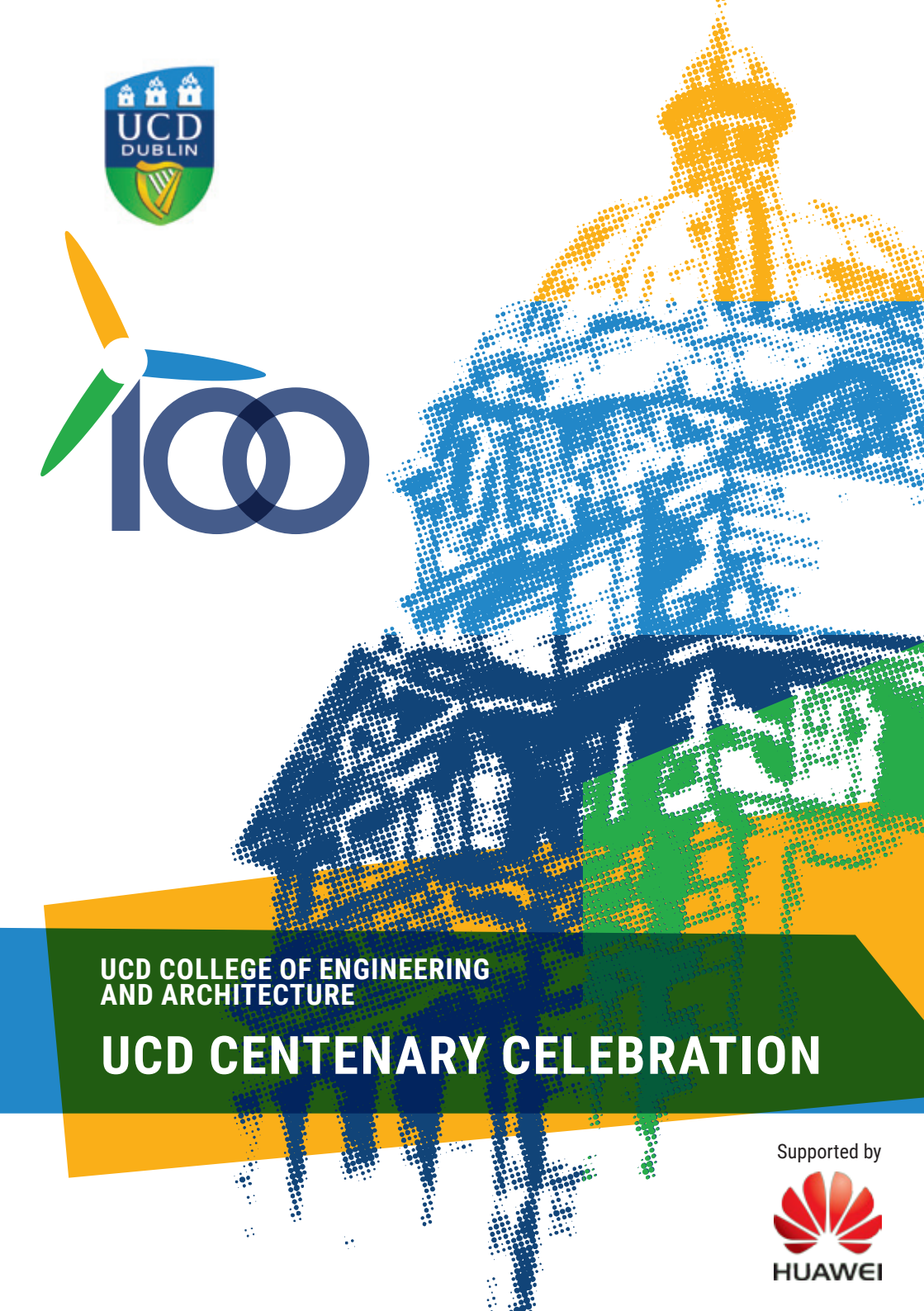

UCD COLLEGE OF ENGINEERING AND ARCHITECTURE

UCD CENTENARY CELEBRATION

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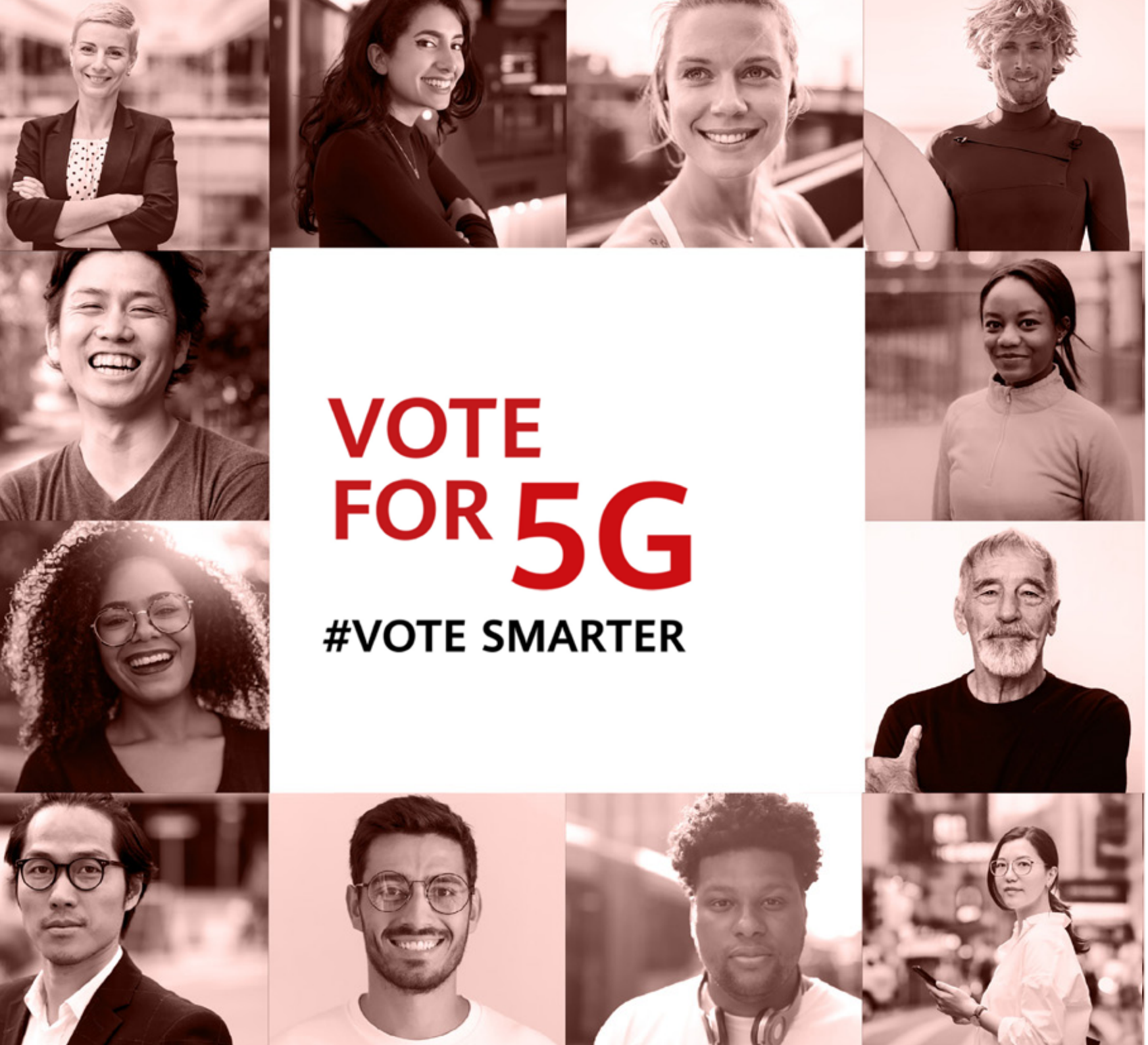

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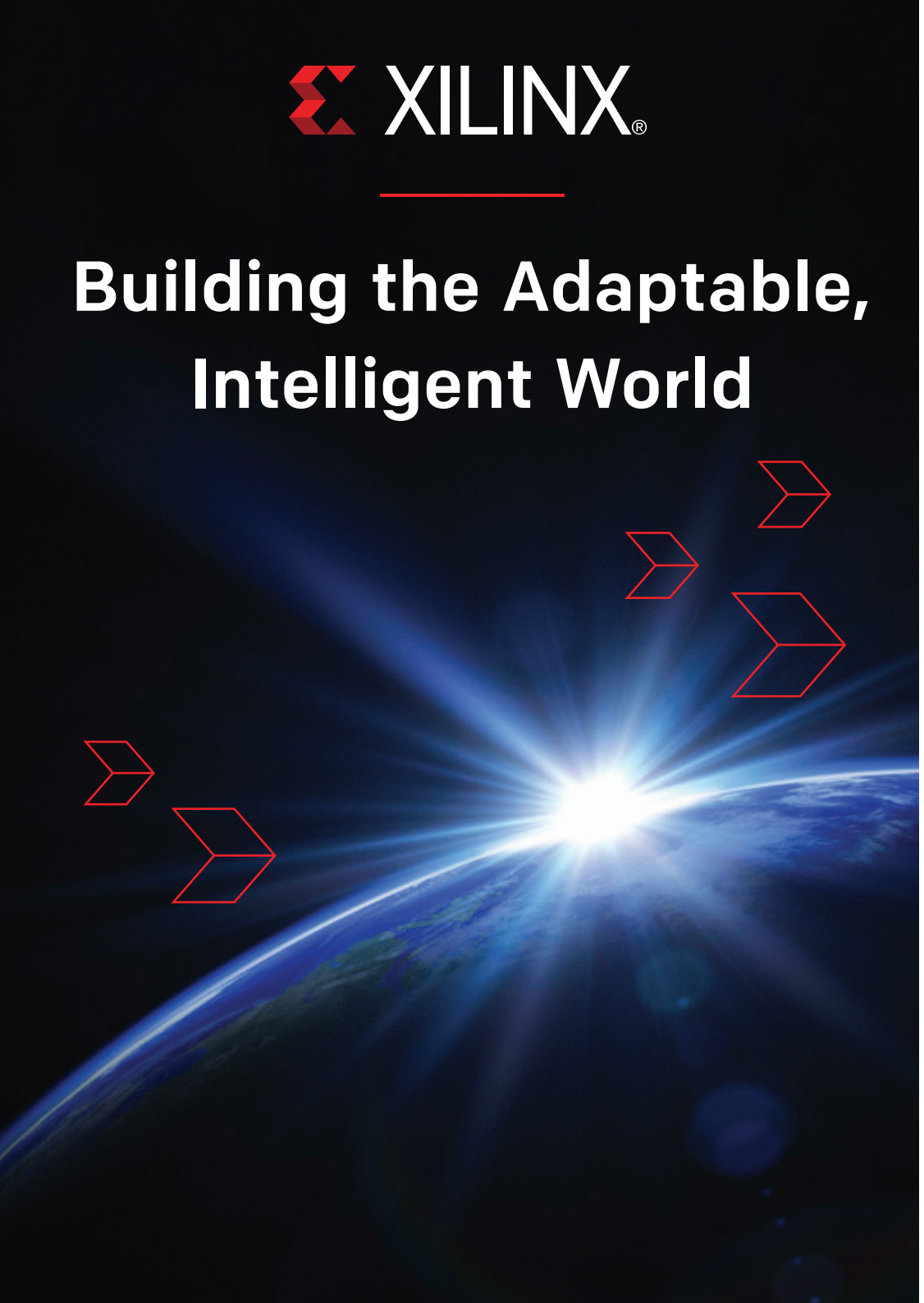

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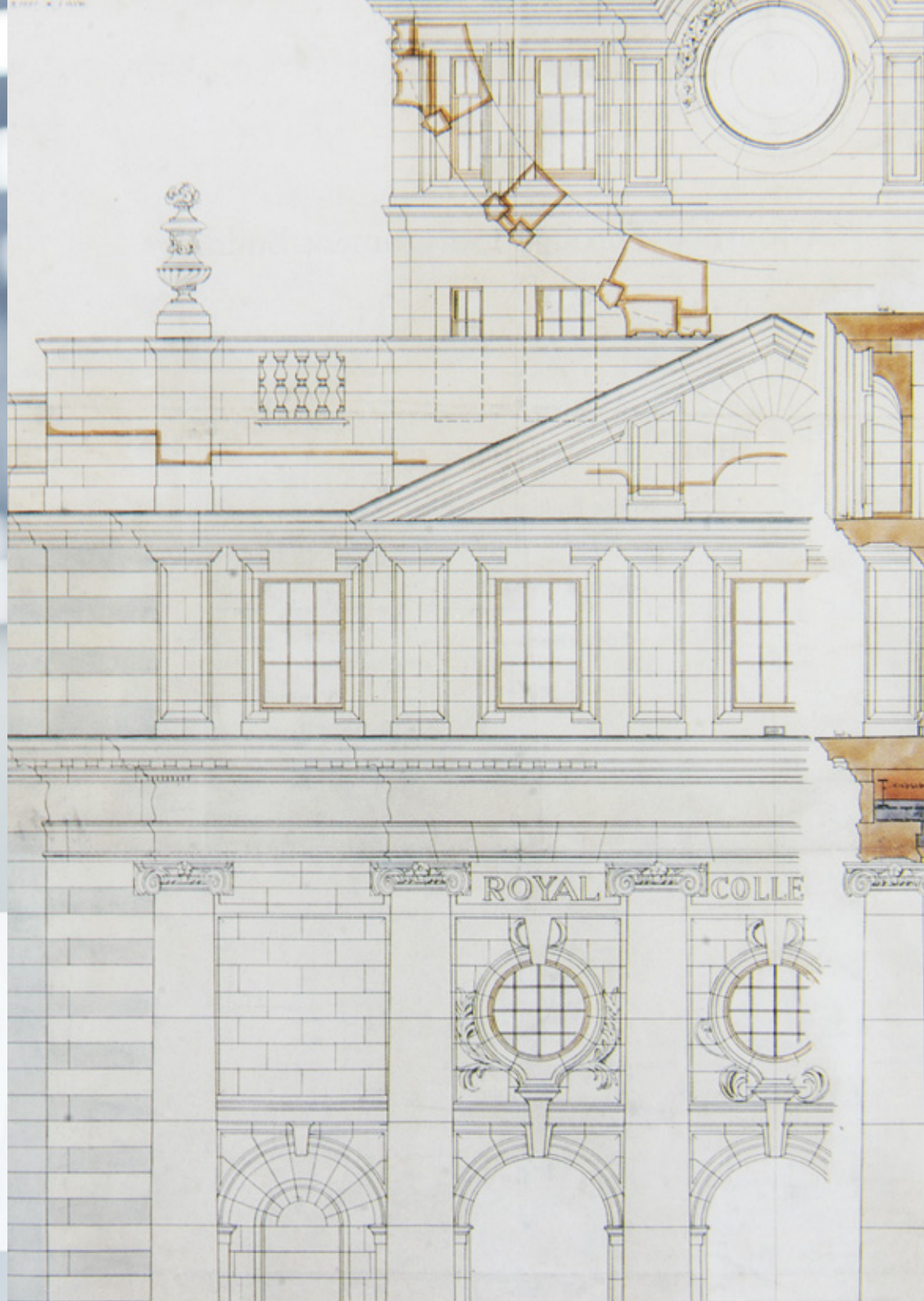


WELCOME

I am delighted to welcome you to the Centenary Celebrations of 3 Schools in the College of Engineering and Architecture: the School of Civil Engineering, the School of Mechanical and Materials Engineering and the School of Electrical and Electronic Engineering. I am delighted also to welcome and thank our sponsors: Huawei, who are our platinum sponsor and Arup, Jons Engineering, KPMG, Xilinx and Ward & Burke Engineering, who are our sliver sponsors.

Today is a day for looking back on your own UCD experiences, and remembering, with fondness I hope, that time. However, we also ask you to look forward to the future and to consider how UCD and UCD engineers can be involved in shaping the future of Ireland and of our world. We face challenging times, with increasing emphasis on the threats to our climate, as well as the external forces that can have negative and detrimental effects on our economy. However, as engineers we can rise to those challenges and play a role in helping Ireland and the world to create a more sustainable and stable future. In UCD, now as in the past, we seek to educate engineers who want to be involved in shaping the future, and in solving our problems. We can also help to solve those problems through our ground-breaking research taking place in our College: from looking at how we can design infrastructure that is both resilient and sustainable, to researching new ways of creating clean energy and reducing emissions, to looking at how engineering can create better healthcare outcomes, amongst many, many other areas.

