

Patrick Francis Hodnett
OCTOBER 15TH, 1939 – JULY 5TH, 2011



It was with much sadness that we learned last summer of the untimely passing of our friend and colleague Frank Hodnett, RIP. Frank is sadly missed by his wife Diane, daughter Nicola, son David, relatives, colleagues and friends. For most of his life, Frank played a major role in the Irish applied mathematical community and was the founding Head of the Department of Mathematics and Statistics (as it is now called) at the University of Limerick. What follows are memories of Frank, written by six colleagues who walked with him along parts of the path of his life.

Finbarr Holland, *Professor Emeritus* (UCC)— Frank's early years in Cork

Patrick Francis Hodnett, first Professor of Applied Mathematics at The University of Limerick, was born in the Square, Bantry, Co Cork, on October 15, 1939, the eldest in a family of three girls and three boys; he died from cancer of the oesophagus on July 5, 2011.

Frank's father was a Post Office engineer, and sometime in the late 1940s or early 1950s, his job took him to Cork City, and the family took up residence in Mercier Park just on the outskirts of the city, a stone's throw away from the Turner's Cross Soccer grounds. In many ways this was a judicious choice by the family. On the one hand, their home was very close to the bus route that connected that suburb to the north side of the city, one that passed the North Monastery, where Frank finished his primary education, and received his secondary education. On the other hand, Mercier Park was just outside the boundary dividing the city from the county, which entitled him to compete later in his career for Cork County Council Scholarships, instead of the more competitive City Council Scholarships. Being so near to the soccer grounds, also, must surely have influenced his choice to make soccer his main sporting interest in his youth. In fact, up to the age of eighteen he played with the local soccer club, Tramore Athletic, and was a member of that club's team that won the Evans Cup, a national competition for under fifteens. Later in 1958, when practically the same team reached the final of the FAI Minor Cup which it won, Frank lost out because, close to the final, having played in all the earlier matches, he came off the panel to concentrate on the Leaving Certificate Examination and the Entrance Scholarship Examination for University College, Cork.

Already, even at this early stage, we see evidence of his strength of character, and his independence of mind. Thus, from an early age he travelled across the city on his own by bus to go to school, by-passing the nearby Scoil Chríost Rí, which was just around the corner from his home. As a pupil at the North Mon—a school renowned in those days for its achievements in hurling and adherence to gaelic culture, which he attended on the advice of friends of the family who had a love of Irish—he played soccer to a high level, something that wouldn't have endeared him to the Christian Brothers, and placed him somewhat outside the pale. Remember,

the infamous GAA Ban was in force at that time, and ensured that he wouldn't be eligible to line out with any of the Mon's teams. Again, in deciding to concentrate on his preparation for impending important examinations, we can but admire his decision to give up a once-in-a-life's opportunity to win a coveted FAI Minor trophy.

The latter decision paid off handsomely for him, however, because later that year he earned a prestigious Entrance Scholarship to UCC, and a Cork County Scholarship to boot. These scholarships enabled him to register in the Science Faculty at UCC in October, 1958, where, alongside many more freshmen who were inspired by Sputnik etc., to pursue a career in Science, including this writer, he settled down to do Chemistry, Experimental Physics, Mathematics and Mathematical Physics, all at honours level, and Science German. I remember he did Chemistry through Irish in his first year at UCC—no doubt a carry-over from his experience in the Mon, where the Leaving Certificate science subjects were taught through Irish; indeed, he was one of only a handful of students who did Chemistry through Irish—another instance of his single-mindedness—and so received special attention from the Lecturer, Dr. Réamonn Ó Cinnéide. On the basis of his First Year Examination results, Frank continued to hold the Cork County Scholarship in the succeeding two years during which time he studied for an honours degree in Mathematics and Mathematical Physics, and was duly conferred in 1961 with a First Class Honours BSc degree in these subjects.

