Irish Math. Soc. Bulletin
Number 84, Winter 2019, 35–49
ISSN 0791-5578

Reflections of Retired UCC Mathematicians

GARY MCGUIRE AND COLM MULCAHY

Abstract. Six decades of UCC history as remembered by five mathematicians

1. Introduction

A good overview of mathematical life at UCD over a several decade period was provided by a series of three articles published in this Bulletin (Nos 63 and 64) in 2009. Those were based on interviews conducted by the first author with three colleagues of his who had just retired, namely Tom Laffey, Seán Dineen and Dave Lewis.

This article can be viewed as a Cork counterpart to those. We emailed questions to numerous retired University College Cork mathematicians and mathematical physicists, with invitations to address other things they wish they'd been asked about. Here we feature the five responses received, from Finbarr Holland (on the UCC staff 1965-2005), Michael Mortell (1973-2006), Donal Hurley (1973-2009), Des MacHale (1972-2011), and Patrick Fitzpatrick (1979-2013). These academics got their primary degrees in 1961, 1961, 1965, 1967 and 1973, respectively. The first three are Corkmen through and through, who also did their undergraduate and master's studies at UCC; the other two hail from Mayo and Belfast, respectively. All did their doctoral work outside Ireland. While they are officially retired, they remain active in various ways. (An extensive 2017 inteview conducted by the second author with Vincent Hart, who spent the early part of his career at UCC, appeared in issue 79 of this Bulletin).

Finbarr Holland, one of the founding fathers of the Irish Mathematical Society, sets the stage with a focus on the striking transformation of the UCC maths department over the course of the 1960s. The story is then taken up by his applied maths classmate Mick Mortell, who later served as UCC president, and younger men who became their colleagues, including Des MacHale who designed the distinctive IMS logo.

2. Finbarr Holland

What were your early interests, and who were your teachers of note?

FH: I was born at home, 10 Fernside Villas, Cork city, on May 12, 1939. My parents came from farming stock, and grew up in Barryroe and Grange, near Timoleague in West Cork, where the Hollands were known as "*Fir na leabhair*". One of the clan, Rev. W. Holland, PP, wrote "History of West Cork and the Diocese of Ross", a book that is well regarded by historians of the area. After their marriage, my parents settled in Cork city. My father became an insurance agent; he enjoyed quizzes, crosswords and Gaelic football. I received my early education first from Presentation nuns, and then Presentation brothers and a small sprinkling of lay teachers, at Scoil Críost Rí, Turners Cross. In my final years there, I attended what was loosely described as a secondary top, and was fortunate in have been taught mathematics at a level a little

2010 *Mathematics Subject Classification.* 01A70,01A72.
Key words and phrases. UCC, History.
Received on 8-1-2020.

beyond Leaving Cert standard by Mr Con O'Keefe — Concubhuir (Con) Ó Chaoimh, who afterwards joined the Inspectorate of the Department of Education, where he left his mark.

After doing my Leaving Cert in 1957, I attended the Sharman and Crawford Technical Institute to study the first part of a Diploma Course in Industrial Science, which was designed to cater for future technicians, soon to be needed to operate the emerging oil refinery at Whitegate. Simultaneously, I studied on my own for the UCC Entrance Scholarship examination, and a special scholarship awarded very infrequently by the City of Cork Vocational Committee. In preparation for the former, I often met Con on his way home, hunched over a racing bike with a pipe dangling from his mouth — cycling off to infinity according to the class wit! We would chat at the side of the road to discuss scholarship questions, such as: what's the smallest integer bigger than $(2+\sqrt{3})^n$? Con was doing an MA by thesis under Paddy Kennedy at the time, and when I pointed out an error to Con in one of Kennedy's scholarship questions, and supplied a correction, he told Kennedy who apparently replied "*Nutet et Homer*". Needless to say, that pleased me no end!

As a recipient of both of the scholarships I applied for, I went to UCC where, for the next three years, I read mathematics and mathematical physics, and qualified for a BSc with first class honours. As well, during that time, I taught mathematics courses by day and night at the Crawford Tech.

How did your 1964 PhD at Cardiff with Lionel Cooper come about and how did you end up back at UCC?

FH: In my postgraduate year, I decided to sit the examination for the NUI Travelling Studentship, which was being offered that year. In those days, it was customary for this to be offered — if at all — only every two years, and prospective candidates at UCC, if they were lucky with the cycle, usually took two years to prepare for it. Hence, if I didn't sit the TS exam in my first postgrad year I would have had to wait for three years before my next opportunity, something I couldn't afford to do. So, I decided to prepare for the TS in one year, which I did with the help of Paddy Barry who laid on extra courses. (The same year a similar decision to attempt the TS in one year was made by Martin Newell in UCG and John Galvin in UCD.)

I revealed my desire to do a PhD to the then NUI mathematics extern, Lionel Cooper, during his summer visit. I also revealed my intention to put the Dirac delta function, which I had learned about from Paddy Quinlan, on a firm foundation. Cooper told me that this had already been achieved by Laurent Schwartz! However, he offered to supervise me, and once I had secured a Travelling Studentship, I set off for Cardiff to work on a thesis under him. This largely involved a generalization of Bochner's representation theorem on continuous positive-definite functions to functions that were only locally square-summable. I was awarded my PhD from the National University of Wales in 1964, and the same year accompanied Cooper to Caltech where I served for one year as a research fellow. I returned to take up a position at UCC in 1965.

The emphasis was largely on teaching in those days, correct?