Many of you will remember your time in UCD through the places that you had lectures, tutorials and laboratories – whether that was in Merrion Street, Earlsfort Terrace, Newstead or the Engineering and Materials Science Building in Belfield. Soon, our first-year engineers will experience a new building in UCD where, as part of the Future Campus, the new Centre for Creativity, will become a home for our first-year engineering students. This building, which will be located near the current Engineering and Materials Science Building, will bring together many parts of the current College of Engineering and Architecture for the first time, with plans for both the School of Civil Engineering and the School of Architecture, Planning and Environmental Policy, to be re-homed there. The Centre for Creativity will offer our students a world-class education experience, with new teaching laboratories, learning spaces and project rooms. It will also be an iconic building which will soon become synonymous with UCD. This marks a very exciting new chapter for the College.

Finally, I would like to finish by remembering the most important part of UCD Engineering – that is our students. For many of our students, the increasing costs of living in Dublin and attending university can be a struggle, while mental health issues and anxiety are also increasingly apparent: each year we see promising students unable to complete their studies due to these financial and other hardships. Therefore, the proceeds from this evening will go towards a hardship fund to help students who are confronted by financial or other difficulties which are hindering their ability to finish their studies. The best way we can help these students is to provide them with the education and qualifications that will give them a promising and happier future. I would like to thank you for contributing to this fund by being here this evening.

Aoife Ahern College Principal

FÁILTE

Is cúis mhór áthais dom fáilte a chur romhaibh chuig Ceiliúradh Céad Bliana do 3 Scoil de chuid Choláiste na hInnealtóireachta agus na hAiltireachta: Scoil na hInnealtóireachta Sibhialta, Scoil na hInnealtóireachta Meicniúla agus Ábhar, agus Scoil na hInnealtóireachta Leictrí agus Leictreonaí. Is cúis mhór áthais dom freisin fáilte a chur roimh ár n-urraitheoirí agus buíochas a ghabháil leo: Is iad sin ár n-urraitheoir platanaim Huawei, agus ár n-urraitheoirí airgid Arup, Jons Engineering, KPMG, Xilinx agus Ward & Burke Engineering.

Seo lá inar féidir libh súil siar a chaitheamh ar bhur laethanta féin ag UCD agus tá súil agam go bhfuil cuimhní geala agaibh ar an tráth sin. Iarraimid oraibh freisin, áfach, féachaint ar aghaidh ar an am atá romhainn agus smaoineamh ar conas is féidir le UCD agus le hinnealtóirí UCD dul i bhfeidhm ar thodhchaí na hÉireann agus an domhain. Is iomaí dúshlán atá romhainn sa lá atá inniu ann agus béim níos géire ar na bagairtí ar an aeráid chomh maith leis na brúnna seachtracha a d'fhéadfadh dochar agus díobháil a dhéanamh don gheilleagar. Is féidir linne mar innealtóirí dul i ngleic leis na dúshláin sin, áfach, agus a bheith páirteach i saol níos inbhuanaithe agus níos seasmhaí a chruthú in Éirinn agus ar an domhan. Ag UCD, táimid ag iarraidh oideachas a chur ar innealtóirí a bhfuil spéis acu tionchar a imirt ar an saol atá le teacht agus ár gcuid fadhbanna a réiteach, rud atá chomh tábhachtach dúinn inniu is a bhí riamh. Is féidir linn cabhrú freisin leis na fadhbanna sin a réiteach trí úsáid a bhaint as an taighde ceannródaíoch atá á dhéanamh ag ár gColáiste: idir féachaint ar conas bonneagar láidir inbhuanaithe a dhearadh, taighde a dhéanamh ar bhealaí nua le fuinneamh glan a chruthú agus astaíochtaí a laghdú agus féachaint ar conas is féidir leis an innealtóireacht seirbhísí sláinte níos fearr a chur ar fáil, chomh maith le go leor réimsí eile.

Beidh cuimhne ag a lán daoibh ar an am a chaith sibh in UCD, cuimhní a bhaineann leis na háiteanna a raibh léachtaí, ranganna teagaisc agus saotharlanna agaibh, cé acu i Sráid Mhuirfean, Ardán Phort an Iarla, Newstead nó in Ionad na hInnealtóireachta agus na hEolaíochta Ábhair in Belfield a bhí siad ar siúl. Beidh foirgneamh nua ag innealtóirí na chéad bhliana go luath. Mar chuid de Champas na Todhchaí (Future Campus), beidh ionad nua ar a dtugtar Lárionad na Cruthaitheachta (The Centre for Creativity) ina lárionad do mhic léinn innealtóireachta na chéad bhliana. Beidh an t-ionad seo suite cóngarach don áit a bhfuil Ionad na hInnealtóireachta agus na hEolaíochta Ábhar suite faoi láthair. San ionad nua tabharfar a lán aonad de chuid Choláiste na hInnealtóireachta agus na hAiltireachta le chéile den chéad uair agus tá sé beartaithe Scoil na hInnealtóireachta Sibhialta chomh maith le Scoil na hAiltireachta, na Pleanála agus an Pholasaí Chomhshaoil a athlonnú ansin freisin. Cuirfear oideachas den chéad scoth ar fáil dár mic léinn in Ionad na Cruthaitheachta (The Centre for Creativity), áit a mbeidh saotharlanna teagaisc, spáis foghlama agus seomraí tionscadail nua ann dóibh. Beidh an t-ionad nua seo ina fhoirgneamh íocónach freisin a bheidh inaitheanta le UCD roimh i bhfad. Seo ré nua spreagúil i saol an Choláiste.

Mar fhocal scoir, ba mhaith liom cuimhneamh ag an deireadh ar an ngné is tábhachtaí d'Innealtóireacht UCD - is é sin ár mic léinn. Tá a lán dár gcuid mac léinn ag strachailt leis an gcostas mór a bhaineann le bheith ag maireachtáil agus ag freastal ar an ollscoil i mBaile Átha Cliath agus is léir go bhfuil níos mó fadhbanna meabharshláinte agus imní ag teacht chun cinn chomh maith: gach bliain feicimid mic léinn a bhfuil gealladh fúthu agus iad gan a bheith in ann a gcuid staidéir a chríochnú mar gheall ar na fadhbanna airgeadais seo agus deacrachtaí eile. Mar sin, rachaidh an t-airgead ón oíche seo i dtreo chiste carthanachta chun cabhrú le mic léinn a bhfuil deacrachtaí airgeadais nó deacrachtaí eile acu atá ag teacht salach ar a gcumas a gcuid staidéir a chríochnú. Is é an t-oideachas agus na cáilíochtaí a chuirimid ar fáil do na mic léinn an bealach is fearr ar féidir linn cabhrú leo saol geal sona a bhaint amach. Ba mhaith liom buíochas a ghabháil libh as cabhrú leis an gciste trí bheith anseo anocht.

Aoife Ahern Príomhoide Coláiste,
Coláiste na hInnealtóireachta agus na hAiltireachta UCD

BEGINNINGS AND GROWTH

A Century of Development

The Faculty of Engineering and Architecture at University College Dublin (UCD) was created in 1909 when the first Dean of Engineering, Professor Pierce Purcell, took up his post. The young Dean set up a programme in Civil Engineering immediately and over the following decade he set about offering a programme in Mechanical and Electrical Engineering. Initially this was achieved through collaboration with the Royal College of Science for Ireland, which itself later came fully into the UCD fold in 1926. Programmes in Chemical Engineering and Agricultural Engineering were inaugurated in 1956 and 1961, respectively.

The first women to be appointed Dean of Engineering, Professor Aoife Ahern, took up her post in 2019. Both Professor Purcell and Professor Ahern graduated from Trinity College Dublin, finishing first in their respective civil engineering BAI classes. Bookended by these appointments, it is timely to reflect on a century of the life and times of 'UCD Engineering' in the intervening decades.

Dean of Engineering Pierce Purcell (front, third from left) leading surveying field trip, 1919

HISTORICAL CONTEXT

The Dean of Engineering appointment in 1909 came about through a major re-organisation of the higher education scene in Ireland, following the provisions of the Irish Universities Act, 1908, "enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons...." By way of historical context, Edward VII was at that time 'King of the United Kingdom of Great Britain and Ireland and Emperor of India', the House of Commons included 100 Irish MP's among its members and the House of Lords included 28 representatives of the Peerage of Ireland.

Prior to the 1908 Act, the higher education scene in Dublin included three important components that would later form building blocks for the establishment of a school of engineering at UCD. These were the Catholic University of Ireland, The Royal University of Ireland and the Royal College of Science for Ireland.

BUILDING BLOCKS

The Catholic University of Ireland (CUI) began its academic mission in 1854, under its first rector, John Henry Newman. Newman's idealism included a vision for both liberal and professional education, either path being a route to formation of the person. He wrote of his intention to set up "....a school of useful arts, developing and applying the material resources of Ireland .....comprising the professorships of Engineering, Mining, Agriculture...." Alas his intent for professional education in the field of engineering was not realised during his tenure. Although he appointed Terence Flanagan as Professor of Engineering it is probable that Flanagan never took up the professorship and consequently no engineering studies were facilitated.

Meanwhile, in a development of later considerable significance to UCD, instruction in engineering and science applicable to industry became possible through the Royal College of Science for Ireland (RCScI). The College was established in 1867 under the inspirational direction of Irish scientist Robert Kane, first Dean of RCScI. Graduates were awarded the 'associate' qualification (ARCScI). Open to all, irrespective of creed and gender, the RCScI provided an alternative for catholics and women who were unwilling or unable to enter Trinity College Dublin for their engineering studies.

Times were difficult for Newman and his appointees because the CUI was not formerly recognised and therefore it could not offer degrees. The situation for the CUI students improved when the University Education (Ireland) Act 1879 led to the establishment of the Royal University of Ireland (RUI) in 1880, an examining and degree-awarding institution. Although a 'university', the RUI was simply an examination body for students in feeder teaching institutions, which included both university colleges and some secondary schools. The examinations of the RUI were open to all candidates, thus providing an opportunity for the CUI to re-organise itself around a set of teaching colleges, providing tuition for students who then took the RUI exams to get recognised qualifications. This development spurred a re-organisation at the Catholic University in 1880 which resulted in three constituent colleges: 'St Patrick's College Maynooth', 'Cecilia Street Medical School' and 'University College Dublin'. University College Dublin, an amalgam of all CUI faculties other than the seminary in Maynooth and medical school in Cecilia Street, was put under the stewardship of the Jesuits. There is no evidence of any resurgence of interest in a school of engineering during the re-organisation. This is unsurprising given that the market demands in Dublin were clearly being met by the combined capacity of Trinity College Dublin and the RCScI. The arrangement of study at UCD leading to RUI degrees endured until 1908 but tensions had been building up among the UCD student body regarding the role in their academic pursuits of a 'Royal' institution. This boiled over into disruption of the singing of 'God Save the King' at a Royal University conferring ceremony in 1904. The police restored order on the day but London was already taking notice of the Irish nationalist desire for a more acceptable university infrastructure. That came in 1908.

The 1908 re-organisation of the higher education landscape in Ireland was root-and-branch, particularly affecting the Queen's Colleges (Belfast, Cork, Galway) and the CUI. The Royal University of Ireland (RUI) was dissolved, as were the three Queen's Colleges. Newly formed was a federal National University of Ireland (NUI) and Queen's University Belfast. Initially the constituent colleges of the federal NUI were University College Dublin together with similarly styled colleges in Cork and Galway. St. Patrick's College Maynooth became a constituent in 1910. The Catholic University of Ireland soon thereafter ceased to be a legal entity. The taxpayer does not seem to have got off lightly: the £20,000 payment to the RUI was not taken as a windfall saving for the Treasury but was distributed as £10,000 each to the NUI and QUB.

Thus when Pierce Purcell was tempted back to Ireland from his job with London County Council to set up an Engineering School at UCD, he had three pillars to build on: the now stable degree-awarding infrastructure of NUI; the tradition of Bachelor of Engineering (BE) exams of the Royal University of Ireland; and the possibility of co-operation with the Royal College of Science in respect of lecturing staff and engineering laboratories. The enthusiastic 28-year old hit the ground running.

INAUGURATING THE 'FACULTY OF ENGINEERING AND ARCHITECTURE'

The inaugural meeting of the Faculty of Engineering and Architecture was held on 19 November 1909, chaired by the President of the University, Dr. Denis J. Coffey, in between his typical daily schedule of three lectures per day. There was but one item of business: the appointment of Dean. Professor Purcell was appointed on the proposal of Prof. H.C. McWeeney, Professor of Mathematics. Architecture were not represented among the nine attendees – although Sir Thomas Drew had accepted appointment as the NUI's first Professor of Architecture, he had unfortunately died two months later. Subsequently William A. Scott was appointed as Professor of Architecture in 1910. Curiously the stipends for the full-time professors were not equal. The 1908 legislation prescribed the stipend for the Professor of Civil Engineering at £600 per annum, slightly less than that paid to professors in Science, whereas the stipend for the Professor of Architecture was £200 per annum, similar to the Law professor.

Purcell and Scott were the only Faculty members of their respective professions. The initial Faculty membership profile included the disciplines of chemistry, experimental physics, geology, mathematics and mathematical physics, each of which was represented by the professor of subject. This position remained relatively unchanged until 1926, with the addition of three new engineering members consequent on the integration of the RCScI into UCD. It was not until the 1960's that engineers and architects formed a majority on Faculty. It should be understood that faculty membership at that time was restricted to senior 'university' (i.e. NUI appointed) lecturers and professors. The situation changed in the 1970's when membership was opened to all tenured academics in engineering and architecture, thus also including 'college' (i.e. UCD appointed) lecturers. Heretofore, Faculty membership averaged 15 members of whom about 50% were engineers and architects. Through the change in practice membership rose to over 60, with engineering and architecture representation rising to typically 85%. More importantly it gave even the most junior tenured lecturer a voice at the table, a direct and regular connection with senior management – the President chaired all faculty meetings – and access to wise mentorship while journeying the learning curve before later assuming higher responsibility in University affairs.

The 'faculty' structure endured for almost 100 years until programme oversight moved to a system of Programme Boards in 2005. This occurred through a change in academic programmes structures, which became module-based and semesterised, with greater opportunity for interdisciplinarity. Resource management also needed to change, leading to the dissolution of the 'Faculty' and 'Department' structure, which was replaced by a reduced number of 'Colleges' and 'Schools' allied to a revised resource allocation mechanism. Happily, the links between engineering and architecture were retained in the new structures during the formation of the 'UCD College of Engineering, Mathematical and Physical Sciences' under the last Dean of the 'Faculty', architect Professor J. Owen Lewis. Professor Lewis expertly managed the transition to the radically different College/School/Programme Board structure over a very short timeframe.

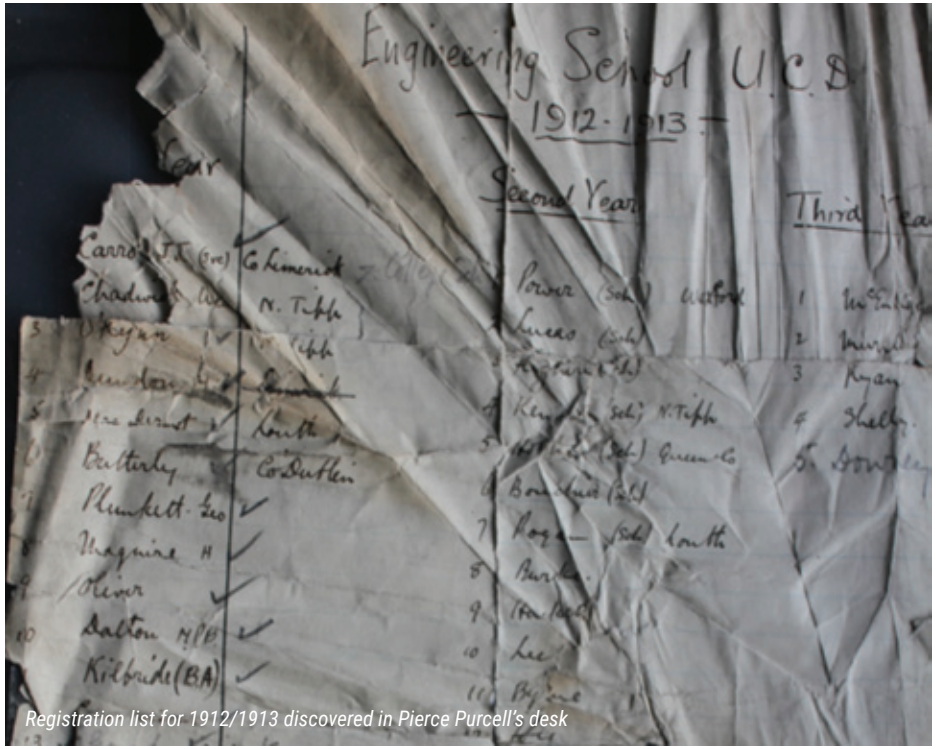
INAUGURAL UCD BE DEGREE IN CIVIL ENGINEERING

The 1909 inaugural UCD Bachelor of Engineering degree syllabus was a three-year civil engineering programme. The Dean, Pierce Purcell, had been appointed to UCD as 'Professor of Civil Engineering' and his view on the pre-eminent place of 'civil eng' among the engineering disciplines was probably in keeping with the times. Even in 1926, when professorships were created in 'mechanical engineering' and 'physics and electrical engineering', the relevant Statute for the former included that "the Professor of Civil Engineering shall...have precedence in regulating the distribution of laboratories in the Department of Engineering". It is interesting that the term used for the post holder controlling resource distribution was 'Professor of Civil Engineering' rather than 'Dean of the Faculty'. The point is somewhat academic, however, as Professor Purcell served continuously as Dean from 1909 until 1952 and retirement at the age of 72 years young!