Throughout his time in UCC, Frank took an active part in the running of the UCC Soccer Club, both on and off the field of play, and in many ways he was the heart-beat of the club. He played with the club in the Munster Senior League and in the Intervarsity competition for the Collingwood Cup, a trophy UCC didn't win until 1973.¹ Sometime during his early undergraduate career, he damaged a cartilage in one of his knees which necessitated him spending a bout in hospital, but as soon as he was discharged and declared fit to play, he resumed his playing activities, anxious to assist the club in whatever way he could. Also, in those early days, he decided to take up weight-lifting to strengthen his muscles, a novel thing then for students to do—many of whom would have been more accustomed

¹Finbarr Holland is grateful to Bernard McLoughlin who supplied facts about Frank's soccer activities, and to Tony Deeney who helped refresh his memory about other details mentioned in this article.

to lifting pints—and this became something of an obsession with him. But this, too, singled him out from the rest of the student body, and evinced the single-minded attitude he brought to bear on everything he did, and the seriousness with which he approached whatever interested him at the time.

Upon receipt of his primary degree, Frank registered at UCC in October, 1961, to do his MSc, which entailed a further two years study, the customary period in those days to study for a taught master's degree, and to compete for the NUI Travelling Studentship in Mathematical Science. But at the beginning of his second year, in order to earn some money, he took up an appointment as a Teaching Assistant at Magee College, Derry, where he had the good fortune to meet his future wife, Diane—a Cornish woman who was unable to use her grant from Cornwall County Council to attend TCD, the university of her choice, because it was deemed to be in a foreign country!—before re-entering UCC in January, 1963, where he resumed his studies. Later that year, the NUI awarded him the MSc degree in Mathematical Science with First Class Honours. On the strength of that he was offered an Assistant Lectureship at Leeds University where he also commenced his PhD in Applied Mathematics, but I leave it to others to take up the story at that point.

A final remark: long after our student days together, but still a long time ago, he and I wrote a joint paper with King-Hele. My interest back then was sparked by a paper Frank delivered at an *ad-hoc* seminar he gave to the Applied Mathematicians in UCC, after which I made a small observation which he graciously acknowledged by putting my name to the paper! Alas, I've no memory of the content of that paper now, though.

Prof. Derek Ingham (Leeds)— Frank's time in Leeds

Frank came to Leeds in the mid 1960's at the start of the rapid expansion in UK universities. He was appointed as an 'Assistant Lecturer in the Department of Mathematics' but in the Applied Mathematics section. His presence was like 'a breath of fresh air' coming to a Department that had a long tradition of staff that had been there for many years. Frank held an MSc qualification but had great ambitions and desperately wanted to study for a PhD. At the same time as Frank came to Leeds, Professor Allin Goldsworthy came as a new Research Professor in Applied Mathematics and

Frank soon realised that he was the person under whom to study. At that time there were weekly research meetings where all the ‘young’ active researchers presented their work and discussed ways forward for their research work. Frank was always determined to be the first to discuss his work. He was always extremely keen and very enthusiastic. However, in addition to his great drive to succeed academically, Frank was a very outward looking person and enjoyed life. For example, he was one of the founding members of the Department of Mathematics football team where he was the centre forward. No matter where he was on the field, he wanted the ball and ‘led the line’ in the way only Frank could do. We played against such illustrious teams as the Meat Market, Yorkshire Post, the Police, etc. In addition, we will never forget his exploits with his old cars. Coming from Éire, he could drive on his Irish licence for one year but he failed his driving test in the UK a couple of times, even though he went to several different test centres! Hence, even after one year of being in the UK he continued to drive with no UK licence - his defence being that he had not actually been driving for one year in the UK although he had been living here for more than one year! Further, his car was old and required an MOT, and the hand brake did not work, therefore he charged us all to find an MOT garage that was not near any hills so that the garage would not test the efficiency of the hand brake. This we did and the car passed.