FH: As a temporary lecturer, I joined a staff of two permanent members, Paddy Barry, as professor — by then Paddy Kennedy was the first professor of mathematics at the new University of York — and Siobhán O'Shea, the sole statutory lecturer. We were assisted by Freddie Holland (no relation) who taught one course to engineers, and a couple of postgraduates who were appointed as student demonstrators to teach two courses throughout the year in exchange for free tuition. At that time, although the total student population was small, a full range of courses was taught which placed a heavy teaching and examining burden on all the staff. First year students doing either

pre-med, pre-dent, commerce or ag science received basic level courses in mathematics. Civil and electrical engineering students received mathematics courses in their first three years, as did arts and science students at pass and honours level. Pass courses were examined in June with repeats in September, when the honours courses were also examined. In addition to examining for the NUI, we were expected to set and mark one or two entrance scholarship papers for the UCC entrance scholarship examination, and assist with the marking of the matriculation examination both of which were generally held in late July after the Leaving Certificate examination. Naturally, this encroached on our research time which was very limited during term time.

At the time I joined UCC, before they could be recommended for appointment to the Senate of the University, candidates for a statutory lectureship in mathematics in UCC were expected to display proficiency in both written and oral Irish in a test conducted by professors in the subject. I took the requisite test, but failed it. However, within a couple of years of this unhappy event, the relevant statute was amended, and when I applied a second time, I was successful and appointed to the position of Statutory Lecturer in Mathematics Number 2 by the Senate of the NUI. The offending statute was completely abolished in 1974.

Yet, growth was just around the corner, both in terms of curriculum and personnel?

FH: In my first year back I taught a postgraduate course on functional analysis to a small group of students that included Donal Hurley and David Walsh, who went on to have successful careers in mathematics. With Paddy Barry's assent, I revamped the undergraduate programme and began by introducing metric spaces and the Lebesgue integral in third year. l was given free rein over the taught postgraduate courses until staff numbers increased and four-year degree courses for honours mathematics became the norm, which led largely to the demise of taught postgrad courses.

The year 1966 was significant for a few reasons: Lennart Carleson proved Luzin's 1915 conjecture that the Fourier series of a continuous function converged to the function not only in the sense of Cesàro summability in a uniform manner, but almost everywhere in a pointwise manner. This result had an immediate consequence for me because it signalled the end of a line of research connected with Luzin's problem that had been driving the subject of harmonic analysis, my main research interest at the time. It caused me to take up the study of Toeplitz and Hankel operators. Later on, I was able to advise David Walsh when he decided to study the latter objects for his PhD.

Sadly, that same year, Paddy Kennedy took his own life (in England) shortly before he was about to take on the role of external examiner for the NUI. His untimely and unexpected death affected us greatly.

The years following my appointment were momentous. It was the post-Sputnik era, and suddenly everybody wanted to do science; also free education was introduced in Ireland by education minister Donogh O'Malley. To cater for the increased intake of students, more staff had to be employed and lecture space built to accommodate them. Fortunately, UCC had a newly appointed and dynamic president in Donal McCarthy, who was well versed in the ways of government, and he winkled enough money to hire new staff and build the necessary lecture rooms. This marked an era of immense growth for the college. During his time, the science building was completed and the building of the Boole library had begun. In recognition of its importance in the development of college, the mathematics department received its rightful share; it responded by expanding its staff and student numbers. In the early 1970s, I took a year's sabbatical leave at Chelsea College, London, and on my return took over the headship of the department to allow Paddy Barry to take on the role of vice-president for a couple of years. Things rested so for a decade!

The 1970s also saw the opening up of communication between various Irish universities and the setting up of the Irish Maths Soc.

FH: Shortly after taking up my position at UCC, I renewed my acquaintance with Trevor West and we started a fruitful collaboration about building up the strength of mathematics in Ireland. We were particularly anxious to improve communication levels between mathematicians in the different colleges. Our first effort led to the establishment of a visiting-lecturer scheme operated by TCD and UCC, whereby foreign visitors were passed from one college to the other in turn, and expenses were shared. Also, to assess the needs of our colleagues, we devised and circulated a questionnaire to them seeking advice on what should be done. As a result of the feedback a series of Summer Schools were instituted under the aegis of the Royal Irish Academy. The first of these was organised by Trevor in TCD, and was hugely successful, both academically and financially, generating enough funds to run future ones. Later, one on analysis was held in Cork, and several more were held at various centres throughout the 1970s. Ultimately, these led to the establishment of the Irish Mathematical Society. A further outgrowth was the setting up a national mathematical contest for secondary students, which laid the foundation for Ireland's participation in the International Mathematics Olympiad, first in 1988 and thenceforth. More detail about this has been published in a recent issue of the BIMS (Number 82 (2018) 69-78).

What do you see as the role of problems in maths?

FH: Problems are the lifeblood of mathematics. At the International Congress of Mathematicians in 1900, David Hilbert broke with tradition, and instead of focusing on his own work, startled the assembled gathering by announcing twenty three problems, several dealing with the very foundations of the subject, that influenced its directions for the twentieth century. This sparked a trend, and was followed a little later, for instance, by the formulation of Luzin's conjecture about the convergence of Fourier series, and Bieberbach's about the growth of the coefficients of univalent power series. These latter questions revitalised and invigorated different areas of analysis for many years to come before they were settled. While a few of Hilbert's problems were solved soon after they were published, the Riemann Hypothesis remains open.

My research interests spanned the areas of harmonic analysis, univalent functions, functions with positive real parts, Hankel operators on function spaces and inequalities. I've collaborated with and/or published joint work on a variety of research topics, problems or solutions to problems, with about eighteen mathematicians of various stripes.

