2007: CONTINUES IMPROVEMENT AND QUALITY ASSURANCE IN THE CAPSTONE PROJECT AT UNIVERSITY OF PRETORIA

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Abstract

The Faculty of Engineering, Built Environment and Information Technology (EBIT) at the University of Pretoria is a leading and dynamic faculty that is one of the foremost providers of high-level intellectual capital and research in the country. The Faculty is renowned for its unique approach to innovation, its international status and links with industry.

The Department of Mechanical and Aeronautical Engineering is one of 14 departments in the Faculty of Engineering, Built Environment and Information Technology, and is the largest Department of Mechanical Engineering in South Africa. Its graduate and postgraduate students are trained to become top quality engineers, owing to the Department's internationally accepted programmes.

The mission of the Department of Mechanical and Aeronautical Engineering is to prepare engineers for success and leadership that is recognised internationally for its quality in the conception, design, implementation, and operation of mechanical and aeronautical related engineering systems.

The Department of Mechanical and Aeronautical Engineering is facing a major challenge in view of the diversity of intake of students and the constant pressure on delivering more engineers to industry in an attempt to feed the growth of the economy. In this strive to increase the number of engineers delivered to industry, quality cannot be compromised and therefore quality control systems must be put and kept in place that will ensure that the University of Pretoria will not only be under the top 500 universities in the world but will improve its position on these lists

One of the major challenges as described in this paper is to ensure the quality of work and also as important the quality of assessment of the final year capstone project.

Introduction

The University of Pretoria (UP) is committed towards fostering and promoting a climate of innovation in the belief that innovation is a significant contributor towards competitiveness,

growth and prosperity. Mindful that it has a responsibility as a trustee to a quality future, UP is shaping South Africa's engineering future. UP boasts the largest school of engineering (5000 students) in the country and a significant portion of the country's future engineers are educated in the EBIT Faculty.

The biggest responsibility towards the South African Industry is that more black and female engineers be delivered to the industry. This is necessary as the pool of students passing grade 12 with maths and science on an acceptable level remains almost constant. The net result of this is that the pool of engineers delivered can only be expanded if more black and female students are attracted to the occupation. In doing so the Faculty of Engineering and the Build Environment had launch successful programs over the last 10 years in attracting and delivering the previously disadvantage students to the occupation as can be seen in Figure 1 and 2.

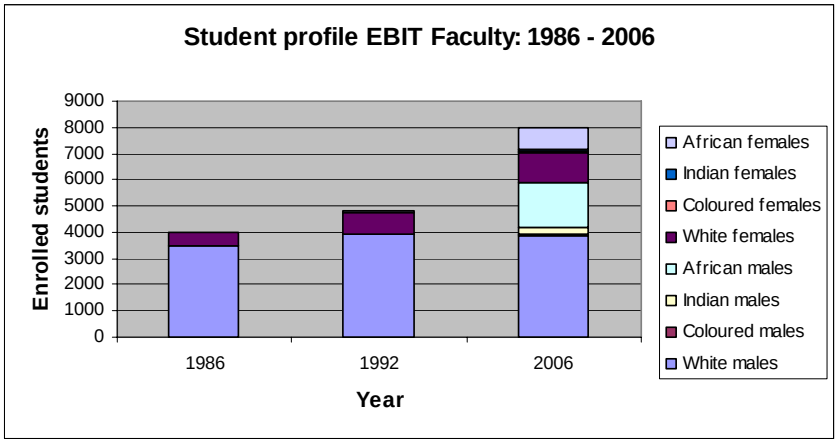

Figure 1: *Student profile of enrolled students EBIT Faculty University of Pretoria over the period 1986-2006.*

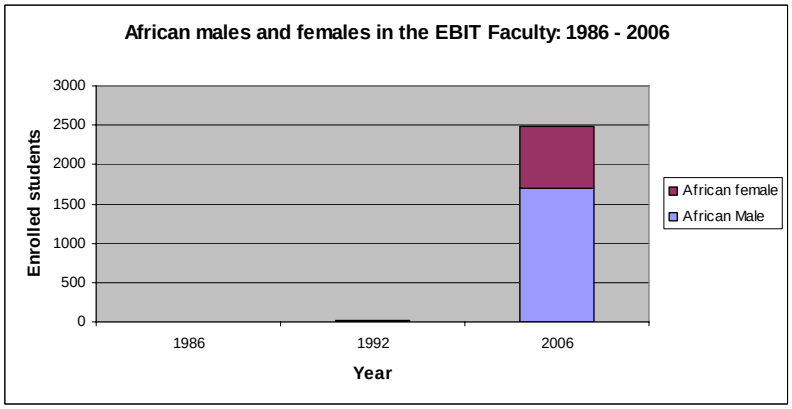

Figure 2: *Gender of black students enrolled in the EBIT Faculty University of Pretoria over the period 1986-2006.*

If this growth in numbers of female and black students can be sustained it will benefit the South African economy and engineering profession as it clear from Figure 3 (Science and Engineering Indicators 2004 and the State of Physics in South Africa) that the amount of graduates in Engineering and Science for a developing country is not big enough.