Frank was a great success in Leeds with his research work, his lecturing and his very likeable character. Yet, Frank had dreams/ideas that Leeds could not match and after a few years he was off to the US. We all knew that it would not be long before he would return to his beloved Éire to become a real national and international force in Applied Mathematics. However, ever since leaving Leeds, Frank has been in regular contact with us and we have exchanged research ideas, performed examining activities, planned how best to promote Applied Mathematics, etc. We, in Leeds, are proud to have been associated with Frank and to have started him on his path to achieving all his goals. However, all this he could not have done without Diane, his wife and his family, all of whom we dearly loved.

Prof. James Flavin, *Professor Emeritus* (NUIG)– Frank’s academic career

CAREER (POSTDOCTORAL)

Following his years at Leeds, Frank’s career may be summarised as follows:

- 1968: Research Associate, Aerospace Research Lab., Dayton, Ohio, U.S.A.
- 1969-73: Assistant/Associate Professor, Aerospace Engineering, University of Connecticut, U.S.A.
- 1974-83: Lecturer/Senior Lecturer, Applied Mathematics, N.I.H.E., Limerick.
- 1984-97: Head, Department of Mathematics and Statistics, University of Limerick (N.I.H.E. Limerick until 1989).
- 1986-2005: Associate Professor/Professor, Applied Mathematics, University of Limerick.

Frank joined N.I.H.E., Limerick (as it then was) as the first member of staff in applied mathematics. According to the folklore, this arose as follows: Ed Walsh (Director of N.I.H.E, Limerick), who was looking for a mathematician for his faculty, rang Paddy Quinlan – Frank’s former professor in Cork – while Frank happened to be visiting Paddy’s office, and the rest is history! Applied Mathematics was first part of the Department of Electronics until it became, under Frank’s guidance, a fully-fledged department - one of the largest and most vibrant centres of applied mathematics in Ireland. While spectacularly developing applied mathematics at Limerick and pursuing an extensive research programme, he progressed through the academic *cursus honorum* - in the face of competition - as summarised above.

RESEARCH

Frank’s research, while largely centred on various aspects of fluid dynamics, extended over a very broad area.

His research publications may roughly be classified as follows:

- (1) Classical fluid dynamics including slow flow of compressible fluids.
- (2) Ocean dynamics.
- (3) Rossby waves.
- (4) Solutions of the Korteweg- de Vries equation.

- (5) Electricity load forecasting.
- (6) Miscellaneous-including industrial applications of mathematics.

A brief description of his work in some of these areas now follows:

Classical fluid dynamics: He considers flow of compressible fluids, with thermal effects, in regions bounded internally by a circular cylinder, and bounded internally and externally by concentric circular cylinders. He identifies a small, dimensionless parameter for each physical problem at hand, and develops solutions in terms of the small parameter, using the method of matched asymptotic expansions where relevant (*e.g.* for slow flow, the Reynolds number is used as the small parameter). Examples of this work are reported in the following papers, all in his own name except the last which is in his name and that of a doctoral student D. Rose:

- The slow compressible flow past a circular cylinder, *Physics of Fluids*, 11, 1636-1647, 1968.
- Low Reynolds number flow of a variable property gas past a heated circular cylinder, *J. Fluid Mech.*, 39, 465-476, 1969.
- Low Reynolds number flow past a heated circular cylinder, *Physics of Fluids*, 13, 2429-2431, 1970.
- Natural convection between horizontal heated, concentric circular cylinders, *ZAMP*, 24, 507-516, 1973.
- (with D. Rose) Unsteady heat transfer from a circular cylinder in a low Reynolds number flow. *ZAMP*, 25, 179-188, 1974.

