

New Concepts in Engineering Education to Meet Modern Technological and Economic Challenges - Case Studies from Wollongong and Staffordshire Universities

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Abstract: Engineering education worldwide is facing a difficult period of strong challenges from different corners. The economical, technical challenges, and misconceptions on the true meaning of engineering are some of the general factors which have contributed to the lack of interest in engineering in recent years. This trend is unlikely to improve in the short run until there would be a growing demand for engineers coupled with a radical approach to engineering education course structuring as well an improvement both in the salary levels and social standing. Political, geographical, cultural and historical factors will undoubtedly bear a variable influence to different disciplines of engineering pertinent to the changing needs of any particular discipline. Interest in engineering education has declined in recent years. This decline is caused by a variety of factors. The increasing interest in information technology and finance related courses is swaying away those students which normally opt out to engineering as a viable career. Other factors, which are case specific, required radical addressing to maintain a healthy recruitment strategy. This paper discusses various methods and techniques for attracting students to engineering and means of maintaining their interests in the course until graduation. This paper describes two approaches, one from the University of Wollongong, Australia and the other from Staffordshire University, UK in which both universities have been faced with similar challenges from neighbouring large metropolitan institutions. A number of novel approaches are described from each institution and as a result there have been an improvement in recruitment numbers as well as a reduction in attrition numbers thus allowing the students to complete their engineering studies successfully and on time.

Keywords: engineering education, inspiration, opportunity.

1. Introduction

Engineering education worldwide is facing a difficult period of strong challenges from different corners. The economical, technical challenges, and misconceptions on the true meaning of engineering are some of the general factors which have contributed to the lack of interest in engineering in recent years. This trend is unlikely to improve in the short run until there would be a growing demand for engineers coupled with a radical approach to engineering education course structuring as well an improvement both in the salary levels and social standing. Political, geographical, cultural and historical factors will undoubtedly bear a variable influence to different disciplines of engineering pertinent to the changing needs of any particular discipline.

Structuring of the engineering courses must address not only the course content but it ought to be carried out with the objectives of maintaining the students' interest to provide the essential basic knowledge of engineering. Recognising the continual course restructuring will place an additional burden on the academics, nevertheless it provides the necessary platform for future well being of engineering. It is now become a fact of the academic life, that more time is spent on lecture preparation and upgrading than a decade or two ago. The on-line interaction is influencing the level of knowledge the students entering the universities and with such high student background availability demands a greater expectations from the delivered university courses. Thus the academics are now faced with two prong challenges. From one side the demand for higher quality education, and second the courses

should not be too long and be interesting. The speed of change leaves the academic very little time to indulge in other responsibilities such as active research.

To address many issues confronting the engineering education, new ideas and new Engineering course restructuring is currently being carried out in both the University of Wollongong, Australia and Staffordshire University, UK to address a variety of issues not just the challenges of modern technology but also to deal with students of different quality and these issues are the subject of this paper.

2. Case Study 1 - The University of Wollongong, Australia

The University of Wollongong is situated in the City of Wollongong, 85 km south of Sydney. The university gained its independence from the University of New South Wales in Sydney in 1975, and since then the University's population has increased from around 2,000 in early 1980 to round 12,000 in 1999. Currently there are nine faculties, the largest is Commerce and the smallest is Engineering. In 1985 there was a sharp increase in engineering enrolment by almost three folds, this trend started to fall in mid nineties.

The following factors were considered to contribute to the increase in engineering numbers at Wollongong in mid 1980's:

- Limited number of engineering places available in metropolitan institutions.
- The metropolitan institutions were mostly situated in the centre and eastern part of the of widely urbanised Sydney city, this meant Wollongong is easily accessible from the south and west of Sydney.
- Enrolment entry marks at Wollongong were lower than the metropolitan institutions.
- The City of Wollongong is environmentally and socially acceptable to students with ample supply of cheap accommodation and beaches.
- Wollongong CBD is a short distant away from the University.
- A large proportion of migrant children whose parents formed the majority of huge migrations program in the mid 1970's were entering the tertiary education stream.
- Wollongong University has the opportunity to attract students from the southern part of the state as the University was the only university offering engineering degree south of Sydney.
- A sizable number of full fee paying students from Asian neighbouring countries choosing Wollongong to study engineering because of good marketing publicity of Wollongong made in Asia and the reputation gained by the University through the high level achievement of its academic staff.