I started composing problems in my late teens when I began teaching at the Crawford Tech, a practice I continued during my UCC days — even to this day, although those I devise nowadays are unlikely to ever see the light of day! I particularly enjoyed setting challenging problems for competitive exams for University Scholarship and local and international Mathematical Olympiads. Over the years, I've also availed of the invitation issued to participants at conferences to submit problems. One in particular that I submitted to a conference proceedings pleased me immensely: it sought a description of the generators of Hankel operators of trace class. This was taken up by the Russian mathematician Vladimir V. Peller, who gave a complete characterization of the class of such operators that belong to the more general Schattenvon-Neumann classes. Since I retired officially from UCC, I've been a regular contributor of original problems — and solutions of published problems — to several journals such as BIMS and the *American Mathematical Monthly*. One such problem appeared last year in the latter, a joint proposal with Tom Laffey and Roger Smyth about the set of eigenvalues of a particular tri-diagonal matrix. It spawned a research article that is due to appear in *Linear Algebra* about a more general class of similar matrices. *Lean leis an obair!*

3. Michael Mortell

What were your early interests, and who were your teachers of note?

MM: I was born in Cork city but lived in Charleville from age five after the death of my father. I attended the Charleville Christian Brothers schools for primary and secondary education, and did my Leaving Certificate in 1958.

My interests were general reading, hurling and school and I was generally viewed as being good at mathematics. Charleville CBS was a small school, there being seventeen students in my Leaving Certificate class. The teacher who had the most influence on me was Brother D.F. Williams. For the Leaving Certificate he taught honours courses in maths, physics, and chemistry, and the pass course in applied maths. Ironically, the latter was the area in which I did my PhD at Caltech. It was the time of Sputnik and the above range of courses pointed me in the direction of science when I went to UCC. The other influential teacher was James O'Sullivan who taught me English. I got a lifelong love of reading and literature from him.

I was not someone who plotted out a life's trajectory but had the philosophy of just taking the next best step and then doing as well as I could until the next decision-time came. At the time of my Leaving Cert the probability of my going to UCC was slight due to the family financial circumstances. However, due to the great generosity of my family and friends and in the light of my Leaving Cert results I was able to go to UCC. If I had not been able to go to UCC I suppose I would have ended up in England, which is where my mother was from.

When I walked through the gates of UCC for the first time in October 1958, there was a queue of students for each faculty and I chose the queue for science and my fate was determined. For first science I chose maths, maths physics, physics, and chemistry, and did the honours course in each of them. I was living in the Honan hostel under the watchful eye of Prof Cormac Ó Cuilleanáin. I worked hard and played a lot of hurling, getting a Fitzgibbon medal before I was eighteen. I added two more, plus the County championship before I was finished. On the basis of the results of the first science exam I was awarded a college scholarship, which greatly eased my financial position.

The next question to be dealt with was what subjects would I choose for the BSc degree. I think I had decided that physics or chemistry were not for me as I didn't particularly like doing experiments and was not very good at them, and I also enjoyed being able to go down to the Mardyke in the afternoon rather than being stuck in labs. So it was to be maths and maths physics for my degree. Again I didn't spend too much time pondering the pros and cons of the question.

The maths physics department consisted of Prof P.M. Quinlan and Dr V.G. Hart plus some MSc students like R.A. Scott and J.N. Flavin both of who later became professors, Scott at University of Michigan and Flavin at UCG. The mathematics department consisted of Prof P.B. Kennedy, Dr Siobhán O'Shea and Mr Paddy O'Donohoe who later was a faculty member at QUB. Dr Paddy Barry arrived in the final year of my BSc.

It is clear from the small number of staff in the departments that a broad syllabus was not possible. In both departments we followed the engineering syllabus and this was augmented by special honours courses. In maths we were exposed to modern mathematics involving proofs and this was focussed on real and complex variables. We did a tiny bit of group theory and a full course on matrices. V.G. Hart taught us dynamics, while P.M. Quinlan taught us complex variable fluid dynamics as well as his own work on the λ-method. The BSc course was clearly quite limited, but given the resources available the teaching staff did a very good job. The person who made the deepest impression on us students was Prof P.B. Kennedy. He seemed to

have a somewhat stern exterior, but personally was a warm individual. He brought mathematics in UCC into the 20th century, and was a brilliant, concise lecturer.

How did your 1968 PhD at Caltech with Jim Knowles come about and was that area what you ended up pursuing?

MM: I chose to do an MSc in mathematical physics mainly as I was more interested in applied problems. Prof P.M. Quinlan had continuing contacts at Caltech and a number of UCC students had gone there to do PhDs. Among them were Prof M.E.J. O'Kelly at UCG, Prof P.G. O'Regan at UCC, and Dr Bernard Reardon at UCD. So it was no surprise that I should choose to go there. My MSc course consisted of real variables, complex variables, and a major in fluid dynamics taught by V.G. Hart. I found these UCC courses to be invaluable to me at Caltech.

There was a new applied math department at Caltech headed up by G.B. Whitham and I decided to do my PhD in applied math under the direction of J.K. Knowles in the area of elasticity. But before beginning research there were one and a half years of coursework to be done. I came in contact with the likes of A. Erdélyi, J.D. Cole, P.A. Lagerstorm, J.K. Knowles, Marshall Hall Jnr, and G.B. Whitham. This was among the best applied maths departments in the world. So I now had to operate and compete in a different league. The standards were very high and the work very hard as you had to turn in homework every week. However, you learn a lot and have to rise to the occasion. This was the best training I ever got! I now understood hard work, and what standards are. My PhD research was in a branch of elasticity called shell theory. A shell is a thin elastic body. I worked on the propagation and focusing of linear waves on a spherical shell – think of a bullet fired into the shell – and on low frequency linear waves on a cylindrical shell, e.g., what speed do they travel with. Since then almost all my research publications are involved with nonlinear waves and consequent shocks. After my PhD, I got a tenure track position in the department of the applications of mathematics at Lehigh University, headed by R.S. Rivlin, a founder of continuum mechanics. I worked on nonlinear waves in bounded materials, where the effect of reflections must be taken into account, and I joined forces with B.R. Seymour. I was promoted to associate professor with tenure.