Ocean dynamics: The basic model employed is that of a perfect fluid (but in the context of Boussinesq's approximation) in steady motion, with Coriolis effects due to the earth's rotation, and incorporating temperature variations. The independent variables are the latitudinal and longitudinal angular coordinates together with the depth, while the dependent variables are the velocity components in the coordinate directions together with the pressure and temperature. Various approximations to the relevant partial differential equations are considered which are deemed appropriate to different oceanic zones, *e.g.* the thermocline, the abyssal region. Solutions of the resulting equations are considered by analytic and numerical

means. Solutions of relevant boundary value problems are considered by both these means and the results are usually compared with observations. Frank's published work on this subject may conveniently be grouped into five areas:

- (1) Papers on the advective model of the thermocline, two in his own name and one with F. Holland and J.A. King-Hele : In the first of these (*J. Marine Research*, 36,1,185-198,1978), by employing the temperature (T) as an *independent* variable and a depth variable (z) as a *dependent* variable, Frank elegantly reduced the five p.d.e.s to a single, fully nonlinear, third order equation in just one variable ($G = p - Tz$, p being the pressure). This would enable him to generate a large class of solutions to the original five equations. The second of the papers, with Holland and King-Hele, (*Proc. R. Ir. Acad.* , 80A, 1,57-62,1980) showed how to obtain a general first integral for the aforementioned equation in G . The third paper (*Proc. R. Ir. Acad.*, 82A, 2,187-199, 1982) considered boundary value problems, by analytic means, in the zonally uniform case (*i.e.* independent of longitude).
- (2) In a paper (*Geophys. Astrophys. Fluid Dynamics*, 78, 73-93, 1994) with A.R. Ansari, the interaction of a simple ocean model with eastern boundary shapes is considered.
- (3) In two papers with Y. Yuan, one (*Proc. R. Ir. Acad.*, 97A, 2,193-207, 1997) considers the effect of small thermal diffusion in a zonally uniform ocean model, while another (*Proc. R. Ir. Acad.*, 100A, 2,115-138,2000) considers a model of the northern ocean with eastern boundary currents.
- (4) In three papers with R. McNamara, one (*Proc. R. Ir. Acad.*, 100A, 1 85-104, 2000) treats a modified Stommel–Arons model of the abyssal ocean circulation, the second deals with zonal influences in a similar context (*Proc. R. Ir. Acad.*, 102A,1,1-27) while another (*Proc. R. Ir. Acad.*, 103A, 2, 217-230,2003) discusses the variation of the vertical thermal diffusion coefficient in a simple ocean model.
- (5) Work related to the above general themes is discussed in two other papers (*Bull. I.M.A.*,16,2-3,68-72,1980); *J.Math.Ed.Sci.Tech.*,38,1029-1049,2007).

Rossby Waves: Frank co-authored with a doctoral student, W.M. O'Brien, three papers on the instability of Rossby waves and allied

waves. These papers were published in *Beitr. Phys. Atmosph.* as follows: 62,90-98,1989; 64,49-54,1991; 64,261-271,1992. The flavour of this work is summarised as follows: Rossby waves represent slow, large scale motions of the atmosphere similar to what is observed in some weather systems; thus the stability or otherwise of these waves is of interest. The instability of Rossby waves had been investigated by Lorentz (1972) by linear analysis and by others (Loesch, 1978; Deininger and Loesch, 1982) using a weakly nonlinear analysis. Hodnett and O'Brien extended these studies to the fully nonlinear regime by solving numerically the non-divergent barotropic vorticity equation and tracing the evolution over a long time period (800 hours). They found (a) that Lorentz's analysis correctly predicts only the initial growth rate of the solution (when unstable), (b) that the nonlinear solution eventually settles into a bounded oscillating state for all values of the wave amplitude A (similar to what Loesch and Deininger and Loesch found for values of A slightly in excess of A_c , the critical amplitude of instability) and (c) that A_c (determined by linear theory) is not an accurate indicator of stability/instability for the nonlinear solution.

