Assessing a decade old capstone senior projects through ABET accreditation program outcomes

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Abstract

Capstone design team project is such a course that allows the Engineering student to put into use the acquired knowledge from courses offered in the Engineering curriculum. The course in its entity fully represent in whole all the Accreditation Board for Engineering Education (ABET) program outcomes require for accreditation or substantial equivalent as the case may be outside the United State. In this work, we present the fundamental differences and our experience in organizing 10 years of capstone design team projects in Mechanical Engineering at Eastern Mediterranean University, Famagusta, TRNC.

Keywords: Capstone design team project; ABET; Engineering Education; Accreditation

1. Introduction

The current technological development and globalization trends that have influence world economy will require at the grass root quality education in order for it to be preserved sustained (Goldberg, 1996). One important aspect of Education that requires attention is the engineering education due to the challenges of adapting to rapidly changing technological innovation that knows no national borders. Current Engineering industries rely on outsourcing of parts rather than a firm manufacturing all the components of its products due to high cost of producing the part where wages are on the high side. In this era of concurrent engineering and networking, engineering education establishments throughout the world will need to adequately prepared engineering student to meet the high demand of knowledge and technical know-how require by most employer of labour. Capstone design team projects, also known as senior design projects or senior capstone projects are critical to producing an engineering education that will fit into the professional society. The capstone design team project courses at the Department of Mechanical Engineering, Eastern Mediterranean University, allow seniors in the department, starting from the 7th semester, to organize themselves into team and take on real engineering projects. Projects embarked on ranges from upgrading an existing machines in the Laboratory (automating a machine), design and construction of machine and/or an experimental work with industrial applications (Solar air heater for drying seeds in agricultural industries). These capstone projects follows the engineering ethics and codes from preliminary stage to final design stage as it’s obtainable in real engineering profession. One major advantage of Capstone projects is that it allows the student to utilize technical knowledge gained from taught courses throughout their education. This course exposes the students
to the real world-engineering scenario. Accreditation Board for Engineering and Technology (ABET), most recognized Engineering education accreditation body in the world, also emphasis the place of capstone courses in adequately preparing engineering student for what lies ahead. The focus of ABET EC 2000 Criteria 3 and 4 is on student learning objectives and the outcome assessment and evaluation that can be fully capture in capstone design courses. For us at the Mechanical Engineering Department of Eastern Mediterranean University, Capstone design courses are the most effective ways of ensuring the programs outcomes described by ABET Criterion 3.

2. Institutional Background

Eastern Mediterranean University is one of the six universities located at the Northern part of Cyprus. It is the only University on the Island with ABET substantial equivalent accreditation for its engineering faculty. In 2005 it was only Mechanical and Electrical Engineering that was given the ABET accreditation status until recently (2010) when all the Engineering programmes offered by the University were accredited by ABET. The department of Mechanical Engineering in 2000 introduces a capstone design course into its curriculum with the hope of equipping the graduate with design experience needed to compete for job openings. The department has attracted lots of international students from more than 15 countries at undergraduate, graduate and post graduate level. Capstone courses, which started as one semester course, have been running in the department for more than 10 years now and have metamorphosis into a real successful engineering experience (Atikol, 2003). The course is now being taken as MENG 491 and MENG 492 in two separate semesters to allow time for the student to be well equipped. Feedback from student (through survey, interview and assessments) at the end of each semester has served as a means of refining the courses to what it is today.

The Bachelor of Science in Mechanical Engineering program at Eastern Mediterranean University is four years with about 40 courses ranging from basic science course in year one, departmental courses, Faculty elective, University and technical electives. The new Program educational objectives of the undergraduate program, as agreed upon by departmental board on 25 November 2010, are to provide a high-standard education and training that will enable its graduates to:

1. Work successfully in Mechanical Engineering-related fields and demonstrate professional engineering competence via attaining positions of increasing responsibility;
2. Engage in activities that foster professional growth and learning;
3. Exhibit effective leadership in multicultural and multidisciplinary settings of the competitive global work environment;
4. Fulfil professional responsibilities, conforming to ethical and environmental values

The curriculum of the program offer by the department is dynamic and changes with latest cutting edge innovation and technology.