Describe how you ended up at UCC and how mathematics developed during your time there.

MM: Despite my tenured position I returned to UCC in 1973 to a lectureship in mathematical physics, and have remained there ever since – except for a sabbatical or two. The department I came into was changed little from what I had left. V.G. Hart was gone to Australia and P.D. McCormack had arrived from Trinity. I did not think the department was in good health even though we still had very good students. I had a relatively very high teaching load – as much as 11 hours per week at one stage – but continued with a good research output by joining B.R. Seymour at UBC in Vancouver over the summer. My training at Caltech stood to me! I did not think the department had moved with the times. My time at Caltech and at Lehigh has impressed on me the necessity for research if the dept and UCC were to have a standing in the wider academic world. During this time I had my one PhD student, Ted Cox, now an associate professor at UCD. Ted and I continued to work together through my time as registrar and president and into my "retirement". I became Registrar of UCC in 1979 and President in 1989. A previous president, Donal McCarthy, had introduced a promotion scheme that was changing the culture of the College. It was becoming clear that staff were expected to do and publish research if they were to progress in their careers. There was a new generation of younger mathematicians. They did well in this

regime, and under Prof P.D. Barry the department broadened and strengthened. The students, still very good, now had a much broader and deeper degree.

What papers, books, lectures or mathematicians influenced you?

MM: In my student days at UCC, I depended mainly on notes given by the lecturers. The lectures by P.B. Kennedy and P.D. Barry in mathematics and by V.G. Hart in maths physics were very important to me. Each knew their subject in depth and explained it clearly to the student. P.B. Kennedy was particularly precise and concise and showed us how a proof should go.

How do you feel about the role of teaching and what is your approach to teaching?

MM: Teaching, and good teaching, is very important particularly if you want to engage the student. Mastery of the content and clear delivery, with an eye on standards, are essential. I am not a great believer in teaching at 3rd level as distinct from lecturing. At university, the good honours student should normally be able to work things out for himself from the lecture notes. Pass level students should be given plenty of help, but must learn to stand on their own feet also. My approach to teaching/lecturing was very simple: be well prepared, arrive on time, do not skip lectures, give good ordered notes. In recent years I assigned homework and worked through it in tutorials.

What is the future of mathematics in general and at UCC?

MM: So mathematics generally is flourishing in UCC and some of the best students are attracted to these departments. In the area of applied maths the number of staff is small, they are all active with a new professor, Sebastian Wieczorek, and the future looks bright. However, resources are a problem, as always.

During my time as registrar and president of UCC I emphasised the role of research and reported on it annually to the Governing Body. I saw my job as facilitating the academic work of the college. To that end significant amounts of money were raised to extend the area of the College and improve the infrastructure. Many academic positions were unfilled due to the austerity of the 1980s and before and all these were filled during the 1990s. Unfortunately this ground has now been lost under recent government policies. The universities are now significantly underfunded.

How do you view the Irish contribution to mathematics?

MM: If you think of Hamilton, Boole and Stokes we are in the major league immediately. Overall, given we are a small nation, I think we have punched above our weight.

What have you been doing since your official retirement in 2006?

MM: I continued to teach until about 2014. I have published about fifteen papers (jointly with other authors) in various international journals, and I continue to do research. I have also published two books (jointly), *Singular Perturbations: Introduction to System Order Reduction Methods with Applications* (Springer, 2014) and *Nonlinear Waves in Bounded Media* (World Scientific, 2017).

4. Donal Hurley

What were your early interests, and who were your teachers of note?

DH: From an early age, I was interested in solving mathematical problems and I was very fortunate to have had inspiring teachers right through schooling. At primary level, attending Clonakilty Boys N.S., my teacher in my final two years was Mr C. O'Rourke who constantly challenged us with problems. There were some really bright guys in the class (including Seán Dineen) so trying to be the first with the correct solution was

very competitive. I remained on for a year after the Primary Certificate Examination (a state examination at end of primary school education) and during that year, Mr O'Rourke covered quite an amount of Euclidean geometry. When I came to doing the Intermadiate Certificate Examination, I realised that during that particular year, I had covered most of the prescribed course in Euclidian geometry. I had also been taught most of the material on the Leaving Certificate arithmetic paper (in those days there were 3 papers in the Honours mathematics course).

At secondary school in Farranferris College, Cork, I had a very enthusiastic teacher, Fr Tom Clancy, in my final year. I remember, in particular, the calculus book we had. Each chapter had a brief presentation of some theory and then there were about twenty problems of an applied nature which ensured that we appreciated the ways calculus could be used. As a result of this, a few of us sat the applied mathematics paper in the Leaving Certificate Examination even though we did not have any clsses in the subject. Fr Clancy also did quite an amount of Euclidean geometry with us, much more than the syllabus required.

At UCC, we had fantastic teachers; Paddy Kennedy, Paddy Barry, Finbarr Holland, Siobhán O'Shea as well as Vincent Harte and George Kelly in mathematical physics. All of them had superb styles of lecturing and made the material accessible.

