

Experience Gained in Applying ABET Criteria to an Electrical/Electronic Engineering Program in a Turkish University*

AYHAN BILSEL and ERZAT ERDIL

Eastern Mediterranean University, Gazimagusa, Mersin 10, Turkey. E-mail: ayhan.bilsel@emu.edu.tr

Preparing for ABET accreditation involved a set of changes in various aspects of the Electrical and Electronic Engineering program at Eastern Mediterranean University. Curriculum redesign was the most difficult component of the efforts. The curricular content was modified with more emphasis on design and practice, more humanities and social sciences; ethics courses were introduced as important components of a global profession. Many procedures were standardized to make the process of evaluation more transparent. A web site was designed to make students' academic status available to parents. Students' performance, before and after graduation, became a subject of concern and statistical methods were developed to monitor the outcome. In general, the preparation for ABET accreditation led to reorganization to improve service to students. The process of preparation has already induced a positive effect in the student body.

INTRODUCTION

DURING the last few decades we have observed a rapid change in both the practice and the teaching of engineering. A key characteristic of this change is globalization. Major companies are now multinational, and engineering is becoming a global profession. Engineers are now working in multidisciplinary, multinational teams, and accordingly the new engineering curriculum needs to account for improved communication and cultural literacy more than ever before [1–2]. Passing courses is no longer considered a guarantee for professional mastery [3].

Although globalization poses many challenges, it also offers opportunities for higher education [4]. A consequence of globalization is the increased mobility of engineers. Consequently, problems of diploma and accreditation recognition is becoming an important issue for most institutions. In Europe, for example, the European Thematic Network H3E established in 1996 entrusted its Working Group 2 with the themes of quality and recognition [5].

For many years ABET Criteria (both the conventional and the EC2000) has been an excellent guide for curricula designers in the USA. Although the Criteria has been designed for American engineering programs, in recent years a number of engineering schools outside the USA are either seeking accreditation (e.g. Karlsruhe in Germany [6], METU, Bogazici, and Bilkent in Turkey [7]), or using it to revise their curriculums

(e.g. Delft in the Netherlands [8], Sharjah in UAE [9]). It is even suggested that the ABET system is best suited as a model for an international accreditation standard, most significantly because of its simplicity and flexibility [10]. We must nevertheless mention that this view is not universal [11].

In this paper we review attempts for accreditation at Turkish engineering schools, and in particular describe the experience and benefits gained while preparing the undergraduate electrical and electronics engineering program at Eastern Mediterranean University. The preparation process took three years of committed work, and involved not only curricular developments but a tracking of students at all stages of their study.

THE TURKISH EDUCATION SYSTEM

All educational services in Turkey are supervised by the Ministry of National Education. According to the law, eight years of primary education, for children aged between 6 and 14 years is free at state schools. Secondary education at state schools is again free but not compulsory. It involves three years study either at high schools or at vocational schools. The academic year at primary and secondary schools consists of 180 working days.

According to the Higher Education Law of 1981, the Council of Higher Education, YÖK, is responsible for planning, coordinating and policy-making for tertiary education in Turkey. The Higher Education Supervisory Board supervises and controls the universities on behalf of YÖK. In 2001 there were 77 universities in Turkey with a

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total student population of 1.5 million (excluding graduate students) [12].

Technical fields of study are relatively popular; 16.8% of the undergraduate population are enrolled in engineering programs. During the academic year 2000–2001 there were 16,967 graduate students studying for MS, and 4704 for Ph.D. degrees. These correspond to 26.1% and 21.7% respectively of the graduate population [12]. The oldest engineering school, Istanbul Technical University, has its origins in 1773, only 32 years after the establishment of the French Ecole National des Ponts et Chaussees. All undergraduate engineering programs at Turkish universities are designed for a standard duration of four academic years of study.

