

# ELECTRONIC ENGINEERING EDUCATION - AN IRISH PERSPECTIVE

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This paper describes the current approach to electronic engineering education in the School of Electronic Engineering at Dublin City University. Since the first student intake in 1979, the University has developed a range of programs to suit the needs of Irish industry, from the B.Eng degree (with single subject certification) to masters and doctoral programs with research and coursework options. In addition, the School of Electronic Engineering is committed to providing Continuing Engineering Education (CEE) which, for the most part, is integrated with the full time taught courses. Some attention is paid to the industrial training component in the undergraduate program which has been a controversial issue in Irish universities. In addition, the position of graduates within the EC is examined.

## INTRODUCTION

Dublin City University was originally founded as the National Institute for Higher Education, Dublin (NIHED) in 1978. Together with her sister Institute in Limerick (NIHEL) (founded in 1975) the objective was to provide a range of courses and programs which would directly serve the needs of Irish industry. To this end, both NIHE's developed along the lines of technological universities and were granted university status in 1989 (as Dublin City University (DCU) and the University of Limerick (UL)). Both Universities, while being separately autonomous, provide courses covering engineering, the applied sciences, marketing, business studies and modern languages.

The other Irish universities, which comprise the National University of Ireland with Colleges in Dublin (UCD), Cork (UCC) and Galway (UCG) and the University of Dublin (Trinity College) all provide 'traditional' degree programs in electrical and/or electronic engineering. In addition two other technical colleges provide degree courses in electrical and electronic engineering. The courses on offer in the School of Electronic Engineering at DCU were tailored with the specific needs of Irish industry in mind (as perceived in the 1980's) and strong links with industry are maintained through the industrial training program (INTRA), industry-sponsored R&D and the involvement of engineers currently employed in Irish industry with part-time (CEE) programs available within the School. In addition, some special options at both the undergraduate and postgraduate level are taught by industry-based engineers. These close links with the industrial sector maintain an awareness of the requirements for a graduate entering Irish industry and provide a direct input into the annual program review process. The feedback from past graduates also provides a valuable source of information.

The general objectives of the programs in Electronic Systems are as follows:

- B.Eng** Provide a sound base of electronic engineering concepts with significant input from mathematics and the pure sciences. The course has a heavy emphasis on design and a number of application oriented specialisations are nominated in final (4<sup>th</sup>) year.
- M.Eng (course)** Allow further in-depth specialisation in specific application areas. This program is fully modular and allows either tight (by taking a number of related topics) or broad (by taking a number of more diverse topics) specialisation to be achieved, as desired.
- M.Eng & Ph.D (res)** Provide the opportunity to pursue pure and applied research in various aspects of electronic systems - often done in collaboration with an outside company.

As well as these basic building blocks, a number of subcomponents and combinations are possible, including and integrated B.Eng/M.Eng, Single Subject Certification and a Graduate Diploma in Electronic Systems. An overview of the courses offered is shown in Fig.1, with the connections to the CEE program illustrated in Fig.2. Individual components are discussed in more detail in the following sections.

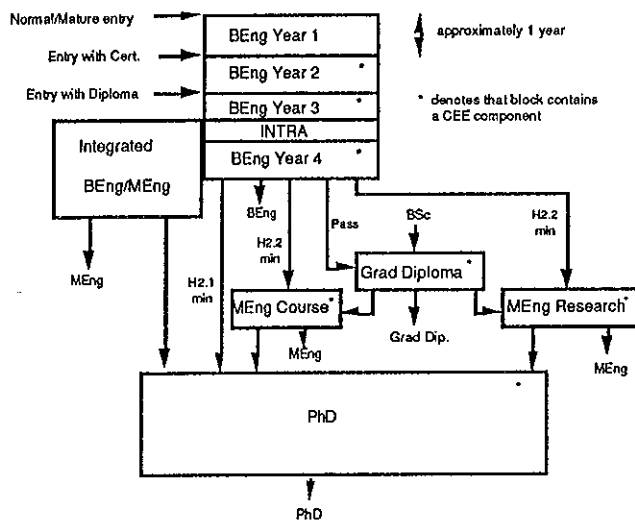


Fig.1 Overview of Electronic Engineering Program

Full Time Program	CEE Options
BEng	1. Part Time BEng 2. Single Subject
Graduate Diploma	1. Part Time Grad. Diploma 2. Single Subject
Coursework MEng	1. Part Time MEng 2. Single Subject
Research MEng	Part Time MEng
PhD	Part Time PhD

Fig.2 Summary of CEE Options

## THE B.ENG PROGRAM

The B.Eng program provides the cornerstone upon which electronic engineering education at DCU is based. It is relatively traditional in structure, progressing the students from the basic sciences and concepts in first year to specialisation within a number of options in final year. Design skills are encouraged from Year 1 and the course contains a significant amount of project work.