Solutions of the Korteweg -de Vries equation: the Korteweg -de Vries equation, which arises in the theory of water waves, for example, is

$$u_t + 6uu_x + u_{xxx} = 0.$$

The solitary wave, or soliton solution, is

$$u = 2a^2 \operatorname{sech}^2 \theta$$

where $\theta = ax - 4a^3t + \delta$, where a and δ are constants. Another solution, called the "two soliton solution" was derived by Hirota. Frank together with a doctoral student, T.P. Moloney, (*J. Phys. A.: Math.Gen.*, 19, 18, L1129-L1135, 1986) showed that this latter solution may be written as a linear superposition of two functions each of which has a form similar to the soliton (or solitary wave) solution. This decomposition facilitates the elucidation of the interaction of two solitons. Extensions and generalisations of these interesting ideas are discussed in a series of papers by Moloney and Hodnett (*SIAM J. Appl. Math.*, 49, 4, 1174- 1187, 1989; *Proc. R. Ir. Acad.*, 89A, 2, 205-217, 1989; *SIAM J. Appl.Math.*, 51, 4, 940-947, 1991).

Electricity load forecasting: This was work done with a doctoral student, O. Hyde, in response to an ESB requirement for forecasts of

systems demand or electrical load. Typically, a forecasting model was developed which identified a “normal” or weather-insensitive load component and a weather-sensitive load component. Linear regression analysis of past load and weather data was used to identify the normal load model. The weather sensitive component was estimated by using the parameters of the regression analysis. This work resulted in some four publications.

Miscellaneous: Frank’s publications in this category extend over a very broad spectrum: they range from magneto-fluid dynamics through the aerodynamics of foil chaff, design of an air journal bearing, to wave induced washout of submerged vegetation in shallow lakes.

Five people completed their Ph.D.s under Frank’s supervision: D. Rose (1973), Univ. of Connecticut; T.P. Moloney (1989), W.M. O’Brien(1990), O. Hyde (1994), R. McNamara (2000), Univ. of Limerick.

Frank’s research at UL was supported by numerous grants:

- (1) Two NBST Research Grants (1982-84, 1986-87).
- (2) Forbairt Basic Research Grant (1995-97).
- (3) Eolas Higher Education-Industry Cooperation Grants with the ESB (1989-91,1996-97).
- (4) European Commission Grants under the Marine Science and Technology Programme (1993-96, 1991-93).

OTHER PUBLICATIONS

In addition to research reports to funding agencies, Frank published articles on the role of mathematics in engineering education, on workshops on interactions with industry held at Limerick. He also published an interesting article on “Osborn Reynolds, 1842-1912” in *Creators of Mathematics, The Irish Connection*, University College Dublin Press, 71-77, 2000.

EXTERNAL INTERACTION

Frank made over forty presentations of his research at scientific conferences, and gave over twenty invited lectures at conferences and other universities.

Frank was active in societies promoting mechanics and applied mathematics. He was Chairman of the Irish Mechanics Group (subsequently Society) from 1977-80. He served as Chairman, from 1996-2000, of the National Committee for Theoretical and Applied Mechanics of the Royal Irish Academy, having served as its Secretary from 1992-96. Indeed, this body was one of the sponsors of the highly prestigious IUTAM (International Union of Theoretical and Applied Mechanics) symposium “Advances in Mathematical Modelling of Atmospheric and Ocean Dynamics” which was hosted by Frank at U.L. in 2000; specifically, he was Chairman of both the Organising and Scientific Committees of the symposium. He also edited the proceedings:

Hodnett, P. F. (Ed.), *Proceedings of the IUTAM Symposium on “Advances in Mathematical Modelling of Atmospheric and Ocean Dynamics”*, Kluwer, Dordrecht, pp.1-298, 2001).

He was also active in ECMI —Sean McKee writes about this.

Frank served as External Examiner for the NCEA, at the University of Strathclyde, and at Queen’s University, Belfast. He was also a member of the Board of Associate Referees, *Journal of Engineering Mathematics*.