Bachelor of Engineering (BE) degrees were among the qualifications being awarded by the RUI at the time of its formal dissolution in 1909. Much was adopted by UCD from existing RUI practice except for the determination of honours grade in examinations. The RUI prescribed a syllabus for 'Pass Examinations' and those candidates "who, in the opinion of the Examiner, have acquitted themselves creditably" were permitted to present themselves at separate 'Honours Examinations', for which an additional syllabus was prescribed. Final degree classification was determined through the addition of half of the marks achieved from the pass examinations to the marks achieved at the honours examination. The system adopted in UCD was based on one syllabus. Honours were awarded at the discretion of the Exam Board to those who performed well across all subjects and achieved an average mark above a certain threshold. The threshold was an open secret among staff and students but the University retained a tradition into the 1980's whereby the closely-guarded 'Marks and Standards' document, governing procedure at Exam Boards, was circulated on a strictly 'need-to-know' basis. Heaven forbid that students would ever game the system and plan their approach to university learning around mere examinations!

A review of the RUI engineering syllabus in the 1900's and the UCD engineering syllabus of the 1910's shows that the transition was a smooth one for students seeking to conclude partially-complete studies while taking classes in the new UCD programme. Both programmes were of three years duration with significant similarities. Professor Purcell was anxious to ensure that the UCD degrees were readily accepted by the Institution of Civil Engineers of Ireland and by public sector employers in the U.K. and the crown colonies, not least India. Little wonder, therefore, that significant innovation in the syllabus was not a feature of the new UCD offering.

The imminent dissolution of the RUI spurred many to complete their engineering studies in a timely manner and the final 'Royal' B.E. Degree exams in 1908 yielded no less than 17 successes. A transition arrangement was put in place whereby students who had passed the First or Second Examination before the beginning of the 1910/1911 academic year could finish their studies in UCD under the RUI regulations. Indeed, the inaugural academic year for UCD Engineering in 1909/1910 yielded a final year examination candidate. Mr. Roderick O'Connor B.A. passed his B.E. Degree examination in 1910 and became UCD's first engineering graduate. The first year class in the



Registration list for 1912/1913 discovered in Pierce Purcell's desk

inaugural year yielded four examination candidate successes, including two First Class Honours and one Second Class Honours.

At the time of dissolution of the RUI, the 'Diploma in Engineering' was available for granting to those who did not follow the traditional route of matriculation and First Engineering exams but who passed the Second Year and BE Degree examinations. One such award was made in the final 1908 RUI examination but the option was not incorporated in the NUI regulations. Nevertheless, special provision was made for crediting some experiential learning as a temporary feature of practice by the NUI during and after the Great War. During the 1914-1918 war NUI students were amongst those whose studies were interrupted by military service. Special provision was made to award 'Honorary War Degrees' taking account of war service. Across the NUI colleges, 14 such honorary BE degrees were awarded, seven in 1917; four in 1918, two in 1919 and one in 1920.

INAUGURATING A BE DEGREE IN MECHANICAL & ELECTRICAL ENGINEERING

The second BE degree specialisation in UCD was launched through collaboration with the RCScI, with Mech and Elec students commencing their final two years of study there from 1916. This collaboration was thus conducted during the troubled years leading to the foundation of the State in 1922. The success of this co-operation was therefore very noteworthy despite tensions from asymmetric state financial support between the two institutions, professional rivalry and some element of sectarianism.

Co-operation between UCD and RCScI made a lot of sense to the new UCD Dean, who found himself with little if any infrastructural assets. All the new Dean had was the surveying equipment inherited from the examination stock of the RUI. In 1909 the RCScI, then housed in 51 St. Stephen's Green (now Office of Public Works), were almost ready to move to their new purpose-built facilities in Merrion Street. Meanwhile the buildings currently on Earlsfort Terrace were not even on the drawing board. The buildings inherited by the NUI and UCD consisted of the former offices, examination halls and exam venue laboratories of the RUI. Over the following decade some of the new UCD buildings were constructed but progress was slow due to economic and political turmoil in Ireland and Europe. The Dean set about gaining access to RCScI facilities for his UCD students.

Instruction of civil engineering students proceeded in cramped facilities. This contrasted with the fine RCScI facilities in Merrion Street, a mere eight minutes walk from 'the Terrace'. An arrangement was agreed whereby Second Year Engineering students in UCD were required to take a 200-hour duration practical course in

Workshop and this course "could be attended at the Royal College of Science, Dublin." A more ambitious proposal was advanced to inaugurate a UCD degree programme in Mechanical and Electrical Engineering.

Financial constraints during and after The Great War prohibited commencement of construction of about 40% of the planned UCD Earlsfort Terrace buildings, including the entire block that would house the School of Engineering. An arrangement was therefore entered into with RCScI whereby UCD Mechanical and Electrical Engineering students would initially take common subjects with their UCD Civil Engineering classmates in Earlsfort Terrace but would take specialist Mech & Elec studies in RCScI, Merrion Street. Fee payment was direct to RCScI for these studies – effectively a 50/50 split between UCD and RCScI for the full programme. These specialist classes were conducted by the highly regarded academics of RCScI and the NUI regulations were amended to grant these lecturers the title 'Extra Mural University Lecturer'. Curiously, UCD insisted that separate NUI exam papers be set for its students and UCD students (BE qualification) sat different papers from RCScI classmates (ARCScI qualification). One can speculate that this related to recognition by professional bodies. Despite their high academic standing, no member of the staff of RCScI was a member of the Institution of Civil Engineers of Ireland, the sole engineering professional body in Ireland at the time. This precluded recognition of the ARCScI qualification by the professional body. Perhaps Professor Purcell felt that there was merit in being able to demonstrate a clear distinction between the UCD and RCScI graduates by avoiding any common examination papers.

Some overtures were made by UCD for two-way traffic in the RCScI relationship. For example, Professor Purcell was willing to personally propose eminent RCScI staff for membership of the Institution of Civil Engineers of Ireland and access to the Earlsfort Terrace engineering drawing office was offered to RCScI staff and students when some of the Merrion Street facilities were commandeered by the new Irish Free State government in 1922. All such offers were declined. Perhaps in the changing political climate of the early 1920's the staff of a 'royal'-branded college in the new Irish Free State could see the writing on the wall. Did the overtures from UCD amount to a case of 'come into my parlour, said the spider to the fly'?

The staff, students and alumni of the RCScI had grounds for concern regarding the survival of their College in the changed political climate. The new Provisional Government requested an expert report in 1922 from a UCD committee on the role of scientific and industrial research in underpinning economic development of the new State. The UCD report recommended full absorption of RCScI's components into the agriculture, engineering and science faculties of UCD. This was accepted by Government who legislated for the demise of the RCScI and the transfer of the Merrion Street facilities to UCD. The RCScI had also been used by Trinity College Dublin (TCD) in the inauguration of their mechanical and electrical engineering programme. UCD facilitated the continued use of the Merrion Street facilities by TCD students when required.

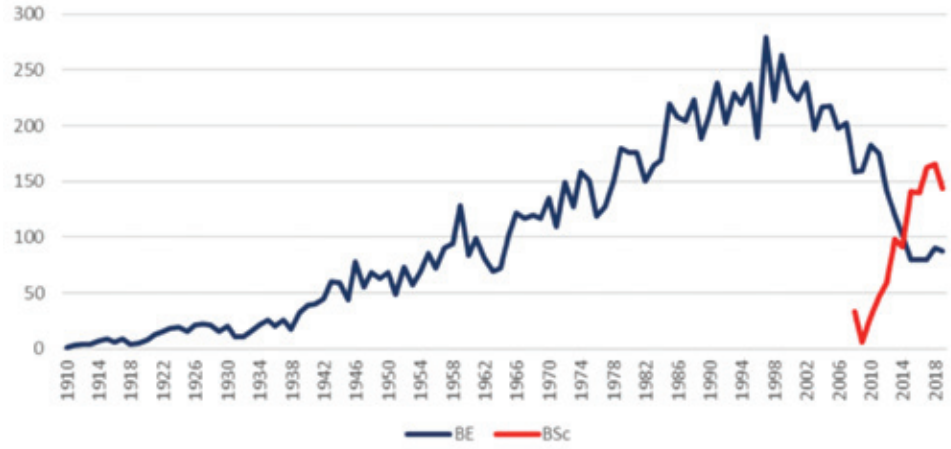
Acquiring the Merrion Street building gave UCD Engineering a 'home away from home' from 1926 but for some engineering students and staff it was the start of a somewhat nomadic existence that would be a characteristic of the UCD Engineering experience throughout the 20th century.

GROWTH IN ADMISSION AND GRADUATION NUMBERS 1909-2019

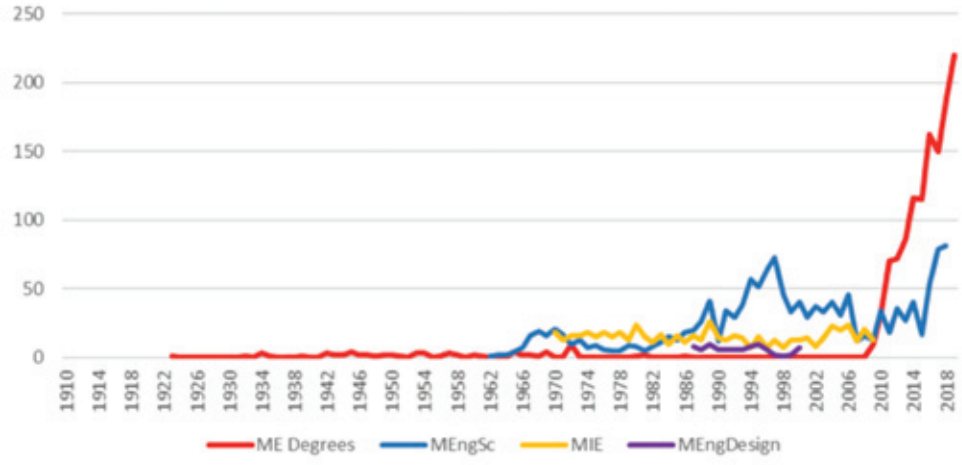
Four students successfully completed first year studies in the inaugural year of the Faculty in 1909. Currently, the number admitted to first year is of the order of 260. One engineering degree was conferred by UCD in 1910 and the total number has since grown to 12,600 undergraduate degrees. Over 3,400 masters degrees have been conferred in engineering in the period. Growth in research at doctoral level is such that the average number of Engineering Ph.D. degrees conferred in the last decade has averaged over 30 per annum.
Class size of a typical First Engineering cohort before World War II was of the order of 40 to 50 students. Failure rates were relatively high, with typically only half of these making it into Second Year on their first examination attempt. The resultant graduation numbers were typically 20 per annum. The high attrition rate at the end of first year was an ever-present trend through the years of the 20th century. This allowed certain lecturers to tease first year students with the time-honoured warning: "Look to the person on your right and on your left. One of them will not be here next year". As an exhortation to pay more attention at lectures it generally fell on deaf ears!

There was a considerable growth in numbers admitted during and after the war, growing to about 100 admitted annually in the late 1940's to about 150 annually in the 1950's. Failure rates remained relatively high yet it became necessary to introduce capacity quotas in respect of the number of Second Year places available in each discipline. Reflecting market demand, the number of Mechanical and Electrical degree graduates exceeded those graduating in civil engineering from the 1940's. Graduation numbers grew steadily year-on-year to average 55 in the 1940's and 79 in the 1950's. There was a slump in numbers in the early 1960's until the new free trade policy of Taoiseach Sean Lemass began to take effect. Economic

prosperity from the mid 1960's fuelled an increase in the need for more engineering graduates. Approval was forthcoming for more resources and UCD was consistently producing over 100 BE degree graduates per year by 1965. Admission numbers were progressively allowed to increase, translating into an average of 127 BE graduates per year during the 1970's and over 200 per year by 1985, averaging 188 across the 1980's.



Undergraduate degrees 1909-2019



Masters degrees 1909-2019

Civil Engineering students, Merrion Street 1948

The first female BE degree graduate was Pamela M.J. Timoney, in Electrical Engineering, in 1967 but the number entering First Engineering Year remained stubbornly low over the next 10 years. When Dr. John J. Kelly was elected Dean in 1979 his first ambition was to increase the number of women doing engineering, which in the 1970's was at best 3% of the First Engineering class. These highly motivated students tended to perform significantly above average. For example in 1981 an unprecedented cohort of five female Mechanical Engineering students graduated, including Darina Murray who set a new record for the highest marks recorded in Mechanical Engineering. In the days before social media the Dean exploited his skills as an able communicator and skilled networker to generate interest in UCD Engineering in girls' schools across the nation, notably through a high-profile public seminar in 1980 which attracted media attention from Gay Byrne, the leading broadcaster of the time. Busloads of female students, accompanied by their teachers, descended on Merrion Street to investigate this hitherto unexplored career option. With inspiring speeches from women engineering graduates and UCD colleague Garret FitzGerald, the message went directly to these talented students, breaking down perceived barriers. The following year the percentage of women in first engineering rose to about 20%, some 40 in the class of 200. Notable student attendees at the 1980 seminars were Orla Feely and Patricia Kieran, who later studied engineering at UCD and joined the University as academics. They have gone on to inspire students through their award-winning excellence in teaching and research. Professor Feely is now UCD Vice President for Research, Innovation and Impact. The significant increase in the female cohort in 1981 established a new baseline figure which has been sustained.

LOCATION, LOCATION, LOCATION

Circumstances have conspired such that UCD Engineering has never yet managed to live under one roof on the main university campus – neither in Earlsfort Terrace nor Belfield. Over the course of the century it has operated out of Earlsfort Terrace, Merrion Street and three locations on the Belfield campus. The current Belfield locations are the Engineering and Material Science Building, the Newstead Building and the Agriculture and Food Science Building. Although the Newstead Building, housing the School of Civil Engineering, is adjacent to the School of Architecture in Richview, both are some distance away from the 'Engineering Building'. However, plans for the UCD Centre for Creative Design, as part of a new Entry Quad abutting the Engineering Building will bring Engineering and Architecture colleagues closer together on the Belfield campus.

EARLSFORT TERRACE

Following the formal dissolution of the RUI in 1909, the NUI and UCD inherited somewhat dilapidated RUI premises in Earlsfort Terrace. The premises had administrative offices, an examination/ conferring hall (former Great Concert Hall of the 1865 Great Dublin International

Inherited RUI premises in Earlsfort Terrace

Exhibition) and laboratories that had been used for practical examinations. The buildings had limited scope to accommodate the 500 students of the new UCD. It did however provide a possible 5-acre site for development. A capital budget of £150,000 was available to UCD, through the provisions of the Irish Universities Act, 1908. Alternatives sites were examined but none were satisfactory. Successful discussions with Lord Iveagh gifted a half-acre of land at the rear of the site (part of the Iveagh Gardens), thereby providing a site just about large enough for the projected 1000 students if the NUI could be moved out. The NUI were re-accommodated in 49 Merrion Square, using £40,000 from the capital budget.

Following an architectural competition, the design of Rudolf Maximilian Butler of Doolin & Butler Architects was accepted for the new Earlsfort Terrace campus. R.M. Butler was later to join UCD as Professor of Architecture in 1924. G.&T. Crampton Ltd. was awarded the construction contract. The winning design envisioned four wings arranged around a quadrangle, bisected by a Great Hall and Library. The west wing, along the boundary with the Iveagh Gardens, was designed to accommodate the Faculty of Engineering and Architecture. Unfortunately, the full design was never built. Cost over-runs resulted from several factors, including significant inflation of material costs caused by the Great War. These increased costs were eligible to the contractor under the terms of contract but the Treasury would not advance funds beyond the amount specified in the 1908 Act. The casualties of unforeseen cost over-runs were the west wing and the Hatch Street frontage south wing. These were never built, despite UCD's occupancy of the site for almost 100 years. This was to be the first of six major disappointments for Engineering in respect of accommodation over the years and would result in the separation of many of UCD Engineering's staff and students from the main body of the UCD community during long periods of the 20th century.

Faced with an indefinite postponement of construction of the west wing, the Dean of Engineering made arrangements to use facilities in both the over-crowded Earlsfort Terrace, 85-86 St. Stephen's Green ('Newman House') and the nearby Royal College of Science for Ireland in Merrion Street. Within a few years the Irish Free State was founded and this quickly resulted in the transfer of the RCScI facilities to UCD. In 1926 Merrion Street became the home of Engineering at UCD. This regrettably involved forced separation of Engineering from the heart of UCD student life in 'the Terrace' but sight was never lost of getting Engineering back to the main campus through government interest in securing all of the Merrion Street buildings, already part-shared with government departments.

