A Strategy for Increasing Undergraduate Power Engineering Course Enrolments

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Abstract

Over the last decade student enrolments in electrical power engineering subjects at the University of Canterbury have been falling. This paper discusses changes in courses designed to stimulate interest in power engineering. One significant change has been to introduce modern applications of electrical power engineering into the compulsory Year 2 courses. A number of other strategies, such as use of practical assignments to stimulate interest, team teaching, industry relevant lectures and fields trips have also helped increase the number of students enrolling in power engineering courses at the University of Canterbury.

1 Introduction

Since 1994 there has been a reduction in the number of students taking optional electrical engineering courses in power systems, electrical machines and power electronics at the University of Canterbury, New Zealand. The decline in power engineering student numbers is not unique to New Zealand but has also occurred in North America and Europe [1][2]. This paper documents the changes made to the electrical engineering curriculum to stimulate more student interest in these subjects and to ultimately increase the number of students selecting optional electrical power engineering courses.

If electrical engineering education is looked at from an international perspective then there are many different stages in an undergraduate degree programme in which electrical engineering subject areas are introduced. Based on a 1996 survey of power electronic and electrical machine courses in North American and Australasian universities it was found that these courses are taught in different levels of detail at the undergraduate and postgraduate levels [3]. It was found in North America that electrical machines is usually a required part of the undergraduate program, but that power electronics is optional, and in some cases only offered at a postgraduate level. This is in contrast to Australasia, where power electronics often forms part of the required course content at the undergraduate level. These two aspects, the dominance of traditional undergraduate electrical machines courses in North America and the dominance of the general undergraduate power electronics course in Australasia, provide a basis to develop a strategy to increase enrolments. 93% of universities in Australasia offer at least one undergraduate power electronics course, whereas the equivalent course is offered by only 39% of North American universities. Power electronics is perhaps the most recent power engineering discipline and it pervades all modern applications and advances in power systems and electrical machines. Student perceptions are that power electronics is a new and exciting technology, as opposed to traditional electrical machines and power systems that are both considered well established with little scope for innovation. By spreading power electronics throughout our courses we figured that students' interest could be restimulated. Other strategies have also been implemented and these are discussed at various stages in the paper.

2 Course Structure

The undergraduate electrical and electronic engineering course structure at the University of Canterbury is a 4 year program with a common intermediate year for all engineering disciplines, followed by three professional (or specialist) years. This structure is presented in Figure 1. Year 2 of study is compulsory for all students and the students undertake three core electrical and electronic engineering subjects of Circuits and Systems, Electronics and Electrical Technology. In addition they undertake courses in Mathematics, Engineering Design, Computing and Mechanics. In Years 3 and 4 the students take one compulsory subject, a Design course in Year 3 and an individual project in Year 4. Other than that the students are free to select 9 subject options in Year 3 and 5 options in Year 4. Allowing students free choice in their subjects has been in place since 1990. Prior to this students were only permitted a very limited range of choice in their Year 4 of study.

The use of subject options result in students selecting subjects that they are most interested in or ones that they perceive will get them jobs. Today, the courses that attract most interest and student numbers are in the areas of communications, signal processing and computer engineering. At the University of Canterbury the course structure can not be changed to force students to take electrical power engineering subjects, therefore to increase students numbers in this area it is the course content that must be changed to interest students in taking these courses. To do this the course content in the three professional years needs to show that the electrical power engineering subjects have modern content, even though some of them have been around for 100 years. The students need to also see that industry requires graduates with the traditional electrical engineering skills together with modern skills such as computing. It is shown in this paper, based on experiences at the University of Canterbury, that it is important for the students to be motivated and interested in electrical power engineering subjects at the introductory Year 2 compulsory courses.