Paddy Kennedy was memorable because of the performance of his lectures. He required that we all wear undergraduate gowns at lectures. I think he was the only academic in UCC who insisted on that. We put on the gowns in the lecture hall before he arrived and took them off again as soon as he departed as we were embarrassed to wear them on the campus. In fact, honours mathematics students were recognised as the guys (at the time there were no women in the class) who had gowns rolled up under their arms. Kennedy was a chain smoker and lit one cigarrette from the butt of the one that was just smoked. Early on in the term, he passed around a pack of cigarettes and invited the smokers to take one. When the pack was returned, he saw that none was taken and remarked that each year he hoped that some brave guy would take up his offer of a "fag". However, the really memorable aspect of his lecturing was his presentation. I still have the notes I took in his course and they are a clear, organised presentation of the introduction to the abstract algebra course. As he lectured, he gave the impression that he was just thinking up the material as he went along; he would stand back, look at the blackboard and reflect for a minute or two and then go and fill the board with his beautiful writing and crystal clear material. He was by far the best lecturer I ever had. Classmates included Michael Brennan (WIT) and David Walsh (MU).

How did your 1970 PhD at Yale under Gustav Hedlund came about and was that the area you ended up pursuing?

DH: I decided to do graduate studies in the USA as funding was a little easier to obtain there as opposed to going to the UK (no funding available in Ireland at that time). The programme there was four years, the first two of which were courses across the whole span of mathematics. That appealed to me as I thought that I should do some more algebra as well as geometry and topology. Vincent Harte explained to me how to apply to USA universities and where I should apply. I applied to several, Yale being my top choice, and I was very pleased to be accepted there.

UCC had a very strong reputation in analysis, especially complex analysis, when I studied there. Going to Yale, my plan was to specialise in functional analysis. Interestingly, during my first few weeks there, I discovered that most of the 20 students in the class were planning to do algebra. I asked a fellow student why this was the case and he told me that it was because of Walter Feit, Nathan Jacobson and some other very strong algebraists who were at Yale. I had not heard of these people! Charles Rickart, who had a reputation in functional analysis, was there and I had heard of him

so he was the person I hoped to study with. In our second year of study, we took our PhD qualifying examination which was a three-hour oral. The custom was that one asked the person one wished to study with to chair the examination and to select the other three or four members of the board. Rickart chaired my board and I took the examination at the beginning of second semester of my second year. I took some more advanced analysis courses and graduate seminars during the second semester of that year.

At the beginning of my third year, I decided to take a course on topological dynamics with Hedlund and he suggested that I also take the differential dynamics course being given by Ziggy Nitecki who had just arrived as a postdoc from the University of California at Berkeley. At that time there was geat excitement in the mathematical community about the work being done at Berkeley by Stephen Smale and his coworkers. The combination of Hedleud's course with Nitecki's was very attractive and I got engaged in the area of differential dynamical systems. I spoke to Hedlund and he said he had a problem for which Niteck's course should give me useful background. Since I had also been discussing topics with Rickart, I informed him of my new found interest, and he encouraged me to work with Hedlund.

Hedlund told me of his problem in geodesic flows about a certain class of geodesics on manifolds of hyperbolic type. It was related to a conjecture of Ya Pesin about the entropy of flows on these manifolds.

What papers, books, lectures or mathematicians influenced you?

DH: When I began research, the main reference for work in geodesic flows was the book by D.V. Anosov, *Geodesic flows on Closed Riemannian Manifolds with Negative Curvature*, as well as papers writted by Hedlund and M. Morse. For differential dynamical systems, the several volumes of the Proceedings of AMS Summer Research Institutes on *Differential Dynamical Systems* (1968) and *Smooth Ergodic Theory* (1969) were the references. People whose work I followed in later years while working on geodesic flows included P. Eberlein (University of North Carolina), K. Burns (Northwestern) and Ya Pesin (Pennsylvania State University).

I began collaborating with Michel Vandyck (Physics, UCC) around 1990, and we developed a differential operator which we called "D-differentiation". This collobaration has proved to be very successful and our work has been applying this operator to several areas in mathematical physics.

Describe how you ended up at UCC and how mathematics developed during your time there.

DH: I spent 3 years at UCG (now NUIG) before being appointed to a lectureship in UCC in 1973. At the same time, 3 others were appointed; Des MacHale, Tim Porter, and Tony Seda. Paddy Barry, who was head of department, was keen to spread the expertise in the department. He was also interested in developing team spirit so we had regular weekly colloquia and regular departmental meetings. The department had the reputation as being one of the most democratic ones in UCC.

At that time, we had no internet or email so doing research was difficult as there were few opportunities to keep in contact with researchers at other institutions or keep abreast of advances being made. One depended on attending conferences but this was of limited value. When email, and later the WWW, became available that changed opportunities dramatically.

The major development in UCC was the formation of the school of mathematical sciences when the departments of mathematics, applied mathematics and statistics merged. We had many meetings discussing the merger as opinions varied widely about

the possibly structure. Des Clarke (philosophy department) guided us towards the structure which eventually emerged from discussions.

How do you feel about the role of teaching and what is your approach to teaching?

DH: I tried to follow the example of the better lectures I had while a student and so prepared my lectures to be well organised and accessible to the students. In lecturing to honours mathematics students, it was easy to find the appropriate level as students were fairly uniform. The situation was more difficult with classes of non-mathematics majors as the level of students was occasionally very varied and determining the correct level could be difficult. But I enjoyed giving the lectures and always got great satisfaction in seeing how well the students had mastered the material while marking the examinations.

I got involved with Finbarr Holland, in the mid 1980s, in giving the Enrichment Classes to students being prepared for the International Mathematical Olympiad. Exposing bright second level students to topics not covered in schools curriculum was very rewarding and a number of these students were motivated to study mathematics when they went on to university.