3. Our Capstone Team Projects

Capstone design team project are necessary requirement in providing an engineering students with practical design experiences from ideas formation stage to the manufacturing of the components. It also exposes the student to the economics of design and the real world market structure that influence the success of a product. Parker et al (1996) observed that capstone design course or course sequence requires senior-level students to apply knowledge gained from previous engineering science, design and laboratory coursework in accomplishing an extended design task. This is one junction that a student evaluates what had been learnt in semesters past and if it is sufficient to carry out and engineering endeavour. Our Capstone design team projects over the years have been able to covered areas like ethics, teaming, and communication (writing and oral presentation) that are often outside the curriculum of typical engineering courses. Also in other to satisfy the ABET EC 2000 Criterion 3 we have intensify efforts to sharpen the writing and oral presentation by organizing seminars and conferences that address these issues comprehensively. We have also pursued convectional ways in approaching engineering problems as seen in engineering profession. Two courses (MENG 491 & MENG 492) in sequence of two semesters are devoted to capstone design. The first course (MENG 491) entails detail training in academic literature survey, writing skills, academic paper writing ethics( such as plagiarism, academic dishonesty etc), engineering ethics, engineering code as related to regions and how to develop an idea to product stage. This first course also teaches how to document daily events as they occur in the team. This part of MENG 491 takes maximum of two months then the teams advance to solving an engineering problem. Other topics treated include engineering economics and environmental regulations. MENG 491 is
structured in a way that an average of 40 students grouped themselves into 10 -12 teams with a minimum of two hours meeting each week and each team meet with their supervisor minimum of one hour weekly. Capstone projects made us realized that the student do not mix well in classroom courses and its difficult for them to form a working team group. Capstone design team projects coordinators had to step in for smooth team formation. Our objective is not to assign the student to groups, as this did not yield desired speed for project completion, but we allow the students to form the groups themselves. Schedule and deadline are given at the beginning of the semester and each team member submits a written progress report to their supervisor and the MENG 491 coordinator. A final report is prepared at the end of the semester by the team and it is presented to member of the jury. In MENG 492 the student continue with what they started in MENG 491 and into the real design stage. At this stage they meet more with their supervisor and work in hand with the workshop technicians that put them through the use of some equipment. Finally, all projects given to the student are project that can be completed within two semesters at most and these projects are not industry base. The projects are either to design and construct a machine/instrument that can use in the laboratory or to upgrade an existing capstone projects (e.g. the solar car capstone project had more than five groups that worked on it at one time or the other). In addition, the finance of most of the projects is very limited with no constant external fund, and the university gives less than $100 for a team projects. This situation limited our options of competitive engineering projects that can demonstrate our readiness to display our technical knowhow. On the grading system, MENG 491 is a zero unit course while MENG 492 is a four unit’s course. It is necessary for a student taking MENG 491 to score satisfactory by the jury before taking on MENG 492. Our complete capstone design team project can be view on our website http://me.emu.edu.tr/hacisevki/1.htm.

4. ABET (Criterion 3- Program Outcomes and Assessments) & Our Capstone Projects

At the end of each semester, all the students enrolled at the Mechanical Engineering program filled a survey on the courses for that semester. A compilation of the Spring 2010 course survey, is used in this work to adjudge the relevance of our Capstone design team projects, the survey used was in line with the criterion 3 of ABET, since the department need to continue its substantial equivalence accreditation. The survey comprises of departmental program outcomes and ABET program outcome. The survey used in this study consisted of 11 items (all ABET program outcome) asking questions about core program outcome of ABET. Table 1 shows the mapping of some major courses in Mechanical outside service courses, University elective and Area elective. The Table 1 shows that all the courses contributed to the ABET program outcome but none contributed to all of the program outcomes except for MENG 491 & MENG 492 (Capstones course). The survey shows what the student felt about the courses and the design course. The capstone design team projects is an embodiment of what ABET canvass engineering courses to be, to adequately produce quality and certify engineers that can sustain the trend of engineering development[Engineering criteria 2000].

5. Observations and Lessons Learnt

Our completed Capstone design team projects over the period of ten years (2001-2011), according to feedback from course surveys collected at the end of each semester couple with post graduation correspondences and feedback from some of our student and their employer shows that we are on the right track. One thing we have worked on over the year is the feedback; it helps us to respond to what the student lack that needs to be included to make them better engineers. The following are some observations and lesson learnt in ten years of organizing and teaching capstone design team project:

1. The team size: We have observed over the years that the size of the team is a strong factor in the success of the group as comprehensively studied by Griffin et al (2004). We have tried a group of more than five students and of two students at different times. We will advise a group side of 3-4, but even number is better. In the case of two people, an active member can hijack the project while the other member will do nothing. In addition, for the case of more than five students in a group, it allows distraction from the projects and meeting will centre more on settling discord. Moreover, it is our experience that successful grouping of the student on their own accord works better than when students were assigned to groups by the course coordinators. Addressing this issue will guaranty a path in right direction in organizing a successful capstone team projects.