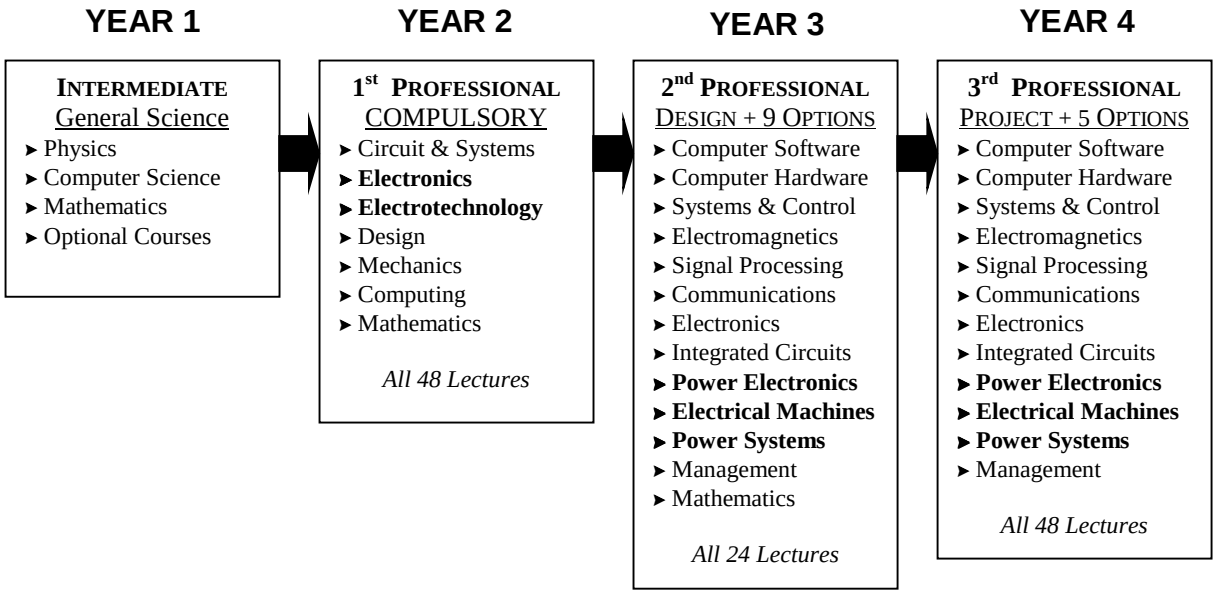

Figure 1: University of Canterbury Electrical & Electronic Engineering Course Structure

3 Student Numbers in Electrical Power Engineering Courses

The percentage of Year 3 students undertaking electrical power engineering subjects compared to the total number of students enrolled in that year has been steadily falling since 1991 as shown in Figure 2. The number of Year 3 students reached a minimum in 1997. It is important to note that if the students do not take the electrical subject at Year 3 it is very unlikely that they will be allowed to enrol in the Year 4 course. Therefore the number of Year 4 students reached a minimum in 1998. Since 1998 the student numbers in Year 3 undertaking electrical power subjects has started to rise again.

Some of the reasons for this increase are changes in the curriculum and methods of teaching. Details of these changes are discussed in Section 4.

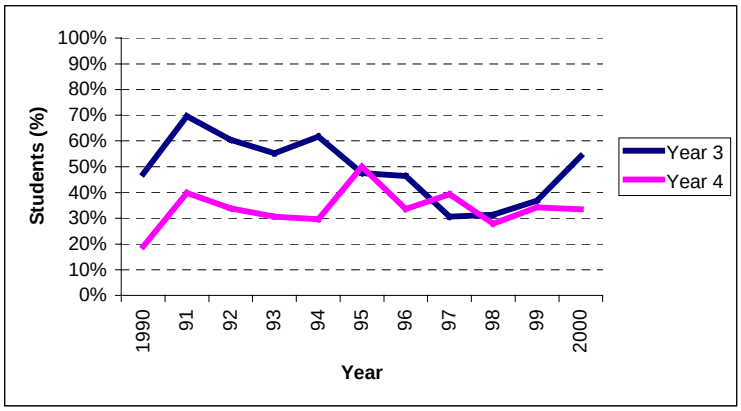

Figure 2: Percentage of Students in Year 3 and 4 Electrical Power Engineering Subjects

4 Strategies to improve numbers

A way to change student perceptions is to introduce to them modern electrical applications. At the University of Canterbury these ideas have been introduced into the compulsory courses so that all students are exposed to them before selecting options. The changes that have taken place in the course material of each of the three electrical engineering subjects (power electronics, electrical machines and power systems) to help stimulate interest in these subjects are now discussed separately.

4.1 Power Electronics

The area of power electronics has had a downward trend of student numbers from 1991 to 1997 as shown in Figure 3. In the Year 2 Electronics course a block of lectures on power semiconductor devices was introduced in 1989. The idea behind this was to expose the students to the use of power devices and some applications. In 1997 these lectures were integrated throughout the course rather than being taught as a separate block of lectures. This is because power electronics is the use of electronics in higher voltage and/or current circuits. By integrating the lectures, the power devices are treated the same as small signal electronic devices and the students see no differences in the usefulness of these devices. In addition, lectures are given on some of the interesting applications of power electronics, such as electric vehicles and switching power supplies. In showing these applications, products produced by New Zealand industry are discussed to show that this technology is relevant and that there are local companies producing power electronic products. From Figure 3 it can be seen that these changes have resulted in an increasing number of students undertaking power electronics in Year 3 from 49% in 1997 to 78% in 2000.