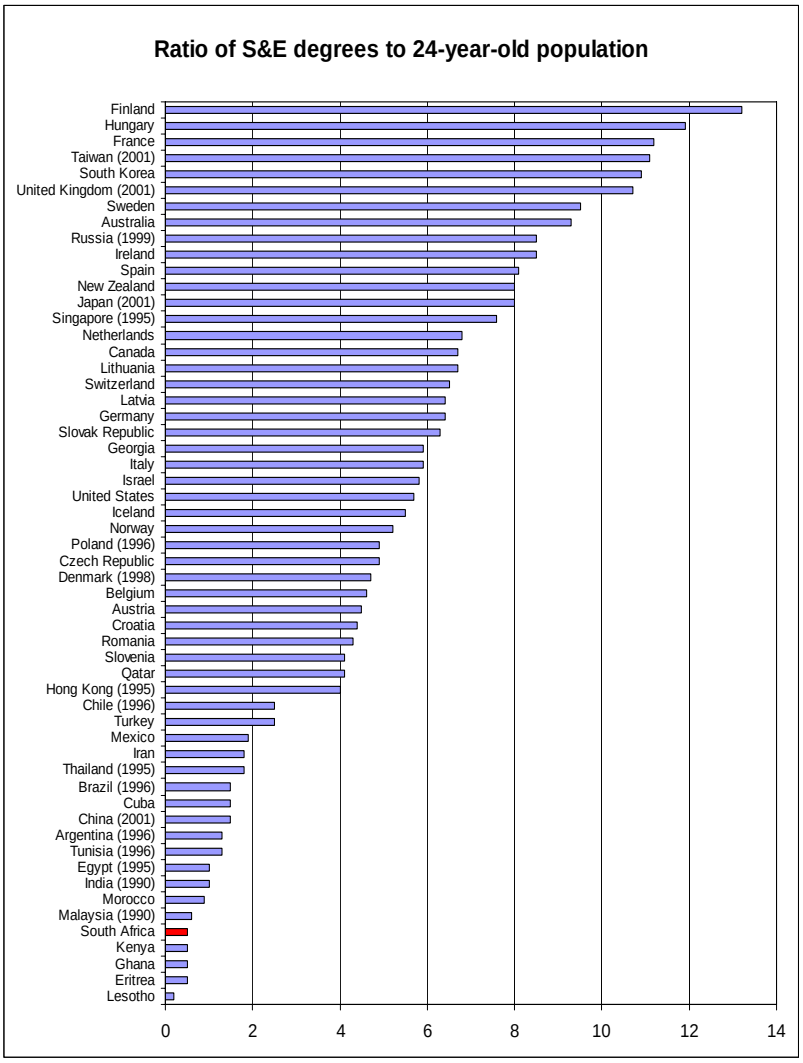

Figure 3: *Percentage of Scientific or Engineering degrees per 24 year olds for 2000, unless otherwise indicated. Compiled from Science and Engineering Indicators 2004 and the State of Physics in South Africa*

Quality of education

As South Africa is a signatory of the multinational Washington Accord, to ensure that the programme is international recognized and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of constituencies in a dynamic and

competitive environment it is necessary that all the modules offered in the program is continuously evaluated to ensure improvement and a process of good quality assurance.

The agreement also recognizes the substantial equivalency of accreditation systems of organizations holding signatory status, and the engineering education program accredited by them. The accreditation system of The Engineering Council of South Africa (ECSA) (http://www.ecsa.co.za/) is based on the accreditation system developed by the Accreditation Board for Engineering and Technology (ABET) (http://www.abet.org/). Accreditation for the engineering degrees at the University of Pretoria is done under policy document PE 61 – version 2. The comparison of Program specific outcomes of ECSA (1 – 10) and ABET (a – k) is shown in table 1.

Table 1: *Comparison of Program specific outcomes of ECSA (1 – 10) and ABET (a – k)*

ABET / ECSA	a	b	c	d	e	f	g	h	i	j	k
1					●						
2	●										
3			●								
4		●									
5											●
6							●				
7								●		○	
8				●							
9									●	○	
10						●				○	

As the University of Pretoria is also part of the CDIO (www.cdio.org) initiative the undergraduate program in Mechanical and Aeronautical Engineering have the following objectives:

1. To develop a deep working knowledge of technical fundamentals.
2. To develop a refined ability to discover knowledge, solve problems, think about systems, and master other personal and professional attributes.
3. To develop an advanced ability to communicate and work in multidisciplinary teams.
4. To develop skills to conceive, design, implement, and operate systems in an enterprise and societal context.