In 1987 the number of universities in Australia was doubled from an 18 to 36 institutions. Such increase in number meant that there are now four universities in Sydney offering engineering degree courses with one institution situated mainly at the western part of Sydney which was traditionally the catchment area for Wollongong. Other factors, which affected the declined in student numbers entering the degree courses and in particular Engineering post the 1990's, are:

- The reduction of new migrant children concentration in Wollongong catchment areas.
- Decline in overseas full fee paying students entering engineering course at Wollongong.
- Increasing interest of the students in more technologically dynamic courses such as computer science and information technology.
- Metropolitan universities lowering the entry standards to attract the students and at times offering the students the university scholarships.
- The introduction of higher education fees known as HECS which has obvious effect of discouraging students away from the engineering.
- Engineering courses conceived as boring and difficult and boring as compared to more leisurely courses.

3. Case Study 2 - Staffordshire University, UK

The number of students particularly in some aspects of traditional engineering courses has been declining over the past decade for a variety of reasons including:

- Decline in traditional manufacturing industries accompanied by the growth in the service sector resulting in different job skills and educational emphasis.
- The requirement usually of mathematics and/or science or technology based advanced level or a suitable BTEC National Certificate or Diploma.

- Difficulties of attracting similar proportions of gender for example to mechanical and electrical engineering the former having an 'oily rag' image making it difficult to overcome this stereotypes particularly in parental guidance.
- Lack of role models in the media easily identified with successful engineering backgrounds which would help to stimulate interest in engineering careers.
- Job opportunities in engineering are not so prevalent compared to IT sector and this is particular relevant to mature students and women returnee's where age and experience is viewed more progressively.

Some university departments have expanded the traditional pastoral concept by introducing more proactive approaches, which include better pastoral care by regular meeting with prescribed tutor to additional tutorials in certain numerical type modules to reduce attrition rates. Alternatively departments have formulated different approaches some maybe considered natural development rather than maintain numbers such as:

- Formulation of schools from a number of engineering departments which not only provide more viable numbers for maintaining courses but offer wider range of modules particular final year allowing more designated degree routes or specialist.
- Widening the horizons by offering courses in Environmental Engineering, Information Technology or Technology programmes that include specialist interest from sports or music to telecommunications or design. Staffordshire University has pioneered developments in this area and information can be obtained from their web site www.staffs.ac.uk . Recent developments are for a proposed degree course in Simulation and Virtual Reality which are rapidly evolving technologies with application for example in accident prevention training in mineral and oil exploration.

4. Opportunity Programme in Wollongong

One of measures undertaken by the Faculty of Engineering, University of Wollongong to increase the number of students is the opportunity programme. A brief description of the programme is presented herein.

The existing entrance requirement for courses offered by the Faculty of Engineering in the University of Wollongong is a Tertiary Entrance Rank (TER) of 70% and an average of two units mathematics of 72%. This level of entrance is maintained consistently throughout all the courses offered by the Faculty: Civil, Mining, Environmental, Mechanical, and Materials Engineering.

In 1996, the Faculty of Engineering in the University of Wollongong made the decision of not lowering the standard of entrance to the courses offered by the Faculty. However, the Faculty decided to use other means of decision to select the students. In particular, there are a number of students who have a high TER, but they do not meet the criterion of mathematics. In addition, these students may be graduates of TAFE colleges with a variety level of industrial experience. A number of students of the latter group proved to have excellent capabilities. Based on these facts, the decision was made to allow a number of students to enter the courses offered by the Faculty, provided they meet some of the minimum requirements. The decision of admission is not only based on students past performance but also based on an interview conducted within the Faculty. As some of these students have deficiency in some of the aspects in the admission to the Faculty, a decision was made to provide such students with a especially tailored programme of additional coaching and tutoring. This includes:

- Conducting bridging courses in mathematics, physics and chemistry during the summer break.
- Providing additional tutoring in the first semester of the first year.
- Organising peer-to-peer mentoring.

The bridging courses were offered to all students who needed review and strengthening their fundamental knowledge in basic sciences, viz mathematics, chemistry and physics. These bridging courses are offered during the summer break before the start of the academic year. Additional tutoring is provided to all Opportunity Programme students. These include tutorials in the first semester subjects offered by the Faculty. The tutors who ran these tutorials are either postgraduate students or undergraduate students from the same Faculty with higher achieving capability. Those tutors are usually students with a weighted average mark of 75% or higher. The last measure undertaken by the Faculty is to provide peer-to-peer mentoring for students in the opportunity programme. Students with high achievement record (weighted average marks above 75%) are given the task of maintaining weekly meetings with the Opportunity Programme students. In these meetings the junior students are fostered by the senior students

and the junior students are provided the opportunity to express their views and ask for help in specific matters. In addition, the senior students act as raw models for the students in the Opportunity Programme. This mentoring programme ensures that the reduction of the rate of attrition among first year students in general and in particular students in the Opportunity Programme. Other objectives of the peer-to-peer mentoring programme is for the junior students to learn methods and techniques of time management and to equip them with study skills. In summary, this part of the programme is to provide the students in the Opportunity Programme with peer support, a much needed support at the beginning of the academic life in the University. In 1997, the opportunity programme was implemented in the Faculty of Engineering and continued during the following years.