The foundation of the Irish Free State followed a period of bloody conflict during the War of Independence. Many UCD students were passionately supportive of the nationalist cause and some were actively engaged in IRA units during this period. One of these was 19-year old engineering scholarship student Frank Flood. He led an assault on members of the Dublin Metropolitan Police crossing a bridge over the River Tolka in January 1921. Captured by British Forces, he was executed in nearby Mountjoy Prison two months after the ambush and buried in an unmarked grave. His remains were reinterred in Glasnevin Cemetery, with full state honours in 2001. The bridge was officially named 'Frank Flood Bridge' by Dublin City Council in 2018. Flood's fellow students made a collection to honour his name through a commemorative annual UCD debating competition.

A strong possibility of reuniting the faculties on the Earlsfort Terrace site re-emerged during the early 1940's, under UCD President A. W. Conway. Arthur Conway had been appointed Professor of Mathematical Physics in 1901 and he tutored 22-year old mathematician Eamon de Valera to success in the RUI examinations and graduation in 1904. The facilities in Merrion Street had been built around a quadrangle with purpose-built accommodation for government departments in the two wings adjoining the space built for the RCScI. Now elected as Taoiseach, a more powerful office under the 1939 constitution, Eamon de Valera was warm to the idea of assisting his former UCD tutor in tackling the accommodation crisis bedevilling the incomplete Earlsfort Terrace complex. UCD could hand over its Merrion Street base to government if assisted in relocating Engineering and Science to a purpose-built complex in an expanded Earlsfort Terrace campus. By this time Lord Iveagh had gifted the Iveagh Grounds to the State, conditional on any new buildings being restricted to the Hatch Street frontage. An audacious plan for a new Engineering and Architecture Building was painstakingly put together involving the permanent closure of Hatch Street Upper to use the street and a portion of Iveagh Gardens as the site for this major development. Despite agreement-in-principle for this from Dublin Corporation (had de Valera's openness to the concept been conveyed?), confidential efforts to get one or other of two major traders to relocate their businesses from Hatch Street Upper were not successful. Unable to satisfy this pre-requisite requirement, it was determined that a large enough site could not therefore be put together and the plan was dropped. The interest of the government in the Merrion Street buildings was noted and put into cold storage for another day!

During the mid-1940's the University determined that efforts to develop an adequately sized campus at Earlsfort Terrace, even if incorporating limited street

Farewell to the Terrace. Final Year Civil Engineering class and staff, April 2007.

frontage land from the Iveagh Gardens, were doomed to be frustrated. A revised approach was adopted, envisioning a multi-campus approach with sites in and around Earlsfort Terrace. Hence there was strong UCD interest in purchasing Mespil House and its grounds on Mespil Road, when it came on the market in 1946. An offer was made, earmarking the property as a site for the Faculty of Engineering and Architecture. However UCD was outbid by semi-state company Irish Assurance Co. Ltd. (later Irish Life plc). UCD complained bitterly to government about the undermining of its efforts to provide adequate facilities by another arm of the State. The government indicated that the University could not expect to rely on the instrument of Compulsory Purchase Order for such land acquisitions.

Recognising the future scarcity of city centre land bank opportunities, UCD President Michael Tierney boldly determined that UCD's future lay outside the city. Assisted by Professor of Architecture J. V. Downes, a plan for a south city campus was drawn up. A process began in 1951 of quitely acquiring land to create a new campus. The nucleus was the Belfield House estate, where UCD already had a foothold of 44 acres in the form of the UCD Sports Grounds. As adjoining estates came on the market UCD would arrange for an individual to bid at auction without revealing the university's strategy, so that prices did not escalate beyond prevailing market rates.

Thus Merrion Street became the home of UCD Engineering from 1926 until 1989. It was not the end of the Earlsfort Terrace story. Two of the five disciplines would 'temporarily' set up camp in the Terrace in 1982 - a 'temporary' arrangement eventually spanning 26 years until 2007!

MERRION STREET

The Royal College of Science for Ireland building in Merrion Street was an elegant purpose-built teaching and research college, together with two wings housing government departments transferred from London to Dublin. As befitted a 'royal' college, the foundation stone was laid by King Edward VII in 1904 and the building was opened by King George V in 1911. The level of investment required, at £250,000 in 1910 prices, provides a benchmark from which to judge the challenge that faced UCD at the time with only £110,000 available to construct new facilities at Earlsfort Terrace for all its students and staff.

Aston Webb of London and Thomas Manly Deane of Dublin were appointed as joint architects. The construction contract was awarded to McLaughlin and Harvey Ltd. Deane had spent over a year in Italy on a Royal Academy Travelling Studentship award. This may have influenced the choice of Sicilian marble for the floors, a memorable feature of the building. Other than the Sicilian marble and Portland stone facade, all other materials were sourced in Ireland. This was politically important at the time – indeed some suggested that the appointment of joint architects was in response to Irish MP's strong representations regarding the appointment of Irish personnel in both design and construction.

The RCScI did not survive long as a 'Royal College' in its new home, facing into a

Merrion Street building facade

Merrion Street building entrance hall

decade of unprecedented upheaval. Many students interrupted their studies to join military ranks in the Great War from 1914 to 1918. During this period the facilities and expertise of the College were used to develop and supply munitions and sphagnum moss field dressings for the battlefields. Those who returned found a greatly changed landscape, with the War of Independence from 1919 to 1921 eventually leading to the establishment of the Irish Free State and the demise of the RCScI as an entity. During the troubled years of the early 1920's, students who had served in the British Forces were being advised that arrangements might be needed for the transfer of their studies to England.

The governments offices in the north wing

Merrion Street, Theatre 53

of the Merrion Street buildings included a room used as the location for the first cabinet meeting of the Irish Free State Executive Council. The room has continually been used for cabinet meetings ever since. The close proximity of cohorts of students to senior government ministers was a security concern for the new State authorities. Members of the Provisional Government were under death threat from opponents of the Anglo-Irish Treaty and some ministers had to take up temporary residence in their Merrion Street offices. UCD students attending RCScI for their Mech and Elec degree studies in this troubled period needed letters of approval from the Dean to gain admittance, a sensitive process that involved vetting of their political leanings, if any.

The RCScI ceased to exist with the passing of the University Education (Agricultural and Dairy Science) Act 1926 when the Minister for Finance transferred the Merrion Street teaching and research facilities to UCD "for the term of ninety-nine years from the appointed day subject to such nominal rent not exceeding five shillings as the said Minister shall think proper". On transfer "all fittings, furniture, scientific apparatus, and other chattels which are on that day on or in the lands and premises shall ...become and be the absolute property of University College, Dublin."

The 1926 Act demonstrated early commitment by the new State to invest in education as an instrument of economic and social advancement. State funding to UCD was increased from the 1908 legislative figure of £32,000 to £66,000 for 1926/1927 fiscal year and £82,000 in 1927/1928.

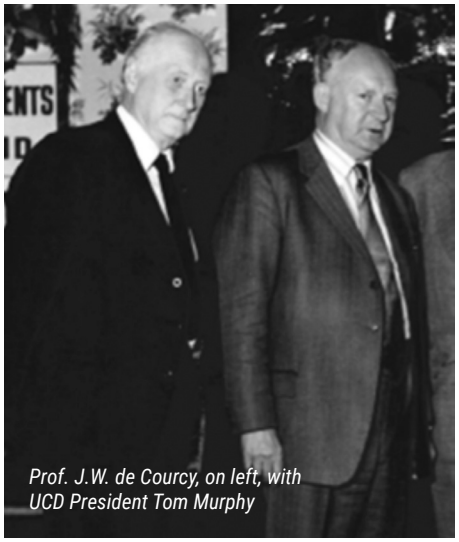
The Act made provision for offers of transfer to UCD of RCScI staff ("all professors, lecturers, porters, messengers, and other officers and servants"). The Minister legislated that: "Every existing officer shall be offered by University College, Dublin, employment in a situation in that College equivalent in respect of duties, salary, tenure of office, and conditions of service to the office held by him as an existing officer immediately before the appointed day." Three senior appointments to Faculty were made – two professors and a statutory lecturer. These were Felix Hackett, appointed Professor of Physics and Electrical Engineering; J. Taylor, appointed Professor of Mechanical Engineering; and Mr. R.G. Allen, appointed Lecturer in Electrotechnology. Other transfer appointments included workshop technician Mr. Peter Puzzau, whose contribution to the work of the Mechanical Engineering Department in subsequent years was particularly praiseworthy. The longest serving of the transfer appointments was lecturer George Ring, who retired from Electrical Engineering in 1967.

Felix Hackett, until then Professor of Physics at RCScI and Dean of the College (1922-1924), had already established an impressive reputation when he was a UCD student, 25 years earlier. Graduating with James Joyce in 1902, his accomplishments included editorship of 'St. Stephen's: a record of University life', published monthly during term. The

magazine invited essays from students, staff and alumni for possible publication. Not all essays made it past the editors – including an essay by Joyce!

Professor Michael A. Hogan succeeded Professor Purcell as Dean of Engineering. Land acquisition in Belfield was under way. In 1959 Hogan was instructed to urgently prepare plans for a new engineering building in Belfield, as the first Faculty to move to the new campus. However, on further evaluation the University determined that moving the Faculty of Science first would have the greatest net benefit in terms of freeing up space in both Merrion Street and Earlsfort Terrace. Construction began in Belfield on the Science buildings, for occupation in 1964. The engineers would have to wait a good while longer, despite the fact that the

Prof. Hogan and Prof. Purcell, 1946



Prof. J.W. de Courcy, on left, with UCD President Tom Murphy

Buildings Committee of Governing Authority was chaired by none other than retired Dean Pierce Purcell, ably assisted by Dean Michael Hogan, who succeeded him as Chair in 1968. Perhaps it was their lack of parochialism to engineering that led UCD President Michael Tierney to later write of Purcell that he was a man who acted "...in what we jointly believed to be in the College's best interests."

Student and staff numbers continued to grow throughout the 1960's and 1970's as the country invested in engineering education to meet the demand for graduates as part of a successful strategy of economic development. The Industrial Development Authority strategy of attracting foreign direct investment, notably in the pharmaceutical and information technology sector, increased the demand for engineering professionals. Consequently, the go-ahead was given in 1975 for the design of a new Engineering Building on the Belfield campus. The schedule of accommodation was determined under the expert eye of Professor J.W. de Courcy of the Civil Engineering Department, who consulted widely on best practice in modern European engineering education institutions. The cost of the new building, to accommodate a design figure of 1060 undergraduates and 175 postgraduates, was estimated at £25 million.

Meanwhile other UCD academic units were continuing to decant from Earlsfort Terrace to new homes in Belfield. An opportunity arose in 1980 to relocate the UCD School of Architecture, when the Masonic School in Clonskeagh came on the market. The Masonic School was located on 17 acres of land adjoining the Belfield campus. A deal was agreed whereby the government, under Taoiseach Charles J. Haughey, provided UCD with the £2.1 million required in exchange for space in the Merrion Street buildings. To honour the deal UCD moved two of the five engineering departments from Merrion Street to Earlsfort Terrace in 1982.

The 'temporary' move of Civil Engineering and Agricultural & Food Engineering to Earlsfort Terrace, completed in 1982, was done in anticipation that all departments would soon be reunited in the new Engineering Building in Belfield, for which planning was now at an advanced stage. A developing global economic recession, however, crippled the national finances and in 1983 the Department of Finance ordered a freeze on all third level building projects. The Dean of Engineering Dr. John J. Kelly, who had been elected to office in 1979 (a first for non-professorial candidates), protested to government at this example of "false economy." His view was privately supported by the Higher Education Authority and the Department of Education who submitted that the pause in advancing the engineering building project was "wasteful and uneconomic." The Department of Finance held firm, citing a need to see multi-annual capital needs for all higher education projects before exchequer funding of the £25 million would be forthcoming for UCD's new building. The project was stalled at design stage while governments came and went in an unprecedented five general elections during the 1980's.

The period architecture of the Merrion Street 'College of Science' lent itself to being an impressive building of the State, suitable as a focal point of government and elegant location for the Department of An Taoiseach. Mindful of his earlier deal with UCD to secure more government offices in 1980, Taoiseach Charles J. Haughey instructed the opening of further negotiations with UCD when he returned to power in 1987. Nevertheless the national finances were still under severe strain and creative thinking was required to get the costs down to a level that would gain cabinet approval. Eventually it was

Head Porter Arthur Keating on final Merrion St. lock up with the Dean, Vincent McCabe

determined that exchequer funding, supplemented by a grant from the European Union Development Fund, could only fund a first phase of the new Engineering Building in Belfield, that would initially provide accommodation for just the three departments in Merrion Street. The two departments that had already moved 'temporarily' to Earlsfort Terrace would follow later in a second phase of construction, when funding permitted. A Faculty meeting accepted the plan. Many in Earlsfort Terrace-based Agricultural & Food Engineering and Civil Engineering were disappointed that, once again, a purpose-built home for all of UCD Engineering was not realisable in the short term and that the trump card (Merrion Street building) had now been played.

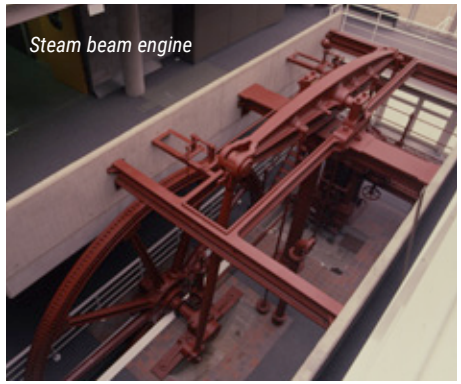
Following completion of 'Engineering Building Phase I', UCD Engineering vacated Merrion Street in 1989 and the State took possession of the entire building to renovate it as Government Buildings. Alas, 'Engineering Building Phase II' was never built. The two engineering departments in Earlsfort Terrace remained there until 2007, when an alternative solution for accommodation on the Belfield campus was found.

UCD ENGINEERING AND MATERIAL SCIENCE CENTRE

The Engineering Building Phase I, later renamed the UCD Engineering and Material Science Centre, was designed by Scott Tallon Walker Architects, appointed in 1976. The appointed civil and structural consulting engineers were Ove Arup and Partners (ARUP Consulting Engineers). The interiors included waffle slabs of high-quality exposed concrete and carefully detailed fair-faced blockwork walls. Though of excellent quality, the unrelenting grey concrete interior did not lift everyone's spirits. A section of the building was remodelled in 2006 to create an administrative hub for the newly-formed 'UCD College of Engineering, Mathematics and Physical Sciences'. The College Principal, Professor Nick Quirke, received permission to introduce painted plasterwork on the block walls of the remodelled section. This welcome innovation has been slightly contagious!

The occupation and commissioning of the new building was overseen by the Dean, Professor Vincent McCabe, who had been elected in 1986 when Professor Kelly had moved to the position of Registrar. Professor McCabe curated the installation of a significant collection of artwork, bringing colour to an otherwise grey backdrop. The collection includes the impressive oil on canvas painting *'Then we upon our Globe's last verge shall go'* by award-winning figurative artist Conor Walton. Fittingly the painting includes a figure that is clearly modelled on Vincent McCabe himself. Further immortalisation of Vincent McCabe in other work by the artist may be found in *'Self Portrait with Binoculars'*, now in the National Self Portrait Collection, and *'Telescopic Vision'*.

The atrium of the four-storey building encloses a significant historical artefact. A 19th Century steam beam engine from the former Jameson whiskey distillery in Smithfield, Dublin was secured for restoration and display. It is housed in a purpose-designed enclosure within the building. The impressive installation is activated on special occasions when the giant wheel spins and the long beam pivots, with attendant 21st Century health and safety measures in place, of course!



Steam beam engine

Following the completion of Phase I in 1989, it was anticipated that Phase II of the building would be commenced as soon as the national finances improved. To this end the western end of the central spine of Phase I was glazed and temporarily flanked by external sheet metal cladding which could be readily removed when the time came to 'dock' Phase II with the Phase I 'mothership'. Alas Phase II never happened but thirty years later, the temporary external sheet metal cladding is still mocking those with long memories!