THE ELECTRICAL AND ELECTRONICS ENGINEERING PROGRAM

Eastern Mediterranean University (EMU), with a population of 14,000 students from more than 60 countries [13] is the largest and the oldest university in North Cyprus. The University originated as the Higher Technological Institute in 1979, and received its parliamentary Charter in 1986. With around 900 academic staff from 35 countries, the University is committed to maintaining and developing international standards of excellence, both in teaching and research. There are seven faculties (in chronological order, Engineering, Arts and Sciences, Business and Economics, Communication and Media Studies, Law, Education), and three schools (Foreign Languages, Computing and Technology, Tourism and Hospitality Management). The language of instruction is English in all faculties and schools.

The Department of Electrical and Electronic Engineering was one of the first established departments at EMU. During the 2002 Fall semester the department had 345 undergraduate and 48 graduate students, and a highly qualified faculty of 5 full professors, 6 associate professors, 6 assistant professors, 1 lecturer, and 19 teaching/research assistants.

The Department's mission is 'to equip students with a wide range of knowledge in the engineering profession and basic sciences to appreciate technological innovations and research studies with an aim to contribute to further development' [14].

PREPARATION FOR ACCREDITATION

Preparation for ABET accreditation started in 1997 but without any formal commitments. In 1998 a curriculum committee was formed to revise the Electrical and Electronic Engineering curriculum. The new curriculum was designed with conventional ABET criteria chosen as the point of reference and it was approved by the University Senate in October 2001.

In early 2001 ABET committees were formed at both faculty and department levels. The chairs of departmental committees were also members of the faculty committee.

The departmental committee of the Electrical and Electronic Engineering was formed with six faculty from the department. It was given the task of distributing workload and organising activities for the smooth and efficient preparations for accreditation.

Some of the tasks were:

- Responding to requirements directed by the faculty committee.
- Communicating and collecting materials/documents from the staff members.
- Establishing standard formats for presenting various documents.
- Organizing a 'performance records' archive to enable easy access for inspection of hard copy academic performance records dating back at least two academic years.
- Survey of all facilities and services available to students and reporting any malfunctions to appropriate offices.
- Establishing contact with as many graduates as possible and their employers.

The desire to have accreditation and the preparatory actions organized by the committee soon inspired good house-keeping, standardization, and a general revision of all functions and improvements in facilities and services.

Restructuring of the curriculum in engineering programs traditionally provokes heated discussion. The fast-changing technologies and relatively slow response of market forces and the requirements of the constituents can sometimes create a conflict of interest among the faculty resulting in a slow-down of the discussion process. Therefore, a small group of five staff members formed a committee to review and redesign the existing curriculum. It took three years of hard work and close cooperation with other service departments to reorganize and ensure that the components of the curriculum fitted the conventional ABET criteria. While the ABET criteria lit the way, there were academic and economic considerations that formed major topics of discussion.

Overall, the following topics required some convincing, concessions and compromise:

- There was some opposition to any change at all in the curriculum. This logic was rather short-sighted and based on stability offered by the well-settled structure of the existing curriculum. It is difficult to deny that, especially in the newly established institutions, curriculum design may have components that favor those fields of specialization already possessed by the existing faculty. This factor alone caused some resistance to any changes at all.
- Having decided to reconstruct the curriculum, the question of having a single track as opposed

to a multi-track option was resolved in favor of the multi-track option. Although economically more demanding, diversity was more attractive and better suited to expectations from a global engineer.

- The choice of tracks (options) was not only dependent on market forces, but also specialization of existing faculty and the budget, as it could involve recruitment of more faculty with specialization in certain fields of interest.
- The diversity of prerequisite courses required by different optional electives caused time-tabling problems. This problem was resolved by introducing a category of core courses called 'Selective Core Courses' (SCC). The phrase 'Selective' refers to date or semester, for registration in such a course. An SCC course that provides a better foundation to an optional elective course is obviously taken first.
- Any proposal for curricular changes in a service course, taken by the department, meant hard and long discussions, no less painful than those within the department. Generally the main resistance was not academic but rather based on reluctance to reorganize faculty work loads.