Quality assurance within the final year capstone project

The main focus of the final year capstone project is to integrate all the different modules offered in the undergraduate program into a well organised quality driven module where the student managed his/her own time in analysing the problem, designing and building an experimental setup and performing tests to verify the analysis done. The final milestone of the project is the report where the student must communicate the work done to the evaluators professionally.

The starting point in a process of continuous quality assurance, in the final year capstone project, it is necessary that all the topics for the final year capstone project be evaluated by a Departmental Faculty committee to ensure that all the topics given to the students are on the same level of difficulty, work content and more importantly that the following components are indeed addressed correctly within the topic:

1. Analysis component
2. Design and building of the experimental setup
3. Test and evaluation

The outcomes that are asses in the final year capstone project are:

- ECSA 2.4 (ABET b) - Investigations, experiments and data analysis
- ECSA 2.6 (ABET g) - Professional and technical communication

The assessment of the student work is done both by the study leader as well as by an external evaluator which must be a Professional Engineer from Industry. To achieve a uniform standard across the different disciplines within Mechanical and Aeronautical Engineering and between the different topics the report is evaluated according to the outcomes as defined by ECSA/ABET. The following areas are specifically addressed:

Outcome 4: Investigations, Experiments and Data Analysis

The student must be capable of applying research methods, plan and conduct investigations and experiments using appropriate equipment. The student must also analyse, interpret and derive information from data.

Outcome.6: Professional and General Communication

The student should be able to communicate effectively, both orally and in writing within engineering audiences and to the community at large. The communication should be of appropriate structure, style and graphical support.

The marking schedules for the two outcomes are shown in Table 2 and 3.

Table 2: Marking schedule for outcome 4.

	Outcome		
1	Did the student conduct his/her investigation in an appropriate and scientific manner? (15)	√	X
2	Did the student plan and conduct his/her investigation and experiment making full use of available and appropriate equipment or software? (10)	√	X
3	Did the student conduct a literature search and critically evaluate material? (15)	√	X
4	Did the student perform the necessary analysis? (15)	√	X
5	Did the student analyse, interpret and derive information from the data obtained? (25)	√	X
6	Did the student draw conclusions based on the evidence or data obtained? (20)	√	X
	Total for outcome 4 (100)		

Apart from the marking schedule for the written report it is required of each student to do a public presentation to the study leader and external evaluator from industry by means of a PowerPoint slide show in which he/she explains the problem statement, research done, analysis of the solution, experimental phase of the project and the presentation of the final data. The presentation is concluded with a proper conclusion. The presentation is evaluated as part of the final mark for outcome 6 and accounts for 33% of the final mark for professional communication. Each student must also do a poster exhibition of his/her work during the evening of the valediction ceremony. This exhibition is not optional and all the final marks are actually kept back till after the valediction ceremony to ensure that everybody is exhibiting. In failing to comply the student will fail the subject as this is part of complying too outcome 6. To assist the students in sharpening their report writing skills interim reports must be completed on pre set dates. The outcome of these reports does not form part of the final mark for outcome 6.

Table 3: Marking schedule for outcome 6 – written report

	Outcome		
1	Did the student communicate the purpose, process and outcomes of the investigation in a technical report? (10)	√	X
2	Was a literature study properly conducted and properly reported on and were the right conclusions drawn from the literature and background study? (15)	√	X
3	Is the report properly laid out, with proper language, grammar and general appearance? (15)	√	X
4	Does the average reader understand the problem and why work was done? (10)	√	X
5	Is everything defined and does the reader have a good idea what the research was all about? (10)	√	X
6	Was it a pleasure to work through the report? (5)	√	X
7	Does the neatness of the report also display the quality of the technical work? (10)	√	X
8	Are the summary conclusion and recommendation handled correctly in the report? (15)	√	X
9	Do you consider the student to be capable of properly communicating his/her work in outside industry? (10)	√	X
	Subtotal – written communication (100)		

To ensure that the technical quality of the project is to an acceptable and professional standard a 50% sub minimum is applicable to both the outcomes as showed. In case of a student not obtaining the 50% for outcome 4 it results in immediate failure and the student has to complete the module in the following year. In case of not obtaining the required 50% for outcome 6 but a final mark of 40% or above is achieved the student is given the opportunity to rectify his/her report within a given time frame. Time schedules with fixed handing in dates are laid down at the beginning of the course. The handing in dates coupled to a closing time is strictly enforced and no late reports are accepted even if it means that the student must repeat the year.

Conclusion

Quality assurance in the final year capstone project is a continuous process starting with the evaluation of the various topics from faculty members by a Departmental committee and is concluded by the final report handed in by the student. The student is guided along the way by means of regular contact with the study leader and regular progress reports. The final quality assurance check is the evaluation of the work done by an external evaluator that must be a professional engineer from industry

Reference

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