UCD Engineering and Material Science Centre

NEWSTEAD BUILDING

An opportunity arose in 2003 to expand the Belfield campus when Philip's Electronics Ltd. decided to relocate their headquarters from Clonskeagh to west Dublin. The UCD President Art Cosgrove seized this opportunity as the tipping point for a three-part plan to relocate remaining academic units from Earlsfort Terrace to the Belfield campus. The 9.5 acre Philip's site, earmarked for the UCD School of Civil Engineering, was absorbed into the Belfield campus. Funding for acquisition and renovation work was raised by disposing of 4 acres on the north of the campus suited to private residential development. The Philip's Building was remodelled for educational use to the design and specification of Kavanagh Tuite Architects on a tight budget of €11 million. The engineering consultants were Clifton Scannell Emerson Associates and the contractor was John Paul Ltd. The end product was to a high standard and many visitors to the refurbished building were surprised to learn that it was not a new-build. The project architect was Brian Kavanagh, a UCD graduate, whose firm had completed several successful projects on campus. Sadly he died suddenly in 2018, just months after his firm had been announced as a member of the winning consortium, led by Steven Holl Architects New York, for the UCD Centre for Creative Design, foregrounding a new entrance precinct to the University.

The remodelled 'Philips Building' was ready for occupation in 2007 by which time Belfield had welcomed the UCD School of Biosystems and Food Engineering to the Agriculture and Food Science Centre, while the School of Medicine and School of Nursing, Midwifery and Health Systems had moved from Earlsfort Terrace into a new Health Sciences Building. In June 2007 the UCD School of Civil Engineering were the last unit to bid farewell to 'the Terrace', marking the formal end of UCD's 98-year presence. Before finally closing the door on the Terrace, a valedictory lecture was given by former Dean of Engineering Professor Vincent McCabe during an 'open house' for UCD graduates on 19th May 2007.

Farewell to the Terrace also meant farewell to Hartigan's Pub in nearby Lower Leeson Street, the unofficial staff/student common room. A framed photograph of the Civil Engineering students and staff of the last academic year in the Terrace was duly presented by Professor Eugene O'Brien to Mrs. Evelyn Mulligan (alias 'Ma Hartigan') in grateful appreciation of the memories in good times and bad. The photograph now hangs in a prominent position in this famous Dublin pub.

The newly acquired land, incorporating the 'Philips Building', was once the grounds of a house named Newstead. This had been the residence of distinguished UCD alumnus, Hugh Kennedy. He had studied at UCD at the same time as James Joyce. A student of law, Kennedy was the founding editor of UCD's journal 'St. Stephen's: a record of University life'. He went on to become the first Attorney General (1922-1923) and Chief Justice (1924-1936) of the Irish Free State. The Kennedy papers were presented to UCD Archives where they are now consulted by those researching the history of the foundation of the State. Part of a walled garden of the former estate is still extant and the UCD School of Civil Engineering have styled their renovated new home as the 'Newstead Building', retaining continuity with the past.

UCD School of Civil Engineering, Newstead Building

EVOLUTION OF TAUGHT PROGRAMME STRUCTURE AND CONTENT

The development of engineering education programmes is heavily influenced by the needs of the market. Market needs have generally been articulated through the professional bodies and their accreditation requirements. The Dean, Professor Purcell and later Professor Hogan, ensured that the programme of study met the educational standard required for membership of the Institution of Civil Engineers of Ireland (ICEI). The Institution, founded in 1835, had received a Royal Charter in 1877 which facilitated international recognition of its members as fit-to-practice. The value of the Royal Charter as a quality assurance benchmark survived through the foundation of the Free State in 1922 but in a parallel development Cumann na n-Innealtóirí (The Engineers Association) was set up in 1928. The Cumann was effectively a trade union advancing the pay, conditions and status of professional engineers, which ICEI could not do under its charter. Many engineers were members of both bodies. Eventually the need for arm's length distance between activities of the two bodies was no longer deemed essential. A merger was legislated for in a 1969 Act of the Oireachtas, leading to the formation of the Institution of Engineers of Ireland (IEI). The Act gave protection in law to the title 'Chartered Engineer' (C.Eng). The first President of IEI was UCD's Professor of Civil Engineering James C.I. Dooge. The educational standards for C.Eng. were set out and university programmes meeting these requirements were accredited.

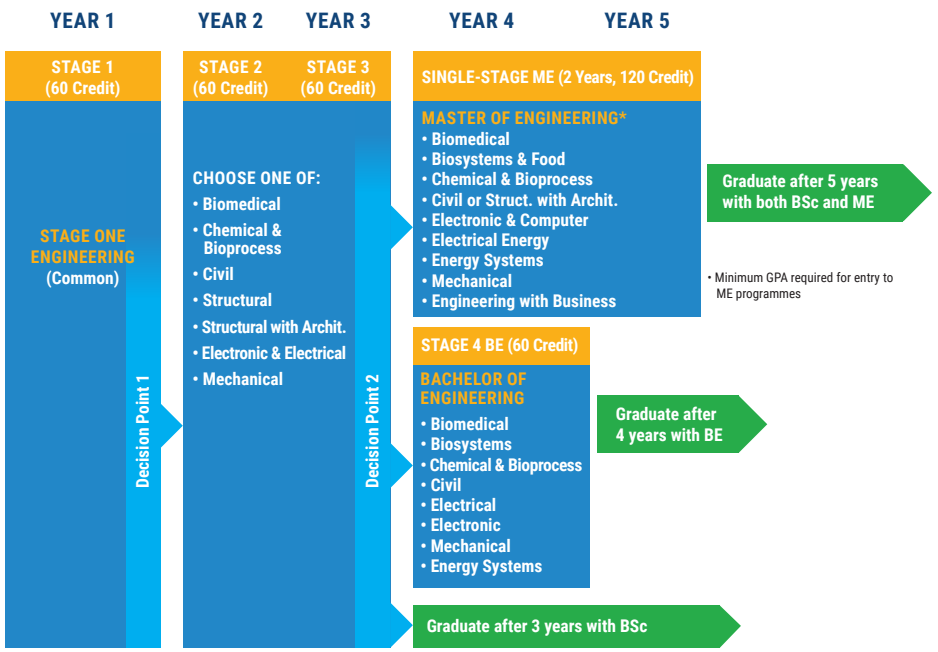
FROM THREE-YEAR BE TO FIVE-YEAR ME

The inaugural BE (Civil Engineering) programme was of three years duration. For practical reasons the inaugural BE (Mechanical and Electrical Engineering) programme required four years of study, due to the practicalities of the arrangement entered into with RCScI. On the merger of RCScI with UCD in 1926, the programme was brought into line with Faculty's three year norm. However, the matter was later revisited and the M&E programme was extended to four years of study in 1934. The two BE degree programmes at UCD were then out of step for two decades as it was not until 1956 that the Civil Engineering programme moved from a three-year to a four-year syllabus. The structure of the later BE degrees in Chemical Engineering and Agricultural Engineering were introduced as four-year programmes.

The situation remained largely unchanged until 2012. The catalyst for change was the signing by Ireland, together with 28 other European countries of the Bologna

Declaration in 1999 to ensure "comparability in the standards and quality of higher-education qualifications" throughout the European higher education sector. The Declaration had the effect of generating interest in harmonized academic programmes to promote, inter alia, student mobility. An unexpected collateral development from discussions throughout Europe was that the IEI (now styled as 'Engineers Ireland') unilaterally raised the educational benchmark for C.Eng. requiring five years of study. Effectively the requirement from 2012 became an integrated 5-year accredited master's degree or a combination of an accredited bachelor honours degree and master's degree ('3+2' or '4+1'). Separately, UCD had already pioneered a '3+2' model of European higher education. Dr. William (Bill) Magette represented UCD in a European Union Thematic Network on Civil Engineering Education which examined models of engineering education. Subsequently UCD became the first Irish university to offer an accredited civil engineering programme that followed the '3+2' model. The structure ideally suited an innovative programme, Structural Engineering with Architecture, being designed and co-ordinated by Dr. Amanda Gibney. It was offered from 2004 and

Pathways to qualification, 2019



served as the template when the new C.Eng. accreditation requirements nudged UCD Engineering to promote three-year duration BSc (Engineering Science) programmes leading to two-year ME programmes.

Although five year study programmes became the new UCD flagship programmes, it was also decided to continue offering the traditional four-year BE degree programmes. The BE degree retains Washington Accord status. Additionally it is a pathway to meeting the educational standard required for Chartered Engineer in Ireland if BE graduates subsequently complete a one-year master's degree, or equivalent.

THE ORIGINAL ME DEGREE

The prestigious Master of Engineering (ME) degree programme was offered throughout the 20th century in a format that particularly appealed to those who had achieved significant advances in the art of engineering through their professional practice. The NUI began offering the ME degree soon after it became a degree-awarding body in 1908. The first recorded UCD Master of Engineering graduate was Edward Duffy B. Sc, B.E. in 1923.

It was recognised that enrolments from practising engineers would, by their nature, be sporadic and the Dean required six month's notice from those intending to enrol so that appropriate arrangements could be made. Entry to the programme was not permitted until at least three years after completion of the BE degree. The format of assessment was two written exams and a research thesis. The research thesis requirement could however be met by "satisfactory evidence of at least two year's experience in the design and construction of Engineering Works." All candidates took an examination in 'Strength of Materials and Theory of Structures'. The second written exam was in 'Engineering Practice' and candidates could choose their specialisation, such as 'Municipal and County Works', 'Railway Engineering', 'Harbour and Docks', 'Irrigation and Drainage' and 'Construction Engineering'.

Only about 70 such degrees were conferred in UCD over the course of the entire 20th century. Members of that elite ME club included UCD academics Jim Walsh in Chemical Engineering, J. W. (Seán) de Courcy and Eamon Hanrahan in Civil Engineering, J. O. (Seán) Scanlan in Electronic Engineering and Gerry Cummings in Mechanical Engineering.

The later use of the ME qualification in the '3+2' programme model, with first such graduates in 2009, took cognisance of a directive from the NUI to minimise the proliferation of new degree titles when launching new programmes and the reality that the ME degree in its traditional programme format was little used at that time.

TAUGHT MASTER'S FOR STEM GRADUATES

Taught master's programmes were introduced from the late 1960's. These catered for two distinct markets. The Master of Engineering Science (MEngSc) degree programmes allowed a deeper technical study of a specialisation. The Master of Industrial Engineering (MIE) degree programme, first offered in 1967, linked engineering and business. It was developed into the Master of Engineering Management, ME(Mgmt) programme, from 2009. A Master of Engineering Design (MEngDesign) programme was introduced in 1986. The programmes were designed to meet the needs of suitably qualified graduates of science, technology, engineering and mathematics.

The MEngSc programmes are generally of one-year full time duration. This model proved popular with international graduates, sponsored by their governments, employers or Irish aid agencies. For example, many graduates from Africa spent 12 months in the UCD Civil Engineering Department upskilling in water engineering. The format was typically one of lecture attendance from September to May, followed by an intense period of laboratory research during the summer. Class size was typically 10 to 15.

The MIE and ME(Mgmt) programmes were designed for the needs of those undertaking master's level study while remaining in full-time employment. The two-year part-time programmes involved up to nine contact hours per week with lectures on Friday afternoons, evenings and on Saturdays. The students typically undertake an applied work-related project in their second year, although alternative options are available. The programmes consistently attracted a class size of 15 to 20 over the years.

The MEngDesign programme was also a two-year part-time programme. Applicants were required to have industrial experience. Coursework accounted for 40% of the programme. Students chose from 17 subjects covering topics such as tribology, design of machine elements, design of automated manufacturing systems, and the design and management of production systems. Although designed for university graduates, it also provided a potential route to a master's qualification for those who had attained corporate membership of a professional institution without an undergraduate degree.

PROGRAMME CONTENT

The syllabus of the inaugural 1909 UCD BE degree programme was built heavily on the existing tradition in Ireland established by the examination syllabi of the Royal University of Ireland. The pedagogy was based on mastering mathematics and the fundamental sciences in First Year. The engineering sciences were introduced in Second Year. Application of mathematics and science to engineering design was the focus of Final Year. This basic framework formed the backbone of the programmes over the years, reinforced by adherence to accreditation criteria.

Irrespective of engineering discipline the rite of passage was 'First Eng.' The traditional format comprised six year-long subjects, many of which overlapped with subjects of the Leaving Certificate. Many found this learning experience boring and demotivating. An exciting change occurred in 2004 with the introduction of modularisation and semesterisation. The learning blocks were split into units equivalent to 100 to 125 hours of student workload, each earning 5 credits (ECTS)

Snapshots of first year syllabus from 1909 to 2019

First Engineering Programme

1909/1910	1959/1960	1989/1990
Mathematics	Mathematics	Mathematics
Maths Physics	Maths Physics	Mechanics
Inorganic Chemistry	Chemistry	Chemistry
Experimental Physics	Experimental Physics	Experimental Physics
Engineering including Elementary Descriptive Architecture	Engineering Drawing	Engineering Graphics
	Workshop Practice & Elementary Surveying	Manufacturing Technology
		Computer Science
		Introduction to Engineering

2019/2020, Semester 1	2019/2020, Semester 2	
Introduction to Calculus for Engineers	Linear Algebra for Engineers	*Option 1, Option 2: select from the following:* Biomedical Sciences: Understanding Human Disease
Intro. to Eng. Computing	Mechanics for Engineers	
Chemistry for Engineers	Energy Engineering	Biosystems Eng. Design Challenge
Physics for Engineers I	Physics for Engineers II	Chemical Eng. Process Principles
Creativity in Design	Option 1	Computer Science for Engineers I
Electronic and Electrical Eng.	Option 2	Intro to Civil & Environmental Eng
		The Engineering and Architecture of Structures
		Energy, Climate Change & Policy
		Materials in Society
		Robotics Design Project

on successful completion. The six year-long subjects were replaced by 12 semesterised modules, totalling 60 credits per stage. More importantly, this included two free electives or options, giving students a greater sense of responsibility for their learning experience. Snapshots of the first year syllabus at intervals between 1909 and 2019 show the lack of innovation prior to the significant shake-up through modularisation. UCD engineering graduates from any discipline or decade of the 20th Century will smile (or groan!) at how little change there was in the First Engineering experience over a long period.

Despite the fact that the RUI syllabus would have been heavily influenced by the graduate attributes for employment in the U.K. and colonies of the British Empire, the inaugural UCD civil engineering programme, largely cloned from the RUI, changed little with the formation of the State. This probably indicates the role of the professional bodies in influencing the educational requirements of its members, with committee structures that would be cumbersome in promoting change. The programme syllabi for the two UCD engineering disciplines saw little if any innovation in the first 40 years, other than a short course on 'Aesthetic Aspects of Civil Engineering Design' presented by Joseph Downes, Professor of Architecture, to the final year civil engineers. However, greater change was becoming apparent in the programmes when the Faculty celebrated its fiftieth anniversary in 1959. The syllabi for that period are presented in the accompanying tables. It may be observed that there was significant commonality of subjects across the three disciplines in Second Year. About half of the Third Year syllabus was common between Electrical and Mechanical Engineering.

Inaugural BE Degree syllabus

Inaugural UCD Civil Engineering Programme, 1909

First Year	Second Year	Final Year
Mathematics	Mathematics	Mathematics and Maths Physics
Maths Physics	Maths Physics	Geology
Inorganic Chemistry	Chemistry applied to Engineering	Engineering including Surveying, Strength of Materials, Materials (testing), Theory of Structures, Constructional Engineering & Contracts
Experimental Physics	Experimental Physics	
Engineering including Elementary Descriptive Architecture	Geology	Option topics (chose 2 subjects): Municipal Works, together with Waterworks OR Railways, together with Harbour, Docks, Rivers, Canals
	Engineering including Surveying, Mensuration, Hydraulics, Materials, Graphics	

ADDITIONAL ACADEMIC REGULATIONS

At intervals over the course of the last 100 years, certain special academic regulations have applied at one time or another to engineering education regarding languages and mathematics.

The encouragement of reviving the Irish language formed part of the mission of the NUI colleges. Before Irish became a mandatory matriculation requirement in the 1930's those who did not have the subject were required to attend an additional course in Irish Language, Literature and History. An academic regulation existed until 1964 whereby all NUI degree examination students were required to have both attended and passed a course in oral Irish.

A foreign language requirement specific to engineering was introduced in 1965, requiring demonstration of competence in translating a technical publication. Before admission to the BE Degree examination students were required to have passed a written test in a recognised foreign language. The test involved translating technical passages into English and dictionaries were permitted at the exam. The recognised languages were French, German and Russian. Spanish was also added for a period. Instruction was provided once per week during First Year. Proficiency in the Russian language was somewhat rare in Ireland at the time but UCD was fortunate to have Commandant Martin Bates of the Irish Defence Forces to tutor the students. Where else but the military to look for a Russian language expert in Ireland during the Cold War period!

