

Engineering School Trinity College Dublin Strategic Plan 2005-2009



Summary

1. Introduction

The School of Engineering at Trinity College was formed in 1841 and is one of the oldest Engineering Schools in the English-speaking world. Since its foundation, Engineering in Trinity has been at the forefront of technological progress. Originally focused on Civil Engineering and specialising in transportation infrastructure in the 19th century, engineering at Trinity in the 21st century continues at the forefront of research in contemporary topics including digital media and communications, biomedical and aerospace engineering, manufacturing and management, structural design, and energy, transport and environmental engineering.

At present, the School consists of three Departments;

- Civil, Structural and Environmental Engineering;
- Electronic and Electrical Engineering;
- Mechanical and Manufacturing Engineering

The School runs accredited undergraduate degree courses in Engineering together with postgraduate degree and diploma courses. In addition, all the departments offer opportunities for higher degrees by research. The School has over 40 full-time academic staff with 600 undergraduate and 300 postgraduate students.

2. Mission Statement

The Strategic Mission of the School is the pursuit of excellence in teaching and research in Engineering with the central aim of producing graduate engineers with a capacity for independent thought in problem solving, creative analysis and design.

To achieve this, we must:

- instil in students an enthusiasm for Engineering and its art and practice;
- teach the engineering science and mathematics which underpin the subject areas of Engineering;
- demonstrate the application of these principles to the analysis, synthesis and design of engineering components and systems;
- encourage students to exercise critical judgement, to work in teams and to develop the communication skills necessary to make written and oral presentations of their work.

These objectives are underpinned by :

- undertaking both basic and applied research;
- provision of advanced facilities for students to undertake graduate research degrees;
- the development of academic staff in teaching and research by ensuring that adequate resources are available to assist them;
- ensuring that the research work is of the highest international standard by participation in international fora and publication in learned journals.

We are committed to meeting :

- the requirements of the relevant professional institutions;
- the needs of Irish, European and Worldwide industry .

3. National and International Context

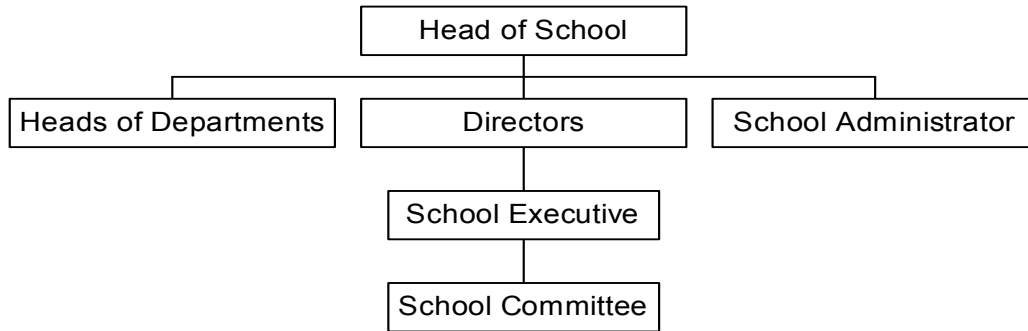
The Engineering School at Trinity College has a significant reputation for both its teaching and research. At undergraduate level, the School currently runs two degree courses, the B.A.I. (Baccalaureatus in Arte Ingeniaria - Bachelor in Engineering) and the B.Sc. (Ing) (Baccalaureatus in Scientia Ingeniaria) in Engineering with Management. For the former, the quality of the incoming students is very high with a current cut-off of 440 points at Leaving Certificate and a median of over 500 points with an intake of 180 students. Graduating students obtain employment in a very wide sector, from Engineering in all its forms to finance and business. In addition, about 25% of students pursue further education both in Ireland and abroad. Of these, quite a number have obtained scholarships to the best universities in the US.

From a research perspective, the School has a considerable international reputation in a range of areas including Bioengineering, Transport, Energy and Environmental Engineering, Digital Media, Telecommunications and Materials and Manufacturing. These areas have attracted substantial research funding and have produced a significant number of top class publications over the past five years. With a current complement of 46 academic, 20 technical and 10 administrative staff, the School is quite small by international standards. It is anticipated that we will expand these numbers by 25% over the next 5 years. This will be achieved by the development of significant activity at graduate level including the establishment of a Graduate School and by increasing the numbers of graduate students.

4. Governance

The School is led by the Head of School together with the 3 Directors (UG Teaching and Learning, PG Teaching and Learning and Research) in consultation with the 3 Departmental Heads. There is an Executive Committee, which acts as the Board, a School Committee and a Management Group.

A schematic of the Governance Structure is given in the figure below.



Schematic of School Management Structure

5. Research

5.1 Introduction and Current Status

The School of Engineering accommodates a wide range of research interests, with much of the activity spanning the three departments. The research conducted within the School is diverse and includes mathematical modelling and experimental measurement-based work requiring expensive equipment. Much of the work is collaborative with other Schools in College and with national and international partners. Several research groups are recognized as international leaders in their fields; these groups are active in areas such as bioengineering, digital media, energy, transport and environment. There are currently two major research centres located within the school: the Trinity Centre for Bioengineering and the Centre for Transport Research and Innovation (TRIP), both funded under the PRTL. Staff from the School of Engineering also contribute significantly to the Centre for Telecommunications Value-Chain Research (CTVR), the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) and the Trinity Consortium on Ageing.