In 1997, 92% of the students in the Opportunity Programme were from groups that are under represented in Engineering. Similarly in 1998, 83% of the opportunity programme students come from the same groups. The distribution of the different groups is summarised in Table 1. It is clear that the Opportunity Programme is providing an opportunity for students from some socio-economic groups to study Engineering. Those groups may generally be disadvantaged by not having the appropriate opportunity.

Table 1. Students in the opportunity programme

Group	1997	1998
Low-socio economic status	34%	34%
Women	6%	6%
Non-English speaking background	15%	15%
Aboriginal and Torres Islander	8%	0%
Disability	7%	6%
Rural	22%	22%

Fig. 1 shows a summary of the pass rates during 1997 and first semester 1998. In total, the Opportunity Programme students attempted 241 subjects throughout 1997 and 177 subjects in the first semester of 1998. The grades shown are High Distinction, HD which is for marks more than 85%; Distinction, D which is for marks in the range 75 and 84; Credit, C which is in the range 65 and 74; and Pass, P is given for marks between 50 and 64. The grade Pass Conceded, PC is given to students who achieve a mark between 45 and 49. Finally, the Fail, F mark is given to students who achieve a mark lower than 44. It is to be noted that the number of conceded pass that a student is allowed during their studies in the course should not exceed one sixth of the total load.

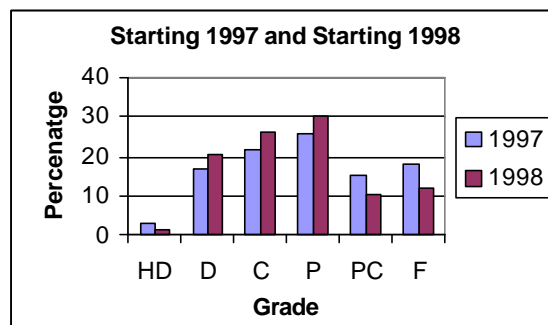


Fig. 1. Comparison of opportune programme students performance in 1997 and 1998

As shown in Fig. 1, the failure rate decreased from 18% to 12% and students with conceded pass grades have also decreased from 15% to 10%. The percentage of students achieving Pass, Credit, and Distinction have all been increased. The only grade which was slightly lower was the High Distinction grade which was lowered from 3% to 2%. In total the percentage of students passing the whole subjects increased from 82% to 88% in 1998 compared to the 1997 results. This indicates that the method of conducting the Opportunity Programme is improving and is having better response from students.

The existing system of recording drop out rates is based on recording any withdrawal from a course. For example if a student withdraws from any course offered by the Faculty, this is counted as drop out even if the student enrolls in another course within the University or even within the same Faculty. Table 2 presents the rate of attrition

in 1997 within the students enrolled in the Opportunity Programme and compares it with the attrition rate in 1998 in the same group. Currently, there is no mechanism to know the exact destiny of the drop out students, however it is known that a number of students left Wollongong to the bigger central universities. In such cases, the Opportunity Programme served as a foundation course for the students and based on their performance in Wollongong, other universities were prepared to accept those students. From engineering point of view there is no loss as new students are gained to the profession, however the Faculty of Engineering in Wollongong is losing after investing considerable amount of resources and time in preparing these students. It can be noted that the rate of drop out in 1998 is considerably less than that in 1997. The main reason behind this is the Faculty invested more time and resources during this year and kept close monitor for all students in the first year and in particular the Opportunity Programme students.

Table 2. Rate of attrition

Year	Rate of Drop Out
1997	20.0%
1998	9.9%

5. Conclusions

The current national decline in the number of students applying to do Engineering is holding. Measures such as the Opportunity programme in Wollongong and others need to be taken in order to maintain the Engineering Profession.

The opportunity programme in Wollongong proved to be a viable and excellent measure to increase the number of students in engineering and at the same time to provide the opportunity to members of the community that deserve such opportunity to improve their education and hence their professional life.

Other measures are also discussed in this paper and those and other measures need to be adopted to increase the number of students in engineering and hence to increase not only the quantity but also the quality of students and hence the graduating engineers.