## Entry Levels

Normal entry to Year 1 is on a strictly competitive basis with a number of places reserved for mature students. Normally, the number of applicants exceeds the number of places by a significant factor (e.g. 3-4 to 1). Approximately 70 first year places are available every year. Entry to subsequent years of the program is available through possession of suitable qualifications and a screening process with interview. Typically, applicants holding a National Certificate in Electronics (two years of full-time study at a Technical College) would be admitted to second year, while holders of a National Diploma in Electronics with 'distinction' (three years) could be admitted to third year. This 'staged' entry procedure provides a mechanism for qualified technicians to transfer to a degree program, either directly or after some time working in industry. Experience with this type of entry has been very favourable, with the slight deficiencies in the more mathematical subjects being compensated for by strong motivation and enthusiasm.

## Subject Options and Final Year

Coursework options are only allowed in Year 4, although some extra orientation may be achieved through appropriate choice of project work (Years 3 & 4). Students choose two options from AI, Communications, Control, DSP, Power Electronics and Microelectronics with the balance of subjects being made up of core subjects (Communications, Control and Software Engineering) and a multi-component subject termed Electronic System Design (contains analog, digital and micro-electronic components with a further section on reliability). ESD has an associated design laboratory and a significant individual project is undertaken in final year. Mathematics is included as a compulsory 'option'. The final mark is evaluated according to the the following weighted sum:

Core	15 %
Electronic System Design	20 %
Maths and Options	30 %
Design Laboratory	5 %
Project	20 %
Year 3 Contribution	10 %

## Project Work

In addition to a standard laboratory program, project work is featured in all years of the BEng programme. The types of projects vary from small group-type projects to extended individual projects, covering a spectrum of subject areas. In Year 1, the design ethic is engendered in students with an exercise to (ergonomically) design a domestic telephone set. These are individual projects which promote their creative skills and feature construction using a polystyrene medium to evaluate the design.

In Year 2, students are involved in group exercises to develop an economically-viable business idea and in Year 3, group projects form an important part of instrumentation and system dynamics courses. The final year project (which involves a commitment of 6 -> 10 hours per week) is a significant exercise which ideally involves a combination of design, hardware and software skills. This and the Year 3 instrumentation project are selected from a range of titles by students and where possible, are carried out in association with an industrial company. Many Year 4 projects find their source in the industrial training program. The mark awarded for Year 4 projects is made up from a number of evaluation methods which include report (theses) quality,

continuously assessed performance, AV presentation and an interview. The contribution of project marks to the overall final year grade is equivalent to two options (see last section).

### Industrial Training (INTRA) Programme

The INTRA programme consists of a six month period which students spend on secondment in industry. At DCU, the Office for Industrial and International Affairs (OIIA) maintains a register of companies who participate in the scheme and arrange interviews for students with the companies. The students compete against each other for their chosen positions, based on a job specification provided for each position. These job specifications are vetted by the OIIA prior to the interview stage to ensure that the training/experience which the job entails will be of benefit to students. In addition two visits by the student's academic tutor is made over the course of the INTRA placement to ensure that the placement is beneficial to both employer and employee, with a report being submitted to the OIIA. Normally, it is possible to find placement for all students, but in exceptional cases students may be employed by the School to develop pieces of laboratory equipment or participate on an industrially funded research project. One exception to this may be students opting for the integrated BEng/MEng program, in which case research work may be undertaken.

The INTRA program is implemented at the end of Year 3 (consisting of only two three-month terms) at which stage the students have a reasonable level of expertise and in general, perform useful work on their placement after an initial settling-in and familiarisation period. The response from companies is generally very positive, who see the INTRA program as an opportunity to get a (relatively inexpensive) short-term input to a particular area which may be outstanding due to the other commitments of the workforce. Some employers also use the INTRA placement as an advertising medium, with the intention of attracting graduates in the following year. An obvious advantage of employing a graduate who has already spent their INTRA with the same company is the familiarity the graduate has with the specific application area and the extended opportunity which the company has had to evaluate the graduate.

Students reaction to INTRA is, normally without exception, very positive. The benefits they gain include (a) experience of the engineering interview process, (b) an opportunity to evaluate a particular company and application area and to compare their experiences with those of other students, (c) an income over the Summer months and (d) a sense of motivation and direction for their final year with the possibility of working on a final year project resulting from their INTRA placement.

Some educators from other institutions claim that integrated industrial training causes students to become 'blinkered' to a specific company, industry or application area. At DCU, however, experience has suggested that this effect is more than offset by the advantages itemised in the previous paragraph.

### POSTGRADUATE PROGRAMS

Courses leading to three postgraduate qualifications are available - Graduate Diploma in Engineering (Electronic Systems) and MEng and PhD in Electronic Systems. Access to these courses depends on the level and/or type of primary degree held. Those with H1 or H2.1 in EE may progress to the PhD program, graduates with honours EE degrees may take the MEng course and graduates with Pass EE or degrees in related disciplines (e.g. Physics) may enroll on the Graduate Diploma course. In addition, transferral between postgraduate programs is possible (see Fig.1).