What is the future of mathematics in general and at UCC?

DH: One of the very exciting aspects of mathematics is the way in which research topics evolve as seminal results are obtained. Because of the developments in computing, I think that data analysis and computer graphics are changing the directions of research. UCC has made some recent staff appointments of people who are very skilled in these areas. Not only are they exploiting these tools in developing their own research but students are being exposed to these new developments.

How do you view the Irish contribution to mathematics

DH: Mathematics is providing the foundation for STEM subjects which the government sees as the basis for future economic development. However, I do have some concern about the Project Maths programme and would like to see a thorough independent analysis of it in the near future.

Many mathematics graduates of Irish universities are making valuable contributions to the sciences at top universities and instiutions abroad. I would like to see more government funding for mathematical research to broaden the opportunities for our graduates to work in Ireland and to attract researchers from abroad. In Ireland, we are still a long way short of the critical mass of professional mathematicians required to make a significant impact on mathematics internationally.

5. Des MacHale

What were your early interests, and who were your teachers of note?

DMH: As a kid, I loved counting and geometric figures. I would ask everyone in the house how many potatoes they wanted for dinner and make out a little chart and present it to my mother. My party piece was to recite very quickly $1+1 = 2$, $2+2 = 4$, $4+4 = 8$, $8 + 8 = 16$, $16 + 16 = 32$, $32 + 32 = 64$, $64 + 64 = 128$, etc. When I helped my father in the garden to plant cabbages and potatoes, all the drills had to be perfectly parallel to each other and all the plants the same uniform distance apart before he was allowed to cover them with earth.

In secondary school I was lucky enough to have an excellent mathematics teacher, a De La Salle brother called James Sheridan (Brother George). He really stimulated my interest in mathematics and challenged me. He encouraged me to solve a given problem in as many different ways (often up to ten!) as possible, which is a wonderful teaching technique. I used to live for his *agusíní* or "cuts" which he gave me as a reward for

finishing routine problems. He had a handwritten journal in which he stored his own special solutions, specially on geometry and the parabola. These were often original of his own making, and I am sorry I did not inherit it. He loved too harmonic ranges, pole and polar, inversion – wonderful classical geometry, sadly unknown to today's generation of students. I really think I owe him my career as a mathematician and my love of the subject. I met him once in UCC after he retired where he told me that some person with the same name as me had written a shameful book of jokes and we agreed this was very embarrassing! He never found out it was me.

For the Leaving Certificate, I did applied mathematics entirely on my own without a teacher, which was a difficult thing to do, and one of my proudest achievements was to obtain honours in it, despite the fact that I was not doing physics.

How did your 1972 PhD at Keele with Hans Liebeck come about and was that area what you ended up pursuing?

DMH: As an undergraduate at University College Galway, taught by Seán Tobin and Tom Laffey, I fell in love with algebra, especially group theory and ring theory. I'm afraid I tolerated analysis and mathematical physics for which I had little talent, but I enjoyed a course on projective geometry given by Tom McDonough, and the MSc course on complex analysis delivered by Sean McDonagh. I lectured for a year (1968-1969) at UCG and got a taste of research on commutativity in finite groups and decided to pursue a career of research in groups by doing a PhD in the UK. Seán Tobin suggested I try Hans Liebeck at the University of Keele and I got a studentship there. I also had offers from Leeds, Aberdeen, London, and Belfast, but I had been to Keele for interview and the country estate campus where all staff and students lived proved very attractive, especially for a keen tennis player! Hans Liebeck was an excellent supervisor and we got on very well together – if the mathematics was not progressing, we often played squash together, until things seemed clearer. At first I was working on a very difficult problem – the breath and class of a finite p-group – still unresolved for groups of odd order. Then one day in the library I came across *The Collected Works of G.A. Miller*, an eccentric American group theorist. This was a treasure trove of about five hundred papers, concerning automorphisms, abelian subgroups, conjugacy classes, etc. This led to my thesis on "Finite Groups with an Automorphism inverting Many Elements" for which I was awarded a PhD in 1972 (conferred by Princess Margaret). I have since had many publications based on the work of G.A. Miller.

What papers, books, lectures or mathematicians influenced you?

DMH: I was very influenced by my supervisor Hans Liebeck and my external examiner Peter Neumann; also by Miller and Tom Laffey. I owe a lot to the great Philip Hall and his great concept of isoclinism – I still have a twenty-page letter he wrote me, full of ideas and encouragement. The text that most influenced me was Herstein's *Topics in Algebra*, a beautiful book that would make an algebraist of anyone.

Describe how you ended up at UCC and how mathematics developed during your time there.

DMH: I ended up at UCC because there were jobs there, one of which I obtained on my second attempt. I had a temporary position there 1972-73, and worked very hard to persuade them that they could not do without me — Martin Stynes won a Studentship that year taking my MSc course in algebra. Under Professor Paddy Barry mathematics thrived at UCC for the next forty years; an excellent mathematician himself, he was a super head of department, and I do not remember a single incident of conflict in that time. He chose staff very wisely, both for their mathematical ability and emotional maturity and I was blessed to be surrounded by colleagues too numerous to mention. As

a perk, I got to give all my favourite algebra courses, but I enjoyed teaching calculus to engineers also. We had some excellent undergraduate students, as good as anywhere in the world – and many went on to fill mathematical positions worldwide. For example, we had Stephen Buckley, Peter Hegarty, Diarmuid Early, Martin Stynes and many others. I initiated the Superbrain Competition and the Irish Intervarsity Examination which gave student mathematics at UCC a cutting edge and made us very successful.