Since 1997 we have also implemented a team teaching strategy in Year 3 power electronics. This strategy gives balance to the way in which material is presented and the students are exposed to a range of topics without bias. Currently the course is taught 50% by a specialist in power system applications and 50% by a specialist in industrial applications. The material up to 1997 was also presented as a course of core material with little recourse to applications of the technology. Students found this approach dull and uninteresting, so in 1997 we have made a more conscious effort to discuss applications and to point to where the technology leads.

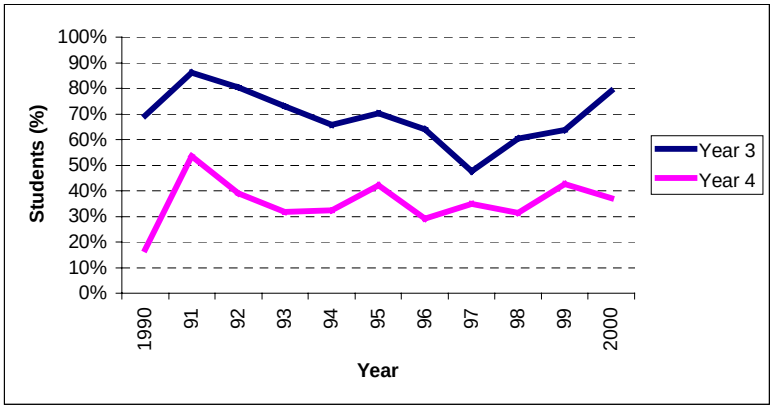

Figure 3: Percentage of Students taking Power Electronics

This strategy, including team teaching, has been followed through to Year 4 power electronics and the emphasis at this level is primarily on applications. To enhance the application emphasis, the course assessment contains a 25% practical team assignment. In this assignment the students have to design a switching converter to match a 10W solar panel to a DC permanent magnetic motor which drives a model radio controlled vehicle [4]. The assignment gives the Year 4 students an opportunity to construct their own power electronics circuit, learn some of the practical implementation problems and use their knowledge in some useful way. As part of the assessment, the students have a public race to determine the fastest vehicle. The winning team may in fact not necessarily have the most efficient and innovative converter. This may be because the team did not consider aspects such as the mechanical robustness and electrical reliability of the converter. Holding a public race is a good way to highlight the practical use of power electronics to the Year 2 and 3 students. By doing this it is hoped to encourage more students to take power electronics all the way to Year 4.

4.2 Electrical Machines

The electrical machines course in both Years 3 and 4 has had very low student numbers. From Figure 4 it can be seen that no more than 25% of the Year 4 students would take this subject and on average it has been between 10 to 15%. The Year 3 level reached a minimum of 17% in 1998.

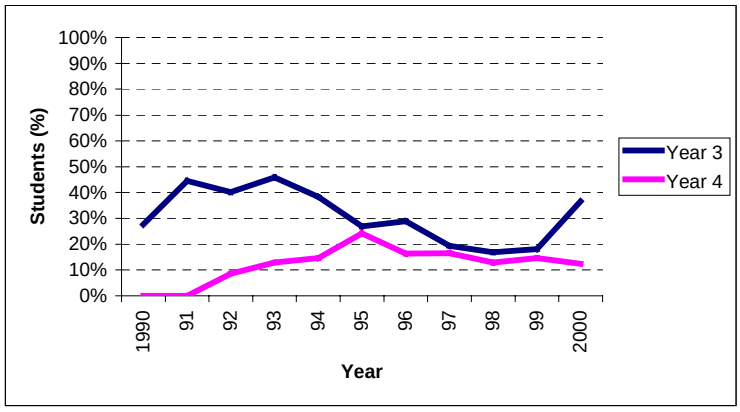

Figure 4: Percentage of Students taking Electrical Machines (Year 4 course not offered in 1990/91)

Traditionally these specialist Year 3 and 4 courses were based on the design of electric motors and transformers. To expand the subject area and to add in a modern emphasis to this course, a block of lectures on motor drives was added. This was initially introduced at the Year 4 level. In this lecture block AC motor control principles are discussed. Since then a block of lectures has been introduced into Year 3 on the control of DC machines and in 1999 for the first time 6 lectures out of 48 were devoted to the general area of motor control at the compulsory Year 2 Electrotechnology course. These included two lectures on permanent magnetic DC motor control using a chopper, three lectures on how to control AC induction motors, and a final lecture on an electric vehicle application of an AC motor controller.