### PG Diploma and MEng (Coursework)

This combination program is entirely modular, with 20-hour courses, 30-hour course and 6 month project components. The 30-hour courses (with two eight hour assignments) lean more towards fundamental engineering subjects (e.g. linear/nonlinear systems theory) whereas the 20-hour courses (with two six hour assignments) are more applications oriented (e.g. speech processing). Where possible, prerequisites for courses are avoided, allowing students the fullest possible choice. The combination of course requirements for Grad. Dip. and MEng are summarised in the following table:

Award	No. of 20 hour courses	No. of 30 hour courses	Project
Grad. Dip.	0	5	Yes
Transfer	1 (+3)	4	Yes
MEng	3	4	Yes

The 'Transfer' option requires students to take one 30H and four 20H courses and project. Having attained a sufficient standard in these components, the student has the option of graduating with a Grad Diploma or taking a further three 30H courses and obtaining an MEng. This route normally takes one and a half years as opposed to the normal one year for MEng (and Grad Dip.). These modular courses, which allow 'topping-up' of skills in specific areas are very popular, both on a full- and part-time basis.

### MEng and PhD (Research)

These are traditional research programs normally lasting one and a half and three years for MEng and PhD respectively. While little difficulty has been experienced in attracting high quality graduates for MEng programs (both coursework and research), PhD candidates are difficult to attract. One explanation for this is that graduates perceive the MEng as enhancing employment opportunities whereas the return on a PhD is not considered worthwhile, bearing in mind the relatively small percentage of Irish industry which is actively involved in R&D. Where possible, research programs have industrial relevance or are industrially funded.

### ACCREDITATION/COMPATIBILITY ISSUES

The BEng has been accredited by the Institution of Electrical Engineers (IEE) and the Institute of Engineers of Ireland (IEI). It is similar to other degree courses in engineering offered in other Irish universities in its four year duration and honours status. However, the normal engineering qualification in Continental Europe (e.g. Germany) takes five years, while some universities in the UK now offer a three year honours program. Many Irish engineering graduates find employment in Continental Europe, the UK and the USA, and while it is not the policy of the School of EE to export graduates, attempts have been made to provide courses which are compatible with their European counterparts. This has increased relevance with the existence of the European Community (EC).

One outcome of this train of thought is the Integrated BEng/MEng. Under this program, students follow the normal BEng course with the exception that the INTRA component and final year project are geared towards a research project which is continued in the fifth year and students graduate after five years with an MEng. This is 6 months shorter than the conventional route to a research masters.

## THE CONTINUING ENGINEERING EDUCATION (CEE) PROGRAM

CEE opportunities are provided to allow engineers or technicians working in industry to update their skills in either a full-time or part-time mode. All of the CEE programs are integrated with the normal full-time courses which minimises the extra teaching overhead and allows a relatively wide range of courses to be offered.

### Single Subject Cert. and Part-Time BEng

In addition to the facility for transferring to the full-time BEng programme, technicians in industry are also offered the possibility of taking individual courses on a part-time basis. Courses offered on this basis are scheduled for 8->10am in the mornings and 4->6pm in the evenings with laboratory and project work carried out in the evening and Saturdays. Obviously, this limits the availability of the courses to technicians who work in Dublin (pop. 1 million) and requires some time commitment from employers. Candidates may elect to just take one or a couple of topics which are directly relevant to them (and obtain Single Subject Certification) or may follow a flexible program of building up courses towards obtaining a BEng. A BEng course taken in this manner nominally takes four years after direct entry into third year. Some prerequisite study courses must be undertaken in the Summer prior to entry if the BEng option is being followed.

### Graduate Diploma and MEng (Course)

Engineers in industry naturally have the option of spending a year of concentrated study at DCU to obtain a postgraduate qualification by course and thesis. However, a two year option is also available which involves substantially less commitment. In the part-time (two year) mode, students attend lectures all day Wednesday with the associated assignments (many of which are computer-based) and project being undertaken in the students own time. Many part-time students have access to microcomputers in their own workplace (or may receive a commitment from their employer in this regard) which removes the need to spend excessive amounts of time on campus. The lecture day requires a commitment from the employer, but allows engineers from quite a distance from Dublin to participate in the program. Approximately half of the thirty places on the GD/MEng are currently filled by part-time students.

### Part-Time MEng/PhD

Because of the flexible nature of a research programme, it is normally possible for any engineer in industry to undertake an MEng or PhD by research. In some cases, employers are willing to allow the candidate one free day per week which would normally be spent on the campus with access to supervision and other facilities (library, computing, laboratory, etc). Many of the projects undertaken in this mode originate in the candidates own workplace which gives the employer a return on any time which he allows the candidate in the pursuit of the research. The ratio of full-time research students to those operating in part-time mode is usually about 3:1.

## CONCLUSIONS

The electronic engineering programs at DCU attempt to provide students with the basic skills and training required to be effective in Irish industry. In addition a number of options are available which allow graduates to obtain postgraduate qualifications, both by coursework (with thesis) and thesis alone. A continuing engineering education program is integrated with the normal full-time courses, providing a number of options for engineers and technicians working in industry at minimum overhead to the School.