We wound up with a very balanced undergraduate course with strengths in analysis, real and complex, algebra, combinatorics, and geometry, and good options at postgrad level including cryptology, introduced by Pat Fitzpatrick.

How do you feel about the role of teaching and what is your approach to teaching?

DMH: I loved teaching mathematics, which I regard as inseparable from research. My favourite class was the first year honours class – very bright young boys and girls in from school, just bursting with talent. I loved to challenge them and widen their mathematical horizons. Every couple of weeks we had a ten minute spot on a special topic, not necessarily examinable – paradoxes, countability, intransitive dice, orthogonal Latin squares, unsolved problems in number theory etc.. These sessions really made them sit up. I enjoyed too giving the undergraduate modules in groups, rings and fields, geometric constructibility etc.. As a result, I became interested in commutativity in rings in which I have worked with Stephen Buckley a lot. But I enjoyed teaching practical calculus to engineers and scientists too, and one of the highlights of my career was an MA course we gave to secondary teachers on Curriculum Studies.

With Tom Carroll and Donal Hurley, I was awarded a UCC prize for a new course on Problem Solving and Mathematical Creativity we put together. This proved very popular with students and included a project.

What is the future of mathematics in general and at UCC?

DMH: The future of mathematics is promising but the future of pure mathematics is more shaky. You cannot be a rich pure mathematician – that is the price you pay for the exquisite pleasure the subject gives you. You can be comfortable and have a good living being paid to do what you enjoy most (remember the old quip – a pure mathematician is someone who has found something more enjoyable than sex!) but you will not become rich. Computer science, statistics, engineering, applied mathematics, financial mathematics, and other areas have seduced many students who would have contributed greatly to pure mathematics. Ironically, all those other lucrative areas depend vitally on progress in pure mathematics, *a la* Boole. The future of mathematics at UCC seems secure – we have good enthusiastic staff, and a geographical catchment area that every year produces world class mathematical students.

How did you get interested in George Boole?

DMH: In 1974, the late Dr Sean Pettit of UCC was doing his doctoral thesis on the history of third level education in Cork and told me he had discovered some letters of Boole's in the archives. I started to write a short article on them, which grew into a long article, which grew into a short book. Then when I realised there was no full-length biography of Boole, I decided to write one. It took me over ten years. Boole's widow had destroyed many of his letters and papers before 1900 as she felt they reflected badly on the religious movements he had been involved in. The Life and Work of George Boole was published in 1985 by Boole Press in Dublin and reprinted by Cork University Press in 2014 for the bicentenary Of Boole's birth. Then in 2018, with my former student Yvonne Cohen, we published *New Light On George Boole* (Cork University Press) a 500-page book of new material on Boole's social, educational, and family life, which

had two highlights – the meeting of Boole and Babbage in London in 1862, which if they both had lived, could have led to the first computer a hundred years earlier, and the sensational theory that Boole was the inspiration for Professor James Moriarty, the arch-villain of the Sherlock Holmes stories.

What are the connections between mathematics and humour?

DMH: This is a largely unexplored topic, but very fruitful. Contrary to popular belief, most mathematicians have a very well-developed sense of humour and love jokes. Logic seems to be the link – mathematics is based on logic, but humour turns logic on its head. Paradox is another strong link. The riddle is close to the claim and the conjecture, and the joke has very much the same structure as the theorem, with the assertion and the punch line in reverse order. I have even written a book on the topic – *Comic Sections* (Boole Press 1983). The Mathematical Association in the UK are soon to reprint an expanded version – so watch this space. I believe that humour and mathematical ability go hand in hand – they both require insight, ingenuity, creativity and the ability to see connections. Look at Tom Lehrer, Lewis Carroll and Stephen Leacock, and maybe myself.

How do you view the Irish contribution to mathematics?

DMH: I think that Ireland, North and South, has definitely punched above its weight in mathematics. Poorly financed, but needing little resources, Irish people, historically and currently, have contributed greatly to mathematics, pure and applied. Hamilton, Stokes, Casey, Murphy, Kelvin, Graves, Newell, Laffey, Kennedy, and many others have given us an international reputation in the subject. It would be an interesting topic to investigate – does the Irish mentality lend itself to mathematics as it does to humour?

Final Remark

DMH: Mathematics has theological implications for me, and is one of the reasons I believe in God. I can't believe that the Universe is just random when I see the beauty, ingenuity, and consistency of mathematics. As some philosopher has said, God exists because mathematics is consistent, but the Devil exists because we cannot prove it!

6. Patrick Fitzpatrick

What were your early interests, and who were your teachers of note?

PF: I discovered mathematics at the age of ten, in first year at St Mary's CBS in Belfast. Our school mathematics programme was divided into Arithmetic, Algebra and Geometry (of the Euclidean variety) and I was introduced to proofs which I loved. One particular incident stands out: we were doing ruler and compass constructions and having learned how to bisect an angle, I recall the teacher telling us "no-one has ever discovered a way to trisect an angle". I was undaunted and the next day when the teacher asked "did anyone try it?" of course I had. Finding out years later why no-one had ever managed to do it triggered that memory, and I identify it in retrospect as when I became a mathematician. I loved mathematics throughout school and had several brilliant teachers especially that one, a young man just out of college, and the other a venerable Christian Brother from whom I learned mathematics and applied mathematics for A-Level. I did my undergraduate degree at the University of Surrey, where I was very influenced by Donald Keedwell who taught me algebra and combinatorics.

How did your 1980 PhD at Australian National University with László Kovács come about and was that area what you ended up pursuing?

