualifications of the first three grades are the same as those required for a University faculty. Members in the first three grades can also conduct laboratories, while full professors and associate professors teach mainly the theoretical parts of the modules.

The law also defines a transitional period of about seven years (until December 31, 2008) for these changes to be fully implemented. All departments at the TEIs have modified their modules offering additional ones, however none in fundamental sciences. Some departments have even reduced the number of fundamental science modules, which were offered previously.

MARKET NEEDS

The Greek market is comprised mainly of private companies of small and medium size, which employ up to 200 personnel each. Larger companies are much fewer and each can employ up to 1000 personnel. Research and development projects are absent from small and medium size companies. Very few large companies may have development projects, which span a 3-5 year period. Therefore, most companies rely on engineers for solving every day production problems, fixing and maintaining production equipment, carrying out special projects, especially with regards to installing new technology equipment and processes and carrying out the necessary quality control in their production lines. The various governmental sectors (Ministry of environment and public works, Ministry of transportation, Ministry of Education and local authorities) absorb engineers from both Universities and TEIs.

Many engineers from both Universities and TEIs become self-employed, opening up their own offices or small businesses related with their profession. The private sector companies also hire engineers from both Universities and TEIs. However the cost for an engineer graduated from a TEI is approximately 2/3 the cost for the respective engineer graduated from a University and thus personnel cost influences company decisions.

DISCUSSION

The extensive laboratory and the six-month practical training period, which are mandatory in order to graduate, are deemed very significant in supplying the students with hands-on experience on engineering technology. However, there was a three-fold increase in the number of students admitted at TEIs around the country in the period 1999 to 2001, as part of the governmental policy to keep students in the country and eliminate migrating to foreign Universities. Unfortunately this abrupt change was not followed by an analogous increase in funding, resulting on several problems with respect to the operation of the TEIs. The laboratories increased the number of students allocated, from about 12-15 per laboratory to more than 20. Also the number of teaching and assisting stuff was reduced from 3 to 2 per laboratory. As laboratories became stuffed and equipment was not properly maintained, there has been a significant deterioration in laboratory training quality. It seems that more laboratory space is needed as well as an increase in the funding for laboratory training. Also more technologically advanced apparatus must be bought to replace older and obsolete apparatus.

Student scientific background has also deteriorated as a result of the tripling of student admissions. This resulted in the lowering of the standards for classroom performance and has decreased average classroom performance. From Table 1, it seems that teaching of fundamental science module has been downplayed significantly, and this coupled with the student's weak science background (from high school) seem to deteriorate student performance in engineering modules, especially in the theoretical part of the module. Students seem not to understand the fundamental laws underlying engineering technology. It therefore seems that it is very important for improving student performance and training, especially in view of the latest legislation changes, that teaching of fundamental science modules (math, physics, chemistry and physical chemistry) needs to strengthen. TEIs can strengthen the student fundamental science background and still stay on the applied side of engineering.

Postgraduate studies are a reality for many departments at TEIs. Various departments at TEIs seem to very quickly grab on the opportunity to carry out various MSc and MA postgraduate programs in collaboration with domestic and foreign Universities. These postgraduate studies will play an important role in improving overall education at TEIs. As most students admitted to these postgraduate programs are themselves graduates from TEIs, it gives them the opportunity to improve their educational level. Postgraduate studies at TEIs are also becoming important because they are accompanied by the opportunity for students to carry out their postgraduate dissertations in applied research programs.

More than 250 research proposals, made by TEI faculty members, have been funded late last year (by the E.U.) and are been carried out and more than 150 additional ones are expected to be funded by the end of this year. Here also it seems important that teaching fundamental sciences, in the undergraduate level, must be strengthened in order to support the postgraduate studies and especially the carrying out of the applied research, which is necessary for the completion of the postgraduate dissertation.

CONCLUSIONS

The following are conclusions regarding engineering education at TEIs and suggestions for its improvement in order to meet changing market needs.

1. TEIs play an important role in supplying the market with engineers trained on applied technological issues ideally suited for use in production lines and for solving every day problems encountered in industry.
2. The recent changes in legislation regarding TEIs give them the opportunity to improve the level of their graduate training and carry out postgraduate programs, offering basic and postgraduate degrees equivalent to the respective offered by Universities, on the applied side of engineering.
3. More careful screening of students is needed for admission to TEIs.
4. The fundamental science background in both the high school level and the modules taught at TEIs must be strengthened and
5. The funding to TEIs must be significantly increased in order to meet the operational costs and to better equip and synchronize laboratories.

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