The lecturer who gives the 6 motor control lectures in this course is the same lecturer as in the Year 2 Electronics course. By using the same lecturer the students then start to see the overlap between modern electronics, computer control systems, power electronics, magnetics and motors. It can been seen from Figure 4 that in 2000 there has been a large increase in the number of students taking the electrical machines course in Year 3.

In the 2000 Year 4 course, a practical assignment of building a coil gun was introduced. In this assignment the students had to design a gun that fires aluminium rods using only the 50 Hz mains supply. The students found this assignment interesting and a challenge. A public "shoot off" was held to determine the team with the gun that fires the furthest. This event attracted a large number of Year 2 student spectators. This assignment showed them that you can have fun in an electrical machines course and that the course content is not just about conventional motors and transformers.

4.3 Power Systems

In the Year 2 Electrotechnology course the area of power systems is not taught directly. Instead, when the principles of, for example, electric fields and transformers are taught, the examples used come from the power system. Changes have also occurred in the Year 3 course to make it more relevant. Traditionally the Year 3 power systems course took a very analytical approach to the teaching of power systems. This course has been changed in such a way to now have half the course with an application-oriented focus with topics such as earthing, protection systems, and high voltage measurement and power system management.

The department runs a voluntary 4-day power systems field trip in which 40 students are taken to an aluminium smelter, an underground hydro power station, a HVDC converter terminal and a large earth-dam power station. In the past this trip was available only to Year 3 students and in particular the students taking the power systems course. In 1998 for the first time the power systems trip was targeted to the Year 2 students. In the last two years since offering this trip to Year 2 students there has been a large increase in the number of students undertaking power systems at Year 3 as can be seen in Figure 5. The power systems trip allows the students to speak to electrical power engineers and find out what they really do.

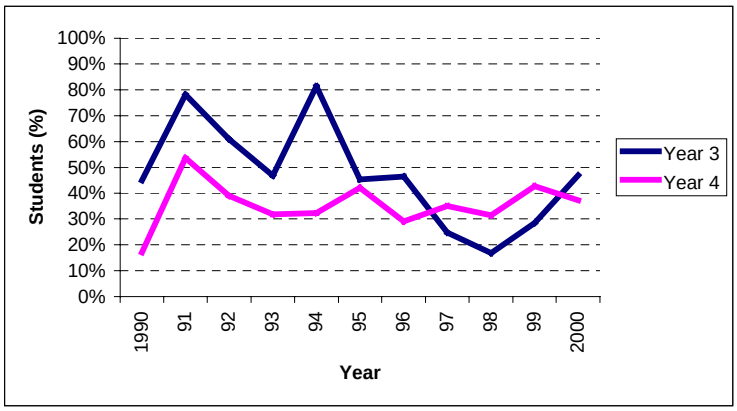

Figure 5: Percentage of Students taking Power Systems

5 Summary of Strategies

To increase the enrolments in our electrical power engineering courses, we at the University of Canterbury have

- integrated basic power electronic devices and application lectures in the Year 2 electronics course
- introduced a 6 lecture block of motor drives into the Year 2 electric technology course

- restructured the Year 3 and 4 electrical machines course to include motor drives and other non-conventional topics
- team teaching in each power course
- added practical assignments, such as a solar car race, as part of the course assessment
- added application and industry relevant lectures
- encouraged Year 2 students to participate in field trips

It is difficult to determine if any one of these strategies has had any particular influence on the increasing enrolments. However, overall the use of these strategies has increased the number of students taking electrical power engineering courses in Year 3. We are confident that this should in turn increase the number of Year 4 and postgraduate students taking power subjects in future years.

6 Conclusions

The overall thrust of the changes has been to introduce the modern technology used in electrical engineering to the students early in their studies in Year 2. By making these courses seem relevant to the modern world and by showing them that there is a demand for these kinds of engineers has helped increase the overall number of students choosing electrical power engineering subjects as part of their degree program. In addition the course content in Years 3 and 4 has been redeveloped to provide a balance of core material and applications. Team teaching is now employed in all the electrical power engineering courses with specialists teaching their topics of interest. The enthusiasm of the teaching staff resulting from teaching their subjects of interest also helps to stimulate the student's interest in power engineering. At this stage it is still too early to say if these changes will produce a continuing long term improvement in the number of students taking electrical power engineering subjects. If the initial trends continue then there is a positive future for power engineering at the University of Canterbury and the profession in general.

7 References

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