Although mathematics was an optional subject in final year, it was a mandatory pre-requisite for the award of First Class Honours in certain branches of engineering. During the 1960's this requirement applied to all branches, although Mathematics could be substituted by Computer Science in the case of Agricultural, Chemical and Mechanical Engineering. The requirement was later standardised on Mathematics but was dropped in the case of Chemical and Civil Engineering in the 1970's, by Agricultural Engineering in the 1980's and by Mechanical Engineering in the 1990's. However Electrical and Electronic Engineering retained the requirement up to the major revision of academic regulations

BE Degree syllabi, Second, Third, Final Year in 1959

1959	BE (Civil Engineering)	BE (Electrical Engineering)	BE (Mechanical Engineering)
Second Year	Mathematics	Mathematics	Mathematics
	Maths Physics	Maths Physics	Maths Physics
	Experimental Physics	Experimental Physics	Experimental Physics
	Fluid Mechanics	Fluid Mechanics	Fluid Mechanics
	Strength of Materials & Graphics	Strength of Materials & Graphics	Strength of Materials & Graphics
	Laboratory Practice & Mechanics	Laboratory Practice & Mechanics	Laboratory Practice & Workshop Practices
	Surveying & Mensuration	Electrical Engineering	Electrical Engineering
	Geology		Mechanisms & Mechanics
Third Year	Mathematics	Mathematics	Mathematics
	Strength of Materials	Strength of Materials	Strength of Materials
	Theory & Design of Structures I	Thermodynamics	Thermodynamics
	Hydraulics II	Mechanics of Machines	Mechanics of Machines
	Soil Mechanics	Electrical Circuit Theory	Machine Design & Production
	Engineering Construction & Quantities	Electronics I	Properties of Materials and Metallurgy
	Production and Properties of Materials	Electrical Machines I	Electronics
	Electrical Engineering	Electrical Measurements and Testing	Electrical Engineering
	Geology		
Final Year	Eng. Economy & Professional Practice	Eng. Economy & Professional Practice	Eng. Economy & Professional Practice
	Theory & Design of Structures II	Generation, Transmission, Distribution of Electrical Energy	Applied Thermodynamics
	Soil Mechanics		Power Plants
	Materials of Construction	Electrical Machines II	Dynamics and Control
		Advanced Electrical Engineering	Fluid Mechanics and Heat Transfer
		Electronics & Communications	Electrical Engineering
		Applied Thermodynamics & Power Plants	
	Engineering Project	Engineering Project	Engineering Project
	OPTIONS	OPTIONS	OPTIONS
	Mathematics or	Mathematics or	Mathematics or
	Sanitary Engineering	Transmission Lines or Control Systems	Industrial Organisation

consequent on the move to a modularised curriculum in 2004.

Academic regulations also required students to have attended at least 75% of the lectures in each subject before being permitted to take the examinations. In practice few lecturers took attendances, although it was practice for a period in the 1970's for First Engineering students during Physics lectures by Dr. Grimley.

CONTACT HOURS

The abiding feature of the engineering undergraduate programme was the relatively high contact hours, compared to programmes in some other faculties. For example the First Eng timetable typically comprised 35 contact hours. The combination of high contact hours and location remote from Earlsfort Terrace or Belfield in the period 1926 to 1989 made engagement in clubs and societies somewhat problematic. Fun was had so it is self-evident that it was by no means impossible to get involved in student life on the main campus.

Split location was another feature. It was not unusual to have one or two lectures in Earlsfort Terrace followed immediately by one or two in Merrion Street. From the late 1960's First Engineering students regularly had morning lectures in Belfield followed by afternoon drawing office in Earlsfort Terrace or workshop in Merrion Street.

First Engineering weekly timetable, 1939/1940

	Monday	Tuesday	Wed.	Thursday	Friday	Saturday
09:00		Maths Physics		Maths Physics		Maths Physics
10:00	Maths	Tutorial	Maths	Tutorial	Maths	Engineering
11:00	Maths	Chemistry	Maths	Chemistry	Maths	Chemistry
12:00	Physics	Engineering	Physics	Engineering	Physics	Drawing
14:00	Chemistry (2-5pm)	Drawing (2-5pm)	Chemistry (2-5pm)	Drawing (2-5pm)	Physics (2:30-4:30pm)	

STUDENT LIFE:

Getting in, getting by, moving on

The formal entry route to UCD from 1909 to 1992 was through the NUI Matriculation Examination. In the early years a Certificate of Character from the head of the last school attended was also required. The 'matric' examinations were set and graded by staff of the NUI's constituent colleges. The examinations were attracting over 1000 candidates per annum at the time of formation of the Irish Free State in 1922, about half of whom were successful each year. The successful candidates, with the financial resources to undertake study in UCD, later queued in Earlsfort Terrace in parallel lines to register for their degree programme of choice. Anecdotes abound of the impatient ones who made their career choice based on the shortest or fastest moving queue!

THE MATRIC, THE MATHS, THE POINTS

The most important subjects for university admission for many years were selected from Greek, Latin, English, Mathematics, Irish and foreign languages. Among approved examination subjects in the 1920's was 'Physiology and Hygiene' but it was "for women candidates only". Irish became mandatory for applicants from Ireland (32 counties) from the late 1930's.

The Senate of the NUI decided in 1938 that entry to engineering programmes would henceforth require a minimum standard in mathematics. A special two-paper Entrance Examination in Mathematics was made available for those without Leaving Certificate Mathematics. Paper 1 was 'Arithmetic and Algebra', including compound interest; mensuration of right prisms, pyramids, cones and spheres; logarithms; and algebra up to and including Binomial Theorem. Paper 2 was 'Geometry and Trigonometry' and the geometry syllabus was summarised as "approximately equivalent to that contained in Euclid Books I to IV and VI". The bar began to rise in 1941 when sister-college UCC demanded a minimum of honours grade for those using Leaving Certificate Mathematics to qualify. A unified approach was not adopted by the NUI constituent colleges at that time but in 1946 UCD raised its requirement to a minimum of 50% in Leaving Certificate Mathematics. Letter grades, were introduced to state examinations in 1969 and the UCD requirement became a minimum of Grade C, later C3, raising the minimum mark equivalency to 55%.

It was possible to 'buy out' the matric exam through satisfactory performance in Leaving Certificate examination subjects. Over time 'matric' exam candidate

numbers progressively fell to a low number. Eventually the Senate of the NUI narrowly voted to abolish the 'matric' exams from 1992 and standardised on the Leaving Certificate as the benchmark for entry. A protocol exists for ongoing NUI liaison with the State Examinations Commission regarding the examination standard and grading practices of those Leaving Certificate subjects recognised for matriculation purposes.

The National Council for Curricula and Assessment conducted a review of Leaving Certificate Mathematics in 2005. The review involved a fundamental evaluation of the relevance of mathematics to students and the design of an engaging syllabus appropriate to their needs. Around this time there was renewed debate regarding the appropriate benchmark for entry to UCD Engineering, addressing particular concerns of academics in Electrical and Electronic Engineering. The bar was raised to Grade B3 in 1998, representing a minimum equivalency of 70%. Denominated entry was introduced to First Engineering in 2001, allowing for a reversion to the Grade C3 requirement in all disciplines except Electrical and Electronic Engineering, where it remained at B3. Following the introduction of new Leaving Certificate grading scales in 2017 the current requirement is a minimum of Grade H4, representing a minimum mark equivalency of 60% on the higher level paper.

Snapshots of minimum entry requirements for UCD Engineering

Year	Matriculation Requirements for UCD Engineering					
1909	5 subjects, one from each of the following groups					
	Latin or Greek	Irish or foreign language	English or History & Geography	Mathematics or Physics	Other approved subject	
1939	5 subjects, one from each of the following groups, with adequate standard in mathematics of NUI qualifying exam or Leaving Certificate (Higher Level), minimum 40%.					
	Irish	Latin, Greek or foreign language	English	Mathematics or Natural Philosophy	Other approved subject	
1972	6 subjects, one from each of the following groups, with adequate standard in mathematics of NUI qualifying exam or Leaving Certificate (Higher Level), Grade C (minimum 55%)					
	Irish	English	Mathematics	Laboratory Science subject	Latin, Greek or foreign language	Other approved subject
2019	Leaving Certificate, minimum of H5 (Higher Course, 50-59%) in 2 subjects and H7 (Higher Course, 30-39%) or O6 (Ordinary Course, 40-49%) in 4 subjects, with adequate standard in mathematics of minimum H4 (Higher Course, 60-69%) and Laboratory Science subject, minimum H6 (Higher Course, 40-49%)					
	Irish	English	Mathematics	Laboratory Science subject	Other approved subject	Other approved subject

The entry requirements increased from five to six subjects in 1972. The allowed the introduction of a further restriction: applicants were required to have a satisfactory grade in a laboratory science subject. The recognised subjects for this were Biology; Chemistry; Physics and Chemistry (Joint); or Physics; and Agricultural Science was later added.

The welcome introduction of free second level education in 1967, combined with economic development, soon led to demand for third level places exceeding capacity. In the event of demand exceeding capacity in a particular programme, eligible applicants were allocated places strictly on the basis of merit, through ranking based on examination performance in six subjects of the matric exams, Leaving Certificate or a combination of both. Later a restriction was introduced whereby only results in a single Leaving Certificate sitting could be used for scoring purposes. This 'points system' was initially administered within the University but has been conducted by a third party, the Central Applications Office (CAO) since 1977.

When first introduced in the 1970's, a minimum score of about 22 points (Higher Level Grade B = 4 points, C = 3 points) was required for UCD First Engineering. Thus a candidate typically needed to average about 65% on six higher level papers. The minimum score required in 2019 was 511 points (Grade H2 = 88, H3 = 77). Thus candidates typically needed to average about 75% across six higher level papers, assuming bonus points in Mathematics are included. Leaving Certificate students are currently incentivised to study Mathematics at Higher Level by being rewarded with 25 bonus points for Grade H6 or higher. In practice this does greatly influence the ranking of candidates applying to engineering in UCD, who require a minimum of Grade H4 in any event, although matriculation requirements and best subject grades for points score are not inextricably linked.

COMPETITION FOR ENTRY TO SECOND YEAR

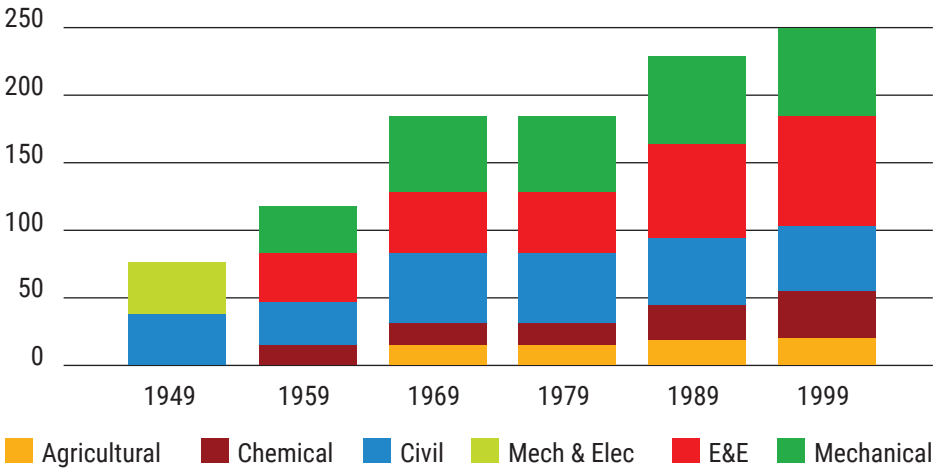
Entry to UCD Engineering has traditionally been to a common undenominated First Engineering course at the end of which students stream into their chosen discipline. Significant fluctuations of students' preferences, usually related to the cyclical fortunes of the construction sector, have created problems for the University in providing steady-state resources in each discipline. This was apparent even with the initial two disciplines of Civil Engineering and

Mechanical & Electrical Engineering. Complexity increased with the division of M&E into separate disciplines in 1957 and the addition of Chemical Engineering in 1956 and later Agricultural (now Biosystems) Engineering in 1961.

The solution, first adopted in the 1940's, was to fix quotas of available places in each discipline from Second Year, which were competed for on merit, determined from the First Engineering examination results.

Practice was not entirely consistent over the decades. In the 1940's the practice was to allocate up to 30 places in each discipline based on the results of the summer examinations. An additional 5 places were then filled following consideration of the performance of both surplus summer exam candidates and successful autumn exam candidates. In the 1950's, all successful summer examination candidates were ranked based on exam performance and allocated a place based on their highest available preference. The Dean would then announce the situation regarding any remaining vacant places and successful autumn exam candidates competed for these, based on a revised statement of their preferences. From the 1960's the ranking of all candidates was based solely on performance in the summer sitting of the First Engineering examinations. Places were strictly allocated thereafter in four iterations:

Quota of available places in Second Year by discipline



- successful summer examination candidates, first year of registration;
- successful autumn examination candidates, first year of registration;
- successful summer examination candidates, repeat year of registration;
- successful autumn examination candidates, repeat year of registration.

Thus repeat students were at a significant disadvantage. They could qualify for a place by doing well in their repeat examinations but they could not leapfrog first attempt candidates.

The 'level playing pitch' approach of ranking based on the first examination sitting was accepted with good grace by disappointed students (but not always by their disappointed parents!). The allocation process was automated on UCD's mainframe computer by Peter O'Neill, Lecturer in Mechanical Engineering, which helped discourage dissent – the computer's decision was transparently fair and impersonally final! Nevertheless further consideration was given to better aligning student preferences with place availability. Consequently in 2001 UCD offered denominated entry for the first time to the five disciplines. A further category of 'Civil or Mechanical' was offered from which a free choice was available on entry to second year. Based on satisfactory experience, it was possible to replace the 'Civil or Mechanical' cohort by a fully undenominated group with free choice in 2004.

This change occurred at a time when the traditional 4 year BE degree programme was being joined by Bologna Declaration '3+2' structured BSc/ME degree programmes. This led to no less than nine UCD Engineering gateways for CAO Applicants in 2006. Meanwhile, the national increase in the number of CAO programme codes facing school leavers was becoming a matter of concern for the Minister of Education. The number of CAO Level 8 programme codes had grown in 40 years from an initial 69 to over 900, through denominated entry to sub-disciplines. The higher education sector was encouraged to reduce the burden of choice on school-leavers by having a reduced number of programme codes through greater use of undenominated first year courses. UCD has been supportive of this philosophy and accordingly one single undenominated Engineering CAO programme code was reverted to from 2017. Happily, the introduction of modularisation and semesterisation has allowed this to be reintroduced without the need for Second Year quotas – students may enrol for modules in their specialism of choice as they progress through the programme.

THE ISSUE OF TUITION FEES

Financial constraints meant that for many decades university places were seen as

the preserve of the children of wealthy families, as opposed to the most intellectually gifted, allowing the cynical observation that university students were "the cream of society: rich and thick!" The annual cost of taking engineering studies at UCD in 1909 was of the order of £18. This had a buying power of about €2700 in 2019 values, which compares with a standard student contribution of €3000 per annum that is currently charged to undergraduate students eligible for 'free fees'.

Tuition fees in the period 1909 to 1940 were calculated on a fee per subject basis. The lowest rate (two guineas) applied to lecture-based courses with high enrolment figures such as Mathematics and Maths Physics. A higher fee (three guineas) applied to courses with both lecture and laboratory classes. The most expensive subject for engineers was Chemistry (six guineas), presumably reflecting the higher cost of consumables in the laboratory classes.

The practice of charging an annual fee based on programme of study, rather than fee per subject, became a more common practice from the 1940's. At that time the fee for each of the three years in the Civil Engineering was £42 per annum. The same annual fee was charged for the Mechanical and Electrical programme except for the extra fourth year, which had a lower fee of £28.

A significant change to the funding of third level institutions occurred in 1996 when the concept of 'free fees' at third level was introduced by the Minister for Education. Under the new arrangement the tuition fee portion is paid by the State in respect of qualifying undergraduate students. Tuition fees are however levied by universities on non-EU undergraduates, all graduate students and on those repeating modules.

A shortfall in exchequer funding to higher education institutions has been partially alleviated by allowing universities to collect a 'registration fee' or 'student contribution' to cover non-tuition student services such as examination entry fees, support for student services and support for student clubs and societies. The level of this contribution from the student is regulated by the State and is currently €3,000 per annum. Meanwhile debate continues on how the State will address the funding of third level education on a more sustainable basis. Reintroduction of tuition fees payable by the students is a difficult political move for a government.

Approximate annual cost of tuition in UCD Engineering, 1909-1995

Year	1909	1919	1929	1939	1949	1959	1969	1979	1989	1995
Fees	£18	£18	£24	£27	£47	£75	£90	£423	£1641	£1753

UCD students voted in 1998 to introduce a student levy of IR£30 (€38.10) annually to fund development of a new UCD Student Centre. A magnificent Centre incorporating world-class sports facilities was progressively developed. Successive referenda allowed increases in the levy over time. Most recently students voted to extend the scheme to 2043 to allow further development. The current rate is €254 per annum.

Taking account of the qualifying conditions for 'free fees', student contribution and levies, a typical EU undergraduate will currently pay €3254 per academic year to study engineering at UCD. Those EU students who do not qualify for 'free fees' pay additional tuition fees of €4320, totalling €7574 per year. International (non-EU/EAA) undergraduate engineering students pay €24,800 in total per annum.