PF: After graduation from Surrey in 1973, I took the PGCE and spend the best part of 3 years in second level teaching. That proved ultimately unsatisfying – mathematics

chased me in my spare time. I did not have the financial means to do a PhD, but in 1976 I was very fortunate to win a scholarship to ANU. My wife Johanna and I travelled together for what was a great "adventure", both personally and professionally. At the Research School of Physical Sciences at ANU, I was immersed in the mathematical environment created by Bernhard and Hanna Neumann which focussed on the theory of varieties of groups, those defined by laws. Laci Kovács was my supervisor and Mike Newman was also very much involved. I studied the variety of nilpotent groups of class four, that is, those defined by the commutator law $[x_1, x_2, x_3, x_4] = 1$, and achieved a full parametric classification. I learned a great deal, both in my thesis work and in the weekly seminar, and perhaps the most important lesson was to understand how little I actually knew.

Describe how you ended up at UCC and how mathematics developed during your time there.

PF: In 1979, I returned to England for the last three months of my scholarship, partly because Laci was going to be visiting Queen Mary College for the summer. I had an interview for a 1-year position at UCC which was successful, so Johanna and I arrived in Cork, with our 10-month old baby, in September 1979. I wrote up my thesis during that year and was awarded the PhD in June 1980. Fortunately, I was selected for appointment to a permanent position at UCC from September 1980.

In UCC the main structural change in mathematics was the amalgamation of the departments of mathematics, mathematical physics and statistics into a school in the mid-90's, and somewhat later the introduction of the degree in financial mathematics. One of the main changes in the development of mathematics from my perspective was the introduction of the computer as a tool. This made doing calculations easier, and allowed an "experimental" element into conjecture. In a completely different direction it made doing mathematics so much easier because it enabled communication with colleagues by email, with TeX/LaTeX to write things down in a common editable language, and obviated the necessity of multiple sequences of typesetting and editing drafts of papers. It allowed us much more time to focus on proof, as opposed to proof-reading.

What papers, books, lectures or mathematicians influenced you?

PF: To begin with at UCC, I worked on some problems in group theory with Des MacHale, who was a huge support in my early years as an academic. But sometime in the mid-1980s I had a conversation with my father who, as a BT planning engineer, was heavily involved in the roll-out of the fibre-optic telephone network in Northern Ireland, and he told me there was a very interesting connection with algebra. One thing led to another and I started to look at error-correcting codes, very interesting mathematical objects that sit between algebra and combinatorics, and are essential for digital communications. I also relished the experience of working with engineers: when I was an undergraduate anyone who was interested in algebra was destined to be a "pure" mathematician, and it was a revelation to discover that applications in the discrete domain, as opposed to the continuous, needed classical algebraic objects like Galois fields, and more recent inventions such as Gröbner bases. So I was able to tap into my "inner applied mathematician" and I enjoyed the experience!

I spent a sabbatical year 1986-87 in Alain Poli's group in Toulouse, and made the changeover from research in group theory to algebraic coding theory. I spent another sabbatical in 1994-95 with Don O'Shea and taught at Mount Holyoke and Amherst Colleges. Together with David Cox and John Little, he had just written the well-known book *Ideals, Varieties and Algorithms* (their later book *Using Algebraic Geometry* included some of my work). I very much enjoyed the interaction with the circle of mathematicians in the Five Colleges, and benefitted greatly from the weekly seminar at

UMass Amherst. It's also interesting to recall that there was an early introduction to the internet at Mount Holyoke, led by the staff in the mathematics department. I still recall the meaning of terms like URL, HTTP, HTML, etc.

How do you feel about the role of teaching and what is your approach to teaching?

PF: To me teaching is an essential part of the work of "doing mathematics". I have always loved interaction with students and the challenges it brings to clarity of thought. Developing new courses is a fruitful way to learn new areas, while guiding PhD students is possibly the most rewarding. I have been very fortunate in that respect. The relationship between teaching and research should never be underestimated.

What is the future of mathematics in general and at UCC?

PF: I think there will always be a (relatively small) number of students who are motivated to study mathematics at an advanced level. The key is to identify and nurture those at an early age, and that means taking specific actions. At UCC, we have held the Mathematical Enrichment classes for at least 40 years, and engaged the students in preparation for a wide range of challenging competitions, not least the national and International Mathematical Olympiads. An essential component of this activity is the nation-wide network that supports it. Our university schools of mathematics have always produced champions and I'm sure that will continue.

However, there is an obvious danger that targeted funding by government agencies, and indirectly by industry, will become so dominant, that mathematics in general, and pure mathematics in particular, will find it increasingly difficult to survive. I think every Irish university is threatened by this, and it is not obvious that university administrations are alive to the danger. I think it's more important than ever for mathematicians to tell the story of mathematics, and include further examples of its "unreasonable effectiveness", not just in physics, but, now more pertinently, in biology, computer science, and communications, *inter alia*. There needs to be a concerted effort to communicate this message. Every generation needs a Eugene Wigner and in the incessant noise of the modern day, more than one.

What have you been doing since your official retirement in 2013?

PF: I retired formally in December 2013 after almost nine years as dean of science and subsequently, after UCC restructuring, as head of college of science, engineering and food science. I have continued since then working at UCC Academy three days per week and I do some mathematics in my spare time. I'm looking forward to doing more of that when I eventually fully retire!

Gary McGuire, School of Mathematics and Statistics, University College Dublin, Dublin 4, Ireland
E-mail address: gary.mcguire@ucd.ie

Colm Mulcahy, Department of Mathematics, Spelman College, Atlanta, GA 30307, USA
E-mail address: colm@spelman.edu