The Centre for Transport Research is the national leader in transportation research and TCD is second only to UCD in environmental research. Ten leading academics from within the School, in addition to a further five from outside, are involved in the PRTL Centre for Transport Research (TRIP). This research links very closely with research on environmental engineering on which there are a further five academics in the School working. For the future, the interfaces between transport, energy and the environment will become increasingly important in light of dwindling fuel stocks and the constraints on environmental impact imposed by the implementation of the Kyoto Protocol.

The Trinity Centre for Bioengineering (TCBE) is another PRTL funded initiative. This group of interdisciplinary researchers includes engineering, medical and life science staff. The research in this field is expected to expand substantially over the next five years with increasing emphasis on the need to understand physiological mechanisms to underpin the development of medical device technology to meet new demands.

5.2 Research Themes

Research activity in the School is currently focused into the following five interdisciplinary research strands, with contributions from researchers in each of the disciplines that make up the School. Promoting the development of these research strands will facilitate integration across the School.

- **Bioengineering (TCBE, Trinity Consortium on Ageing)**

This strand involves the application of the principles of Engineering to advancements in healthcare and medicine. Research areas include impact biomechanics, medical device design and testing, bone mechanics, prosthetic implants, biomaterials, cell mechanics and tissue engineering, cardiovascular biomechanics.

- **Transport and the Environment (TRIP)**

Transport policy and innovative strategies to solve traffic congestion are key areas in addition to sustainability and environmental issues across all sectors. Research areas include aero-acoustics and noise generation in aircraft and land transport, traffic congestion and highway safety, public transport. This strand will also address the requirement for more efficient energy production and includes work in convective heat transfer and two-phase flows, combustion control and the sustainable development of renewable energy.

- **Digital Media, Communication and Signal Processing (CTVR)**

This strand addresses some of the challenges in systems upon which modern society is critically dependent. Research areas include audio and acoustic analysis, microphone array signal processing, Bayesian signal and system identification, motion picture restoration and multimedia processing, video segmentation and transmission, software radio and ad hoc networks.

- **Materials and Manufacturing (CRANN)**

This strand encompasses research into material characteristics and manufacturing processes across the engineering disciplines represented in the School. Research areas include characterisation of semiconductor materials, liquid crystals and magnetic fluids, modelling and optimisation of metal-forming processes, abrasive machining, behaviour of metallic foams, fatigue and fracture of materials, simulation modelling of manufacturing systems, modelling and measurement of abrasive tools.

- **Construction Innovation (Funded Chair)**

This is an emerging theme which has recently acquired funding for a Chair. It will build on existing expertise in Structures and Geotechnical Engineering. For the former, activities include structural analysis and optimisation, vibration of structures, computer aided design, concrete technology, earthquake and wind engineering. On the Geotechnical aspects, research includes soft soils and peats, numerical modelling of stiff clays, limit state geotechnical design, tunnelling, environmental geotechnics.

These research themes reflect the current and emerging research strengths within the School and are broadly consistent with the College's main research pillars, in particular, Materials & Intelligent Systems and Health & Translational Research. In addition, the School is planning a major, interdisciplinary research theme in Energy, Transport and the Environment. This area is one of particular strategic significance, both from a national and an international perspective (oil and gas markets, Kyoto Protocol, Transport 21) and is likely to grow in importance in the coming years. In addition to contributing to the key research strands within College, the School is currently engaged in a process of strengthening research links to other Engineering Schools within Ireland, in the strategic research areas identified here.

Despite the identification of strategic research themes, diversity will remain important

6. Graduate Education

6.1 Taught Programmes

Each programme has a director and all taught programmes are self administered and run on a self-financing basis.

The school currently runs four taught Masters programmes:

- M.Phil. in Music and Media Technologies;
- M.Sc. in Bioengineering;
- M.Sc. in Civil Engineering;
- M.Sc. in Mechanical Engineering (Erasmus Mundus).

These courses graduate, in total, about 50 students per year.

The School runs continuing education programmes including a number of Postgraduate Diploma courses which are run each year with a total annual throughput of over 200 students. These are an important part of the School activities as Continued Professional Development (CPD) represents a significant aspect of training for engineers.

6.2 Research Programmes

At present there are 122 students on the M.Sc./Ph.D. register. All students studying for research degrees are initially registered as M.Sc. students and may only transfer to the Ph.D. register upon completion of a satisfactory transfer report. This is prepared approximately one year after registration. All research students are supported financially through research grants won by supervising staff members and/or student driven initiatives such as IRCSET. In addition to locally registered research students, some research groups admit some externally registered research students as trainees under funded programmes such as the Marie Curie Programme.

Over 200 research degrees have been completed in the School over the past five years.