SCHOLARSHIPS AND BURSARIES

Funding the cost of a university education could be helped by competing for scholarships and bursaries. These also allowed the University to recognise excellence.

The NUI offered competitive entrance scholarships from its 1908 inception. Funding was significant. In 1910 for example these were valued at £25 at a time when engineering tuition fees amounted to about £18 per annum. Successful candidates had the possibility of renewal based on performance in first and second year examinations. Monetary prizes ('exhibitions') were awarded to the two highest performing candidates in the engineering examinations. In 1910 the top-ranked examination candidate in each year of the UCD engineering programme was awarded £20, while the runner-up was awarded £10. The practice of rewarding top performing students, subject to attainment of a high honours standard, was continued over the century. Although the awards budget increased with inflation, the value of the award per student had to be reduced as the budget was eventually stretched over the top performers in each of five engineering disciplines. Class prizes were also awarded on the basis of performance in particular subjects – for example 'Year's Work' – but the monetary amounts were nominal. For example in the 1970's class prizes ranged from £3 to £30. Nevertheless even £3 would buy a round of 12 pints of Guinness in 1975!

Prestigious awards were also competed for in final year, most notably the Pierce Malone Scholarship and the Bursary in Engineering.

A bequest of £1425 was made to the National University of Ireland in the early years of its foundation through the will of Mr. Pierce Malone. The will made provision

for the establishment and endowment of scholarships in both engineering and in philosophy ('Mental and Moral Science'). The successful candidates were selected based on examinations set and assessed by the relevant NUI external examiner. Initially the Pierce Malone Scholarship in Engineering was assessed through the performance of entrants in two examination papers: 'Strength of Materials' and 'Theory of Structures'. The first UCD winner was Edward Duffy in 1915, who later became the first ME graduate in 1923. Several award winners would later become UCD engineering academics and leaders. These include Prof. Michael A. Hogan (1918 award); Prof. James C.I. Dooge (1942 award); Prof. Thomas J. Casey (1954 award). In the 1944 competition, Liam F.A. Stephens, later to become a UCD academic, qualified for both the Pierce Malone Scholarship and the Bursary in Engineering, which created a pleasant headache for the NUI – one person could not receive both! The Bursary was awarded to Stephens and the Pierce Malone Scholarship went to the next best candidate, who was from UCC that year. UCD Alumnus Joseph A. Kindregan, previously Head of the Department of Civil and Structural Engineering at the Dublin Institute of Technology, won the award in 1976. He is currently President of the Institution of Structural Engineers.

Eamon Hanrahan, Liam Stephens, Michael Hogan, 1954

The NUI introduced a Bursary in Engineering competition in 1930. The Bursary was tenable for one year on condition that the awardee enter an approved 'engineering office or engineering works'. An interim report, signed off by the supervisor, was submitted after 6 months. From 1948 two bursaries were available – Bursary in Civil Engineering and Bursary in Mechanical & Electrical Engineering. Following the introduction of Chemical Engineering, a single bursary was available from 1956 on a rotating basis across the three disciplines. The award was valued at £150 in 1930 – a considerable sum at the time. The figure remained unchanged until the mid-1950's when it was increased to £400. It had increased to £3500 by 1979. Bursaries were offered across Chemical Engineering, Civil Engineering and Electrical & Electronic Engineering as late as 2000.

In the 1930's, the BE Degree examinations were spread across both a summer and autumn sitting and eligible candidates for the Bursary were required to have obtained honours in both sittings. The Bursary competition was based on three examination papers. Paper 1 and Paper 2 were those set for the Pierce Malone Scholarship competition. The additional Paper 3 was also set by the External Examiner.

The first winner was a UCD graduate, Joseph J. Morrissey (1932 award), who later became UCD Dean of Engineering. Later award winners among UCD academics included Prof. Edward 'Gus' McGennis (1951 award) and Prof. Vincent A. Dodd (1960 award). The 1952 Bursary was won by Dr. John J. (Sean) Raftery who later lectured on several aspects of professional engineering to UCD students, following years of extensive professional and academic practice in both Asia and Europe.

Continuing the NUI tradition of entrance scholarships, UCD established the UCD Ad Astra scholarship programme. Scholars benefit from a €3,000 scholarship, mentoring and a range of tailored supports. The scholarship is tenable for the duration of the undergraduate programme, subject to meeting performance criteria for renewal each year. Scholars are recruited in three areas of excellence: academic, performing arts, elite sports. Currently engineering students represent over 10% of Ad Astra scholars.

MOVING ON: THE CONFERRING CEREMONY

Many friendships forged through hours of toil in lecture theatres, laboratories, sports clubs, student societies and the pub endured long after College life. Inevitably however life circumstances led to conferring day being the last time a handshake or warm embrace was exchanged between close friends before careers took the young engineers to the four corners of the world.

St. Patrick's blue and saffron: Asst. Prof. Jennifer Keenahan

The invitation to successful students to attend 'a meeting of the University to confer degrees' was extended by the authorities with a firm expectation of attendance. Regulations regarding conferring were strict in the newly formed NUI colleges. Attendance in person by a graduand was mandatory for those wishing to graduate. Those requesting permission to be conferred in absentia had to provide evidence of extenuating circumstances "...of very special circumstances and urgency." Being out of the country on the day of conferring was only accepted if the graduand was "outside the British Isles". However "... women candidate graduates who are members of religious communities shall in all cases be permitted to receive their degrees in absentia." Alas it seems that religious and society norms at the time discouraged public acknowledgement and celebration of achievement by nuns, although the same did not seem to apply to those in male religious orders.

Part of the fun of conferring was, of course, the donning of caps, gowns and hoods. Initially the dress code was a black gown and a hood lined and faced in a colour identifying the faculty from which the students were graduating. For engineering the lining colour was terracotta. Red gowns were later prescribed for doctoral degrees. The reorganisation of academic units in 2005, ending the 98-year tradition of the 'faculty' led to change. A standard design was introduced from 2013 based on the UCD colours of St Patrick's blue and saffron. The hoods are a combination of the two colours, while gowns are black or blue for undergraduate and doctoral graduands, respectively.

CLUBS, SOCIETIES, ASSOCIATIONS

The Engineering Society

Not a second was lost by the first Dean of Engineering in the setting up a student society for engineering. The Engineering Society was established in academic year 1910/1911 with Professor Purcell as President. Meetings were very frequent with three meetings per month initially, rising to weekly meetings by 1920. Early and later meetings of the Society included discussion of such timeless topics as engineering education and electric vehicles.

The Society established two sections in the 1930's to cater for its two engineering disciplines but decided to restructure these into separate societies in 1955. The President of the inaugural Civil Engineering Society was Professor Michael A. Hogan and the inaugural Chairman was Denis G. Quinlan. The Mechanical and Electrical Engineering Society was inaugurated by Professor Patrick Leahy as President and John S. Gunning as Chairman. Following graduation, Sean Gunning worked in the energy sector and was awarded The Vietnamese Friendship medal in 2015, one of Vietnam's highest honours. In time honoured Irish tradition, an early item on any association's agenda should be the split! So it was and in 1958 separate Societies were established for Mechanical Engineering and Electrical Engineering, under Auditors Richard M. Humphreys and E. O'Kelly respectively.

The highlight of the year from the 1950's was the final year 'study' trip. In 1952, for example, 32 final year Mech and Elec students visited engineering works in the Dusseldorf area, viewing at first hand the reconstruction of the (West) German

Engineering Society meetings and timeless topics

21/3/1911	Lecture	*"Architecture in Nature"*
21/3/1912	Debate	*"That a reform of the present system of the education of the Engineer is desirable"*
12/12/1913	Lecture	*"Efficiency in Engineering Education"*
8/11/1920	Debate	*"Has Engineering progressed since the Egyptian Dynasty"*
11/12/1933	Debate	*"That the Shannon Scheme was a White Elephant"*
19/3/1934	Lecture	*"The Future of Electric Traction by Storage Battery"*

economy, seven years after the devastating effects of World War II. Visits to Germany and the Netherlands were particularly common but a trip to the Soviet Union was undertaken in 1977 by 'Civil Soc', taking advantage of incentivised schemes by Russia's propagandist foreign youth travel agency 'Sputnik'. Such final year trips were made affordable by using 'affinity group' status to qualify for low air fares and the groups were accompanied by a popular member of the academic staff. If not popular before the trip, the brave academic certainly was by the end!

ENTREPRENEURSHIP: YERRAWADDIES AND SIVIKEMS

Formally recognised UCD student societies were not the only such groupings in UCD Engineering. A commercial enterprise was set up by Mech and Elec engineering students to run dance nights in the Olympic Ballroom, Pleasant's Street, off Camden Street. Trading as the 'Yerrawaddies', the organising and operational committee was drawn from final year students of engineering who acted as event promotors, hiring the ballroom for a night each week. At the end of each academic year, the enterprise was sold on to the incoming committee of final years. The dances attracted large crowds of UCD students and were commercially successful. It seems that the name was derived from a traditional student chant "YERRAWADDY-YERRAWADDY-U-C-D!", although the chant more associated with the UCD engineering students at the time was:

"We are, we are, we are, we are the engineers,
We can, we can, we can, demolish forty beers,
Drink up, drink up, drink up and come along with us,
For we don't give a damn for any old man who don't give a damn for us."

A similar venture was set up in the early 1960's by a group drawn from the Civil Engineering and Chemical Engineering students. Trading as 'Sivikems' the group organised weekly dances in the Four Provinces Ballroom, Harcourt Street.

MAGAZINE 'THE ANVIL'

During the 1960's and 1970's the students of Engineering annually published a magazine, entitled 'The Anvil'. One of its editors, Paul McNulty, later joined the academic staff and served as Professor of Agricultural Engineering. The magazine attracted articles on a wide range of issues from both students and staff.

ENGINEERING GRADUATES ASSOCIATION

Shortly after he became Dean of Engineering, Dr. John Kelly established the Engineering Graduates Association (EGA) in collaboration with former graduates Tom Hardiman and Liam Connellan. The EGA raised over £1.0 million from the engineering graduate community to build a

'Kelly's Corner': Triangular-shaped former University Industry Centre strategically co-located with the Engineering Building

Graduates Memorial Building alongside the new Engineering Building in Belfield, then under construction. The building was officially named the University Industry Centre (UIC) and its purpose was to promote greater contact for the School with the Irish world of engineering, including greater research activity through funded research related to Irish industries. The concept grew and has now been superseded by NovaUCD in larger premises on campus. The building is now home to the UCD John Hume Institute for Global Irish Studies but affectionately remains as "Kelly's Corner" in the memory of the engineering graduates who funded its construction.

The Engineering Graduates Association had occasionally honoured individuals from its inception and instituted a 'Distinguished Graduate Award' in 2002 to recognise those who are excellent role models for today's students. The first recipient of the award was P.J. Rudden. Prior to this Mr. Eoin Kenny was honoured by the Association in 1997, while his daughter, Orna Ní Chionna, received the Distinguished Graduate Award in 2008. The recipient in 2018 was Eileen Harkin-Jones, who in 1999 became the first women to be appointed as an engineering professor in Ireland.

Engineering Graduates Association Honours List

Year	Recipient	Year	Recipient
1984	E. Patrick Galvin	**2008**	Orna Ní Chionna
1990	Patrick Leahy	**2009**	Don Godson
1997	Eoin Kenny	**2009**	Brian Kearney
2002	P. J. Rudden	**2010**	Oliver Tattan
2003	Vincent McCabe	**2011**	David O'Reilly
2003	Joe O'Donovan	**2013**	Liam Connellan
2003	John J. Kelly	**2014**	Patrick Joy
2004	Vincent O'Doherty	**2015**	Orla Feely
2005	Jim Dooge	**2016**	Laura Burke
2006	Pat Mercer	**2017**	Pat O'Doherty
2007	Jack Golden	**2018**	Eileen Harkin-Jones

Dean J.O. Lewis, EGA Distinguished Graduate Joe O'Donovan, EGA President Tony O'Brien

EGA Distinguished Graduate Pat Mercer with Dean Vincent McCabe

ALUMNI ASSOCIATION AWARDS

More recently the University inaugurated annual UCD Alumni Awards in 2014 to celebrate the outstanding achievements of its global alumni who have made an exceptional contribution in their chosen field and who reflect UCD's founder John Henry Newman's ambition for "true enlargement of mind". Since then UCD engineering alumni to be honoured are Donal O'Riain, founder of the Ecocem group of companies; Ian Quinn, co-founder of Creganna Medical Device; Edmond Harty, CEO and technical director of Dairymaster and John Carey, who leads businesses in Europe, Africa and the USA.

P.J. Rudden, first EGA Distinguished Graduate Award recipient

GLOBAL ENGAGEMENT

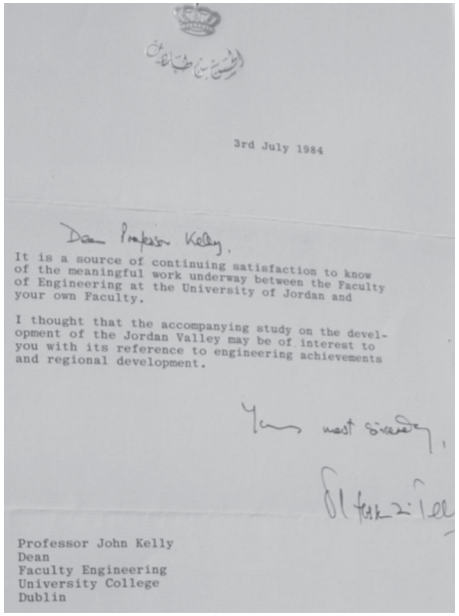
The reach of UCD Engineering extends beyond the Dublin campus. Significant global engagement began in 1975 when an informal group of higher education institutions came together to promote and co-ordinate the engagement of the Irish higher education sector in countries, especially those in Irish bilateral aid programmes. UCD Engineering played an important role in the formal body, Higher Education for Development Cooperation, that grew out of this initiative. More recently, UCD Engineering has been engaged in the development of a UCD College and dual degree engineering programmes in China.

HIGHER EDUCATION FOR DEVELOPMENT COOPERATION (HEDCO)

HEDCO promoted the development of higher education skills and expertise in developing countries through institutional capacity building. UCD's Dean of Engineering, Dr. John J. Kelly, was appointed Chairman of HEDCO in 1985. UCD personnel were particularly involved in projects in the Faculty of Engineering and Technology at the University of Jordan, Amman; Bethlehem University, Palestine; and the Higher Institute for Advanced Science and Technology, Damascus, Syria.

Funding for HEDCO's services came from Ireland's Department of Foreign Affairs, the European Commission, United Nation's agencies and the World Bank. The organisation was most active in the 1980's and early 1990's. The participating universities contributed, not least by the release of staff.

A measure of the appreciation for UCD Engineer's contribution may be gauged through correspondence from King Hussein bin Talal to Professor Kelly in 1984.



3rd July 1984

Dear Professor Kelly,

It is a source of continuing satisfaction to know of the meaningful work underway between the Faculty of Engineering at the University of Jordan and your own Faculty.

I thought that the accompanying study on the development of the Jordan Valley may be of interest to you with its reference to engineering achievements and regional development.

Yours most sincerely,

Professor John Kelly
Dean
Faculty Engineering
University College
Dublin

Correspondence from King Hussein of Jordan

BEIJING DUBLIN INTERNATIONAL COLLEGE

UCD Engineering programmes are offered in the Beijing-Dublin International College, a joint venture between UCD and Beijing University of Technology (BJUT) located on the BJUT campus in Beijing. BJUT is a member of China's Project 211, a select group of 100 institutions of higher education in China chosen to play a leading role in training China's high-tech workforce for the 21st century.

Degree programmes in Science, Engineering and Economics include the BE (Internet of Things), and BE (Electronic and Information Engineering). Upon successful completion of the programme a student is awarded two degrees, one from each university. Students may qualify to take their final year in Dublin, especially those intending to do their graduate studies in UCD. All core modules are delivered through English with just over half being delivered by UCD lecturers in Beijing.

Professor David FitzPatrick, Head of the School of Electrical, Electronic and Mechanical Engineering, was appointed as Provost of the BDIC in 2012. He was succeeded in 2019 by Professor Paul Fanning, UCD International Dean – China, a graduate and academic member of the UCD School of Civil Engineering.

BDIC Class of 2019 conferred in presence of UCD President Andrew J. Deeks, BJUT President Gonghui Liu and His Excellency Eoin O'Leary Irish Ambassador to China

CHANG'AN UNIVERSITY

UCD Engineering has also commenced a dual degree programme in Xi'an at Chang'an University, one of China's Project 211 universities. Following successful research collaborations, building on a formal collaboration understanding signed in 2014, UCD and Chang'an University have already developed two significant collaborations and further deepening of the relationship is currently being rolled out. A master's degree pathway programme has annually seen 10 to 15 students come from Chang'an University to undertake UCD graduate studies in Dublin since 2016. The new dual degree programme, leading to a BE (Civil Engineering Infrastructure) and Chang'an University degree in Road, Bridge and Cross-River Engineering, had its first intake of 117 students in 2018. The final year of the programme mirrors the structure of the BE (Civil Engineering) delivered in Dublin, allowing two-way mobility. Building on this template, further programmes will include Automotive Engineering, in collaboration with UCD School of Mechanical Engineering, and City Planning, Transportation Engineering and Environment Planning in collaboration with UCD School of Architecture, Planning & Environmental Policy.