The curriculum was redesigned but without succeeding in lowering the overall credit hour total. However, the share of credit hours allocated to different category courses was substantially changed to parallel ABET requirements. The most striking changes were in the credit/hour share of humanities/social sciences and design-oriented courses as part of the total credit hours of the program. The humanities/social sciences-based courses have been, and still are, largely omitted in the Turkish high schools. Furthermore, traditionally the undergraduate programs in Turkish universities are mostly technically oriented but poor in the design component. It was the ABET requirements that made us aware of such features in our old curriculum. The main stream of changes are summarized below:

- The single track program is replaced by a program having five options:
 - communications engineering
 - computers
 - information engineering
 - integrated circuits
 - power/control engineering.
- Arbitrarily taken five technical elective courses are replaced by four optional elective courses.
- No change is made in the total credit hours of the program.
- The credit hours allocated to the Humanities and Social Sciences (HSS) elective courses are doubled with a compulsory 'Ethics in Engineering' course.
- A course based on electrical measurements is discontinued but the contents spread to laboratory study sessions; a new course, 'Introduction to Electrical and Electronic Engineering', is

added to help guide students towards specific careers in the field.

- Two mathematics courses, 'Complex Calculus, and Numerical Methods', are replaced by a newly designed course, 'Mathematical Methods for Engineers': emphasis is given to mathematical methods used in engineering rather than mathematics as a science.
- The electronics courses are reduced from three to two, but a new course, 'Digital Logic Design II', is added in response to current demand on digital systems.
- A new course, 'Communication Skills', is added with contents designed to improve and encourage using modern communication skills in the engineering domain.
- A non-credit course, 'Project I', is introduced in the penultimate semester. This forms a pre-project study, when students collect information, data, components etc. that they will require in the final semester in 'Project II' forming the actual credited practical design study.

Other committees, reporting to the ABET committee, were formed to help prepare for accreditation. These were: Laboratory Studies; Graduation Project; Statistics; Archive of Academic Records, and Alumni Committees. The formation of the Laboratory Studies Committee and its successful study helped to reorganize otherwise omitted aspects of the laboratories. Uniformity was established in producing written material, experimental procedures and report writing. Stock keeping and updating consumables were computerized and made available to faculty. The desire, involvement and excitement of accreditation provided a well defined reason to improve the laboratory facilities. Faculty felt relaxed, while demanding updating and expansion of laboratory services, as it was essential if more emphasis was to put on practical studies. Accordingly, the design-oriented project studies were made compulsory core courses in the program. Reorganizing laboratories also made it easier to forecast future equipment needs and for updating existing equipment. Not only did the running of laboratories become smoother, but students benefited most as they appeared to show more interest in laboratory studies even to the extent that they demanded extending the opening hours well outside the normal working hours.

One of the most unique features of the new curriculum was the emphasis given to design and practice oriented studies. Hence, students were required to get involved in a capstone type project in the final year of their study program. Accordingly, a Graduation Project Committee was formed to help organize these project studies. An incentive was created for faculty to prepare at least four different project proposals to be kept in a pool of projects that would be offered to students for their choice in the final year of their studies. A standard was established to establish the suitability of projects through stringent requirements during

the evaluation of the student performance. Students reported their study in a well-formatted document and also prepared an oral presentation using the most up-to-date software and visual aids. Close-circuit video recording and replay facilities helped students to analyze their behavior and presentation capabilities. A standard procedure is designed to help evaluate the overall performance of students by a jury, including the student's supervisor assigned by the department head. All these helped students to gain more self-confidence and be better skilled in written and oral communications.

The performance of students over the last seven years were analyzed at all stages of the course program. This led to the identification of weak points in the course program or students' performance. Some problems were revealed that could be linked to the different academic backgrounds of students. Other problems, relatively not as crucial, could be attributed to difficulties faced by the foreign students, who, in adapting to local features and using English, a non-native language, as the official language of instruction in the university. These and other related factors all together indicated a need for modification of the existing academic advisory system to help improve academic performance and human-relations with the student body. Hence, the performance records of students were made continuously available to faculty on a website. Also, informal events planned to improve the faculty-student interactions also helped to identify deficiencies in academic and other facilities provided to students. As an outcome of these discussions, the department organized closer cooperation with the School of Foreign Languages in an effort to help improve the performance of our students to better satisfy departmental expectations. This included the analysis of the results of the new streaming policy applied to students by this school. Likewise, closer contact with the Faculty of Arts and Sciences was organized to plan a reduction in class sizes and an increase in the number of tutorial hours with the aim of improving student performance in basic sciences and mathematics courses.