2. Sponsors and Industrial participation: The capstone experience should be structured in such a way that industrial participation is encouraged. The experience of Capstone in the United State when an industry provide fund for a project is the ideal. In our over ten years of capstone experience most of the funding for the projects comes from the
students with a little support from the University (100TL/team). This limitation in finances deprived us from pursuing some novel design. We are still sorting for funds through our Alumni and our graduate in industry to help finance our capstone designs team projects and to make them industry base/oriented.

3. Engineering Skills: Valuable Mechanical Engineering skills that students got the chance to further develop and use in all capstone projects include precision and accuracy in measurement, ability to perform error analysis. The software in drawing and in economic analysis. And hand held experience in the use of available equipments in the workshop and ability to think fast and correct.

4. Diversity of culture of our student: The department hosts more than 15 different nationalities as students. One big issue is the mix required for a successful team projects. Cultural differences prevent homogenous mixing a situation we are working on, our diversity has worked positively in some ways but it is still an issue we are working on. There is temptation for students from the same country to congregate and form a group. We know that working at international level involves working with people of different race, we try to make sure that a single nationality do not form a group.

5. Other course work conflict: We should not forget that the student taking this design courses are also taking classroom courses. In fact the most affected is the MENG 491, which is a zero unit course, student prefer to attend classes with units than this course. We have to arrange the MENG 491 classes in the evening when all other class must have ended. The student taking construction projects spent more time in the workshop and some of them had to miss some regular class.

6. Improved communication skills: We witnessed improved communication skills among the student taking the two design courses. Oral skills, through weekly presentations, and writing skills, through interim and final reports improved rapidly. The student economic background also improved as they were mandated to appraise their projects and getting estimated cost (for equipment and personnel) of their respective projects. In addition, all projects got students to address issues from multiple engineering disciplines, namely: electrical and computer engineering, mechanical engineering, and systems engineering.

6. Conclusion

This paper described a more than ten years of capstone design team project in Mechanical Engineering department of Eastern Mediterranean University in conjunction with assessment of ABET Engineering Criterion 3. In-depth information about the Capstone courses were provided and with limitation and success witnessed in the past ten years. A well-planned and practiced capstone design course is necessary for any engineering students that want to be relevant in place of employment.
TABLE 1: MAPPING OF COURSES ACCORDING TO SURVEY RESULTS

| Criterion 3 No: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|----------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|
| ABET Criterion 3 | MENG 104 | MENG 190 | MENG 201 | MENG 233 | MENG 245 | MENG 246 | MENG 286 | MENG 300 | MENG 331 | MENG 345 | MENG 353 | MENG 364 | MENG 375 | MENG 400 | MENG 491 | MENG 492 |
| a | An ability to apply knowledge of mathematics, science, and engineering, | - | - | - | x | x | x | x | - | - | x | x | x | x | x | x | x | x |
| b | An ability to design and conduct experiments, as well as to analyze and interpret data, | - | - | - | x | x | x | x | - | x | x | x | - | - | - | - | x | x |
| c | An ability to design a system, component, or process to meet desired needs within realistic constraints | - | - | - | x | - | - | - | - | - | - | x | x | x | x | x | x | x |
| d1 | An ability to function on multidisciplinary teams | - | - | - | x | - | - | x | x | - | - | x | x | x | x | x | x |
| d2 | An ability to function on teams | - | - | - | - | - | x | - | - | - | - | - | - | - | - | - | x | x |
| e | An ability to identify, formulates, and solves engineering problems, | - | - | - | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| f | An understanding of professional and ethical responsibility, | - | x | x | - | - | - | - | x | - | - | - | - | - | - | - | x | x |
| g | An ability to communicate effectively, | x | - | x | x | - | - | x | - | - | - | - | x | x | x | x | x | x |
| h | The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context, | - | x | - | - | - | - | x | - | - | - | - | - | x | - | x | x | x |
| i | A recognition of the need for, and an ability to engage in life-long learning, | - | x | - | x | - | - | - | - | - | x | - | x | - | x | x | x | x |
| j | A knowledge of contemporary issues, | - | x | x | - | - | - | - | - | - | - | - | - | - | - | - | x | x |
| k | An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice | x | - | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
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