6.3 Future Developments

The following have been identified as key areas of development within graduate education in the school:

- development of a five-year MAI to achieve a Bologna-type accredited Engineering degree. This will be modular in structure and will require the submission of a substantial thesis based on project work. It is envisaged that an initial graduate output of approximately 60 students per year could be achieved within two years;
- development of high level modular courses in cooperation with external institutions through an extended graduate school. These would form the basis of an integrated M.Sc./Ph.D. programme;
- further development of inter-institutional taught/research training programmes with international collaborators. The School has already established shared/double diploma courses with leading European universities at postgraduate and undergraduate level;
- the School-wide extension of continuing education. At present this activity is concentrated within the Civil, Structural and Environmental Engineering discipline.

Proposals are under development in conjunction with leading researchers in Engineering units within UCD, NUI Galway and UCC to develop an all-Ireland Graduate School in Engineering. (Colleagues from both QUB and UU have also been involved in these discussions.) It is envisaged that this will introduce the necessary economies of scale to

sustain a comprehensive array of advanced courses at a graduate level in targeted subject areas. Such courses will be a critical element in the development of a four-year integrated Ph.D. programme.

7. Undergraduate Education

7.1 Philosophy

The aim of the undergraduate programmes in Engineering is to produce high-calibre engineers who:

- have a breadth of understanding of general engineering principles;
- have a depth of knowledge in their chosen specialist discipline;
- have the capacity to think both analytically and creatively to solve problems and to communicate effectively.

To achieve these objectives, students are given a sound foundation in the broad principles and applications of engineering science followed by a more in-depth treatment of topics within their chosen discipline. In emphasising both engineering principles and specialised knowledge, graduates are better prepared for the inevitable technical innovations that will confront them in their later careers. These objectives are reflected in our Mission Statement.

The strategy of the School for developing its undergraduate teaching is directly linked to the need for professional accreditation of all our courses. This necessitates a particular philosophy driven by outcome dependency. As stated in the Mission Statement “**our aim is to produce graduate engineers with a capacity for independent thought, creative analysis and design**”. To achieve this, we are currently in the process of restructuring the first two years of the course (Freshman years). The emphasis is now to create a rational curriculum defined in terms of learning outcomes and their assessment. This will enable more direct involvement of the students in design and build type projects. In creating such a curriculum, the School is committed to the development of the CDIO (Conceive, Design, Implement and Operate) philosophy as an integral part of the undergraduate degree programmes. This philosophy is recognised internationally as an innovative educational framework and one that is necessary to produce the next generation of engineers. The CDIO philosophy addresses the two high-level objectives of contemporary engineering education which are to educate students in a range of technologies that grow and change rapidly while also developing the interpersonal, communication and problem solving skills of the student. The CDIO approach places an emphasis on problem based analysis at an early stage in the student’s career with a particular emphasis on engineering systems. This is in keeping with curriculum developments in the top engineering schools worldwide.

7.2 Undergraduate Courses

The BAI Engineering and the BSc(Ing) Engineering with Management (EM) degrees are the undergraduate programmes offered by the School. During the Freshman years (1 & 2) of the BAI, all students take core courses in general engineering as well as foundation courses in civil, mechanical, electronic and computer engineering. At the end of second year, students choose which area of engineering they wish to specialise in during their Sophister years. The engineering options offered by the School are:

- Civil, Structural and Environmental Engineering;
- Mechanical and Manufacturing Engineering;
- Electronic Engineering;
- Electronic and Computer Engineering
(joint with School Computer Science & Statistics)

Alternatively, students may, in their 3rd year, opt to take a Double Diploma which entails spending the Junior Sophister year at INSA, Lyon, France, returning to College to complete

the Senior Sophister programme after which they finish with a 5th year in Lyon. This entitles the students to the award of the BAI from College and the Diploma d'Ingenieur from INSA. Furthermore, we accept a number of Erasmus students into both the JS and SS courses. These students come from partner institutions across Europe.

The BSc(Ing) EM programme has as its aim the education of graduate engineers capable of working in the competitive environment of world-class manufacturing. To achieve this, the syllabus introduces a strong management science context into the existing engineering programme. Approximately 80% of the syllabus comprises subjects identical to those of a standard mechanical and manufacturing engineering degree with the remaining 20% comprising management subjects such as marketing, finance, quality systems, information systems, and human resource management among others. Emphasis is placed on projects, case studies, and teamwork.

The School accepts applications for entry to undergraduate courses from mature students and from students who have completed appropriate courses in the Institutes of Technology. These are considered on a case by case basis.

7.3 Future Strategies

Among a range of innovative teaching methods, the School is currently examining the efficacy of e-learning techniques. To date, we have embarked on a number of initiatives which include :

- Case-study based materials course in which students learn through graded web-based exercises designed around real-life failures;
- Problem Solving Groups: students are grouped into teams to do web-based exercises in first year to solve problems through on-line quizzes and in class tests - exam performance of the class improves and the students learn to work in teams;
- A number of courses have been set up with web based access to all notes and tutorials through the "webcourse" initiative of the College. The School policy is to encourage all academic staff to use this mode of "partial delivery";
- A main objective will be to develop web based "virtual" laboratories for those applications where this is considered appropriate.