Special attention was given to transparency in teaching and evaluation. During lecture sessions, using of audio-visual facilities were recommended and multi-purpose desks were designed to help this task. Hence, Internet links could be displayed while most updated software was used during presentation of lectures. All lecture notes and presentations, homework, quizzes, in-term and final examination papers were made available to students on Internet sites together with the grades. Contrary to our expectations, that this would decrease student questions and communication, the reverse occurred and student involvement was enriched. The transparency in evaluation was further improved by keeping hard-copy records of all the examination papers and other documents that contributed to evaluation in the past two

academic years. These were kept in the academic records archive which could be visited by appointment by faculty, parents or any other interested academic institution. The uniformity and quality of assessment was the pride of the department and standard procedures were designed to help achieve this aim. This involved some paperwork, creating standard forms to be filled in and strict schedules. However, some faculty expressed concern that the procedure compromised academic freedom.

An effective method of evaluation for identifying the status of achievement towards the program objectives involved developing a method of assessment. The overall strategy was to gather many different kinds of information, including quantitative and qualitative data both from internal and external sources. It was therefore important to collect, analyze, and evaluate such data to ensure that future employers are satisfied with the performance of our graduates, as part of the mission of the department. This required an efficient, serious and continuous tracking of graduate activities in their profession and/or in their academic domain. A web page and an online questionnaire were formed which helped to develop a database intended for varied statistical analysis. This provided feedback towards improving the program and fulfilling its mission to have graduates equipped with professional knowledge and experience that will satisfy the requirements of the constituents.

CONCLUSIONS

Preparation for ABET accreditation is an experience of transition from a traditional track to a more flexible transparent program. It involved collective hard work. The curriculum redesign was the most difficult phase of the transition. Procedures were standardized and made transparent. The improved and enhanced interaction between the faculty and students helped reveal and alleviate some problems. Until our endeavor for accreditation by ABET, there were no serious studies regarding employment of our students or the judgment of employees regarding the capabilities of our students in their market. Tracking of graduate employment and links with the employers provided a measure of students' achievement towards the fulfillment of the program's mission. The response of some employees, towards accreditation, has been positive. This was the general view of some industrial organization, expressed during their visit to university to recruit graduates. In general, the preparation for ABET accreditation led to reorganizations for better service to students. Some of the positive actions and gains may be listed as:

- an internationally recognized course program;
- more emphasis on design and practice;
- more humanities/social sciences courses are

introduced, as important components of a global profession;

- laboratory studies and procedures improved;
- collective work and better interaction between the faculty and students and improved relations;
- the process of evaluation is made transparent;
- a web site to make the academic status of students available to parents;
- the standardization of many administrative processes;
- the routine control of effectiveness of facilities provided to students.

Although it is very early to have any accurate measure, the accreditation excitement induced in the student body has already seemed to improve their performance.

The conventional criteria was chosen as the point of reference, although in the USA EC2000 is now in use. This was due to ABET not planning to offer substantial equivalency in EC2000 for institutions outside USA until the year 2006.

Through the process of preparation for ABET accreditation, the concept 'quality' has transformed

from an abstract entity into a 'living culture'. Standardization became a part of this culture. The collective involvement of faculty has resulted in closer relationships and enhanced confidence. The most striking change in the curriculum was the deviation from the total domination of technical subjects. For the first time we became aware of the importance of humanities and social science subjects. A course on engineering ethics has been introduced.

As more Turkish universities seek accreditation from ABET, we believe that the landscape of Turkish engineering education will change. First, the traditionally very high number of total credit hours will be reduced. Recently, Istanbul Technical University has reduced the total number of credit hours from 176 to 150 (mean value for the 14 engineering departments) [15]. Similarly, the total credit hours in Middle East Technical University's chemical engineering program was reduced from 165 to 146 [16]. Second, more humanities and social sciences electives, which at some Turkish engineering schools are non-existent, will find a place in the curriculum.