Inaugural First Engineering class, UCD-Chang'an University dual degree programme, 2018

DOWN MEMORY LANE

Deans and Heads of Academic Units

It is impossible in this overview of the collective development of UCD Engineering to do justice to the individual contribution of those who have served in leadership positions as Dean, Head of Department and Head of School over the years. Nevertheless the listings below are presented to spark recollections of people, places and events that have endured in the memories of our graduates.

Dean of the Faculty of Engineering and Architecture 1909-2005

Term	Dean
1909-1953	Pierce Purcell
1954-1968	Michael A. Hogan
1968-1973	Joseph J. Morrissey
1973-1979	Patrick Leahy
1979-1986	John J. Kelly
1986-1992	Vincent McCabe
1992-2001	Vincent Dodd
2001-2005	J. Owen Lewis

College Principals and Dean of Engineering 2005-2019

Term	Office Holder
2005-2007	Gerald Byrne
Dean of Engineering, College of Engineering, Mathematical and Physical Sciences	
2007-2011	David Timoney
Dean of Engineering, College of Engineering, Mathematical and Physical Sciences	
2011-2014	Gerald Byrne
Dean of Engineering, Principal, College of Engineering and Architecture	
2014-2018	David FitzPatrick
Dean of Engineering, Principal, College of Engineering and Architecture	
2019	Michael Bruen
Interim Dean of Engineering and Principal, College of Engineering and Architecture	
2019-	Aoife Ahern
Dean of Engineering, Principal, College of Engineering and Architecture	

Heads of Department in the period 1909-2005

Agricultural Engineering	Chemical Engineering	Civil Engineering	Electrical & Electronic Engineering	Mechanical Engineering
Paul McNulty	John P. O'Donnell	Pierce Purcell	Felix Hackett	Patrick Leahy
	Jim Walsh	Michael A. Hogan	James J. Morrissey	Seamus Timoney
	Geoffrey Hamer	Jim Dooge	J. O. Scanlan	Vincent McCabe
	Dan Carroll	Eamon Hanrahan	Anraoi de Paor	Gerald Byrne
	Don MacElroy	Tom Casey		
		Aodh Dowley		
		Eugene O'Brien		
		Mark Richardson		

Heads of School, 2005-2019

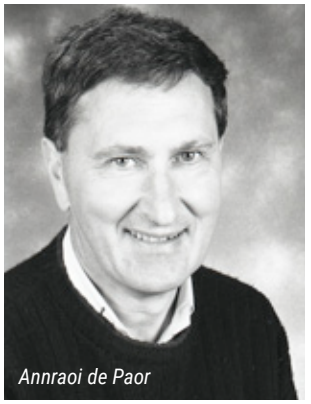
Biosystems and Food Engineering	Chemical and Bioprocess Engineering	Civil Engineering	Electrical and Electronic Engineering	Mechanical and Materials Engineering
Francis Butler (2011-2014)	Don MacElroy (2005-2014)	Mark Richardson (2005-2016)[1]	David FitzPatrick (2005-2011)[2]	David FitzPatrick (2005-2011)[2]
Colm O'Donnell (2014-	Eoin Casey (2014-	Aoife Ahern (2016-2019)	Tom Brazil (2011-2015)	Michael Gilchrist (2011-2018)
		Amanda Gibney (2019-	Andrew Keane (2015-2018)	Kenneth Stanton (2018-
			Peter Kennedy (2018-	

Note 1. UCD School of Architecture, Landscape and Civil Engineering, 2005-2011
Note 2. UCD School of Electrical, Electronic and Mechanical Engineering, 2005-2011

Staff members present at the formal closing of the Merrion St Engineering building in October 1989

Eugene O'Brien

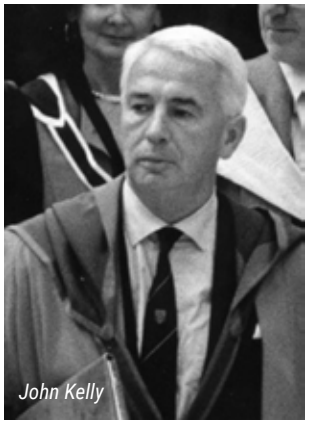
J. Owen Lewis



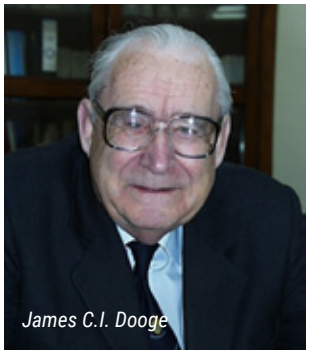
Annraoi de Paor

Aodh Dowley

J. O. (Seán) Scanlan



John Kelly



James C.I. Dooge

Gerry Byrne

Head of UCD School of Civil Engineering, Assoc. Prof. Amanda Gibney, continues tradition by using the desk of the first Dean of Engineering, Pierce Purcell.

BUILDING ON THE PAST, LOOKING TO THE FUTURE

Research and innovation in the UCD College of Engineering and Architecture delivers important impact – advancing knowledge, supporting enterprise, informing policy, and underpinning the nature and quality of the education delivered to students. This impact can take many different forms, over different time scales. Writing in the book 'The Building of the State: Science and Engineering with Government on Merrion Street' Professor Orla Feely reflected that the ".....the story of science and engineering in the building from 1911 to 1989 mirrored in many ways the story of the country over that time....and the development of a technology sector known and respected throughout the world." That respect emanated from the excellence of the UCD graduates, tutored by their academics whose teaching was informed by their research.

Highlights of research over the decades, referred to in 'The Building of the State: Science and Engineering with Government on Merrion Street' included James Drumm's electric traction battery; Pierce Purcell and Eamon Hanrahan's research on different aspects of peat, one of Ireland's important natural resources; Michael Hogan's work during World War II with the Emergency Scientific Research Bureau; James Dooge's hydrology research; J. O. (Seán) Scanlan's research on analysis and synthesis of electronic circuits; Anraoi de Paor's application of control theory to renewable energy and biomedical engineering; Paul McNulty's research supporting innovation in the Irish agriculture and food sector; Séamus Timoney's research and patents on internal combustion engines and independent suspension systems; and the electric car developed by Jim Lacy and John Byrne. Students of the 1970's were impressed when Professor Lacy arrived into work each day in the elegant car, registered HZO 888, achieving the equivalent of 480 miles to the gallon of petrol on his daily commute!

Future challenges for the researchers of UCD Engineering will certainly be global in context. These will be tackled in collaboration with UCD's many global partners. Some highlights of current research in civil, electrical, electronic and mechanical engineering, selected by the current Schools, are presented here. While by no means exhaustive they help to convey samples of the national and global impacts of the research, scholarship and innovation undertaken in the College.

WIRELESS AND ENERGY-HARVESTING TECHNOLOGIES

One of the driving trends of the 21st century is technology's ability to connect. Dr. Elena Blokhina, UCD School of Electrical and Electronic Engineering, is developing new architecture for signal generation to facilitate 5G, the latest standard in wireless infrastructure, and she is designing energy-harvesting technology to enable small devices such as sensors to use nearby movement as a power source. The impact will be a more connected and sustainable web of devices. The research includes smart ways to interconnect numerous antennae and synchronise them so they can receive the transmission efficiently and quickly in such a complex, non-linear system.

Another strand of the research looks at how small, remote devices, such as sensors, can make use of the energy available in the environment. This involves designing a system that can take vibrations from the environment – maybe from traffic passing over a bridge, for instance, or from people walking up and down a staircase – and the system can convert that into power for the device. Dr. Blokhina's electrostatic energy harvesting is a particular niche where her research shows strength at a global level, in this collaboration between UCD and Sorbonne University, being among the most advanced in the design of such complex systems.

THE INTERNAL HEALTH OF EARTHWORKS FOR MORE STABLE INFRASTRUCTURE

As earthwork infrastructure ages and faces pressure from climate change, we need a fast and economical way to assess the earthworks that support our roads, railways and watercourses. Dr. Shane Donohue, UCD School of Civil Engineering, is researching seismic wave-based technology to help major transport and infrastructure managers rapidly assess earthwork assets at scale. This will enable timely maintenance, reducing the risk of failure. Seismic waves are transmitted into earthworks and geophones are used to measure the velocity of the waves as they travel through the structure. Changes in soil moisture and pore pressure, which are related to the stability of the structure, are detected from which 2D and 3D images are built up to help identify where a failure could occur.

With climate change, more extreme weather events are anticipated as well as drier summers and wetter winters. This will put embankments under more pressure as they shrink in dry periods and swell in wet periods, causing more failures. Dr. Donohue's research has opened up the previously underexplored option of using seismic wave technology for rapid and non-invasive assessment of earthwork stability.

The benefit of the seismic wave-based method is that it can assess that internal structure and could be used to monitor and diagnose signs of problems across large expanses of earthworks including water-retaining structures whose stability is vital in preventing flooding, especially during extreme weather events. The method can assess the internal structure and stability of these geotechnical assets rapidly and on a large scale. Being able to pick up the problem early will offset the cost – both human and economic – of dealing with the aftermath of a failure.

CONTROLLING UNWANTED OSCILLATIONS IN ROCKETS AND SATELLITES

Dr David McKeown, UCD School of Mechanical and Materials Engineering, is developing new ways to monitor movement and trigger interventions on the fly to improve the operations of next generation rockets. To help improve rocket design and operation, Dr McKeown is working with the European Space Agency's (ESA) Future Launcher Preparatory Programme, with a focus on rocket dynamics and control. New technologies are being developed to monitor shake in the structure from both the force applied from the rockets and the effect of fuel sloshing in the tanks. Ability to detect these subtle unwanted movements will allow counter-response from orientation of the thrust to keep the rockets on course. Software is being built to automate such control systems. A greater level of control of such movements through intelligently re-orienting thrust will allow rockets to be made from lighter materials. The benefits include lower cost of rocket manufacture and operation, larger payloads, higher orbits or greater distance.

He is also involved in one of the current space-related activities in Ireland: working with UCD School of Physics and industry on the EIRSAT-1 satellite, which is due for launch in 2020. The satellite will be released into space from the International Space Station, and it needs to stop tumbling and spinning in orbit before there can be communication with the satellite from the ground. Dr McKeown's lab is working on the de-tumbling and pointing algorithms that will allow the satellite to function effectively in orbit, enabling the satellite to point towards specific regions of space, so that a detector on board can capture information about events signalled by gamma-ray bursts from distant galaxies.

NEW PERSPECTIVES ON RIVER MODELS

Modelling major river basins can bring about deeper insights into the potential flashpoints for flooding and carbon cycling as well as dynamic data to help local communities and businesses to use the river as a resource. Dr Fiachra O'Loughlin, UCD School of Civil Engineering, is using freely available satellite data to better model and understand large river systems, helping other researchers and organisations build more effective models of river basins around the world.

On-the-ground measurements of river characteristics can often be scant but Dr. O'Loughlin uses satellite information to build models of river behaviour. Working with colleagues across the globe, satellite data has been used to measure and map the width of the Congo River at frequent intervals, and to build a hydraulic model of the central region of the Congo basin. Comparison of data from remote sensing with available data taken directly at source has validated this novel approach to river modelling.

Working with colleagues in Bristol University, UFRGS (Federal University of Rio Grande do Sul) and Ohio State University, a key breakthrough has been finding a way of processing satellite images to digitally 'remove' vegetation to reveal the nature of the underlying ground. The resulting product, the first global 'Bare-Earth' Digital Elevation Model based on the Shuttle Radar Topography Mission (SRTM) for all landmasses between 60°N and 54°S, is now freely available for researchers and organisations to use as Open License. To date use includes studies of the Amazon, Mekong and Volta Rivers.
The research enables the prediction of water levels at specific locations for inland rivers at specific times. Applications include transport planning, climate change modelling and flood prediction. For example, planning payload for slow-moving barges along the Congo, allowing maximum payload to be more accurately estimated for inter-city journeys of several week's duration. It can be used for climate change models that take account of carbon cycling in river basins where wetlands are significant carbon sinks. Rainfall and runoff models allow flood prediction.

TOWARDS MASS PRODUCTION FOR PRECISION MICRO/NANO DEVICES

Dr Nan Zhang, UCD School of Mechanical and Materials Engineering, is bringing innovations in precision manufacturing from lab-based prototypes to large volume manufacturing in industry. Innovative design and manufacturing approaches on a mass scale are underpinning Irish manufacturing, not least in the medical devices industry. His research applies micro/nano-mould tool manufacturing technologies and micro/nano-replication technologies to fundamental and applied problems relevant to designing, developing and producing new devices.

The research focuses on the manufacture of microfluidic devices, functional surfaces and freeform optics. The research group explores possibilities with materials such as bio-plastics and with novel tool materials such as bulk metallic glasses. With metallic glasses, the structure is amorphous, there are no crystal grains, and this material can be patterned at the nanometre level. The research group provides expertise and capabilities in Ireland for innovative precision tool manufacture, such as

through microfluidics in which Ireland needs to build manufacturing capacity to stay competitive in specialist markets. A specific moulding technology is used to replicate the small channels in microfluidics, using variotherm-assisted precision injection moulding for mass production. Nanoprinting is employed for photonics and functional surfaces, such as lenses and solar cells, and making nanostructured surfaces in medical devices to encourage cells to attach and grow to those surfaces or to prevent fouling by bacteria. In parallel, Dr Zhang combines 2D materials with precision electro-forming process to develop high performance precision nickel micro/nano mould tools. Hardness of mould is significantly increased, while friction of coefficient is reduced. This indicates longer tool life and less potential demoulding damage.

OPTIMISING THE LAST MILE OF 5G WIRELESS NETWORKS

A critical issue that needs to be resolved in sending data rapidly and reliably in 5G wireless networks is the last hop between users' devices and the serving base stations. The connections in the last hop can suffer from severe interference, and it is expensive and inefficient to overcome that by allocating dedicated time slots or frequency bands to each device. Dr Le-Nam Tran, UCD School of Electrical and Electronic Engineering, is developing new ways to optimise this important transmission step for future wireless networks.Given that wireless signals are generally omnidirectional it is inevitable that interference will occur when multiple devices are looking to communicate at the same time. This reduces signal strength and the speed of the entire network. The aim of 5G is to have data speeds ten times faster than 4G, but solving the issues around the last hop between device and base station need to solved without using sophisticated technologies. Adopting existing sophisticated technologies would require levels of expenditure that would discourage network providers and lock out potential customers through unacceptably high network charges. Dr Tran is working on new low-cost and low-complexity methods to overcome these issues, using a holistic approach and advanced mathematical tools.

The mathematical algorithms that Dr Tran is developing will allow base stations to form radio beams in a manner that supports several low-power devices at the same time. This will avoid the need for the network provider to allocate separate channels or time slots to users, which would be restrictive and expensive as user numbers grow. A key aspect of his research is addressing the relative strength of competing signals. Much can be gained by reducing and controlling the power of the signal. The research seeks to find smarter ways to reliably transmit signals between devices and base stations with minimal amounts of energy. Thus the research will also address the issue of 5G potentially raising global energy demand disproportionately.

THE STORY GOES ON ....

Sharing a memory of his student days in UCD, Professor Paul McNulty wrote: "My abiding memory of UCD occurred while sitting in the basement lecture theatre of the former Royal College of Science in Upper Merrion Street. The late Professor Michael A Hogan, Dean of Engineering and Architecture, was at the podium. Looking intently at the newly inducted engineering freshmen, he proclaimed, 'You are the future leaders of the nation.' Wow! He left me breathless but impressed."
Hopefully this booklet and commemorative event will have stirred pleasant memories of the life and times of UCD Engineering. Please add to the story by sharing a memory through the UCD Alumni website www.alumni.ucd.ie/memories

We would love to hear from you!

Professor Tom Brazil, 1952-2018, ".... a loss that is felt when someone, who has made a true impact on the lives of others, silently passes away."

ACKNOWLEDGEMENTS

Tony Fagan, Oran O'Rua and Mark Richardson are grateful for assistance from UCD colleagues during the preparation of this booklet. Our thanks to Lisa Bennett, Jenna Bjorkman, Enda Conaty, Imelda Delap, Sinéad Dolan, Paul Fanning, Bei Gao, Andrew Griffiths, Vincent Hoban, Kate Manning and Maura McGinn.

Cover design based on an iconic sketch of the Merrion Street facade by Irish artist Liam C. Martins, a sketch that graced the cover of many course notes and laboratory manuals distributed to engineering students.

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