REFERENCES

1. S. F. Johnston, Towards culturally inclusive global engineering? *Eur. J. Eng. Ed.*, **26**, 2001, pp. 77–89.
2. S. Irandoust and J. Sjöberg, International dimensions: a challenge for European engineering education, *Eur. J. Eng. Ed.*, **26**, 2001, pp. 69–75.
3. L. Schachterle, Outcomes assessment and accreditation in US engineering formation, *Eur. J. Eng. Ed.*, **24**, 1999, pp. 121–132.
4. G. McBurnie, Leveraging globalization as a policy paradigm for higher education, *Higher Ed. Eur.*, **26**, 2001, pp. 11–26.
5. G. Augusti, European engineering formation: the problem of transnational recognition. *Eur. J. Eng. Ed.*, **24**, 1999, pp. 7–14.
6. Y. Julliard, C. Meinecke, and A. J. Schwab, Applying ABET engineering criteria to a German electrical engineering program, *IEEE Int. Symp. Technology and Society*, 2001.
7. I. Akduman, L. Ozkale, and E. Ekinci, Accreditation in Turkish universities. *Eur. J. Eng. Ed.*, **26**, 2001, pp. 231–239.
8. W. W. Massie, Curriculum revision in the light of ABET 2000 Criteria, *32nd ASSE/IEEE Frontiers in Education Conference*, Boston, USA, November 2002.
9. N. Kallas, and I. Zabalawi, A creative approach for a rapid establishment of successful engineering programs, *Proc. Int. Conf. Engineering Education, 2002*, Manchester, UK, 18–22 August 2002.
10. C. A. C. Imbert and G. S. Kochar, International accreditation of engineering degrees for developing countries, *Proc. Int. Conf. Engineering Education, 2002*, Manchester, UK, 18–22 August 2002.
11. A. I. Vroeijenstijn, Towards a European hallmark for engineering education, paper prepared for *ICEE Conference*, Rio de Janeiro, Brazil, 15–20 August, 1998.
12. *Present State of Turkish Higher Education*, Council of Higher Education Report 2001 (in Turkish). Available online at www.yok.gov.tr/raporlar/kasim2001/kasim2001.htm
13. *Bulletin 2001–2002*, Eastern Mediterranean University, Gazimagusa, North Cyprus, 2002.
14. E. Erdil, Preliminary program assessment report for substantial equivalency evaluation, EMU-EE Report (unpublished), 2002.
15. E. Ekinci *et al.*, Course distributions of the engineering curriculum of Istanbul Technical University, in G. Saglamer *et al.* (eds.) *Engineering Education in the Third Millennium*, Vol. 1, Alsbach, Leuchtturm-Verlag, (1999) pp. 339–343.
16. C. Ozgen, Accreditation from abroad: implications to chemical engineering education in Turkey, in G. Saglamer *et al.* (eds.) *Engineering Education in the Third Millennium*, Vol. 1, Alsbach, Leuchtturm-Verlag, (1999) pp. 78–83.

Ayhan Bilsel is a professor of physics and Dean of the Faculty of Arts and Sciences at Eastern Mediterranean University. He received a BA (Hons.) in physics from the University of York, and M.Sc. and Ph.D. degrees in physics from the University of Essex. His current research interests are in physics education, in particular physics in

engineering education. He is a member of the American Physical Society, the American Association of Physics Teachers, and the Institute of Physics (UK).

Erzat Erdil is an Associate Professor of Solid-state Physics. He received his first degree B.Sc(Hon) from the Imperial College of London University in 1970. He then obtained M.Sc. and Ph.D degrees and researched on electroluminescence display panels. Erzat Erdil was employed at the Hirst Research Centre, GEC, UK during 1974–1979. He then joined Smiths Industries, UK and worked as a liaison engineer. Dr. Erdil directed the Higher Technical Institute, the foundation of the Eastern Mediterranean University (EMU), during 1980–1983 and also headed the Electrical Engineering department until 1986. He was involved in the university administration for over 14 years. He acted as the Dean of the Faculty of Engineering, 1986–1987 and then directed Polytechnic Institute of the EMU until 1994. Presently he is teaching and researching. He is a corporate member of the Institute of Electrical Engineers, UK, a Chartered Engineer and member of many other professional institutes.