CONCLUSION AND GENERAL

Frank had many sporting interests: he was a keen soccer player in his youth, and in later years developed a great interest in horse racing while he was also an enthusiastic fan of Munster rugby.

He was a highly regarded member of the Irish mathematical community whose passing leaves a void in the lives of all who knew him. But above all, he will be missed by his wife Diane, his children David and Nicola and his grandchildren.

Leaba i measc na naomh go raibh aige.

Gordon Lessells (University of Limerick)– Frank’s involvement in ILIAM

For 10 years, Frank was heavily involved with ILIAM, the Information Linkage between Industry and Applied Mathematics. Originally the brainchild of Dr. John Carroll (NIHE, Dublin), this was an attempt to bring together industrialists and applied mathematicians to promote cooperation and information flow between industry and academia. *ILIAM 1* was held in June 1984. At *ILIAM 2*, a joint coordinating committee was set up consisting of Frank Hodnett (NIHE Limerick), John Carroll (NIHE Dublin) and Tony

Donegan (University of Ulster) with a view to rotating future ILIAM seminars between the three institutions. These meetings continued for at least ten years. During those years, a huge variety of talks were given from Aircraft Design in 1986 to Statistical Analysis of the Foreign Exchange Market in 1993. *ILIAM 10* was held at the University of Limerick in May 1993. The success of these meetings was a spur for Frank to get involved with a larger project with the same philosophy *viz.* ECMI; Sean McKee takes up this story.

Prof. Sean McKee (University of Strathclyde)– Frank’s involvement in ECMI

Professor Frank Hodnett, representing Ireland, was one of eleven Europeans to found the European Consortium for Mathematics in Industry, ECMI. This took place in Neustadt-Mussbach, a pleasant wine growing region of Germany on the 14th of April 1986. In addition to Frank Hodnett, the other ten men were A. Bensoussan (INRIA, Paris), A. Fasano (University of Florence), M. Hazewinkel (CWI, Amsterdam), M. Heilio (Lappeenranta University, Finland), H. Martens (Norwegian Institute of Technology, Trondheim), S. McKee, (University of Strathclyde, Scotland), H. Neunzert (University of Kaiserslautern, Germany), D. Sundström (The Swedish Institute of Applied Mathematics, Stockholm), A. Tayler (University of Oxford, England) and H. Wacker (University of Linz, Austria). For 10 years, Frank remained on the Executive Board travelling, twice a year, to various parts of Europe, providing good humoured common sense to some of our more excitable European partners. In 1991, he organised, funded and ran the sixth ECMI Conference in Limerick. Influenced by Hansjorg Wacker’s work on optimising hydro-electric systems, Frank Hodnett and I used to meet periodically in Dublin to put together a European proposal. Although never successful, this led to both parties obtaining funding elsewhere: in particular, Frank built up a good relationship with the Irish Electricity Supply Board (ESB) and this resulted in a number of publications mainly concerned with the prediction of electricity demand.

Michael Wallace, *Professor Emeritus* (UL)– Frank’s career at NIHE/UL

Dr. Frank Hodnett arrived in the National Institute for Higher Education, Limerick in the spring of 1974 as the first lecturer in Applied Mathematics. For the next 31 years, he worked tirelessly for the

cause of Mathematics and its applications at initially NIHE, later to become the University of Limerick (in 1989). His objectives and achievements progressed in parallel. Initially he set about establishing suitable streams of Mathematics for existing programmes *i.e.* Electronic and Materials Engineering, Business Studies and Administrative Systems. Frank strongly believed that all Mathematics should be taught by Mathematics faculty and it is to his credit that this maxim is still in place at UL. As student enrolment increased (240 in 1974), further appointments were made in the areas of Statistics, Operations Research, Control Theory, Algebra etc. Although initially members of the Electronics Dept., Frank insisted that we met as a separate group with the intense belief that the Mathematics faculty should have its own department, later to become a realisation in 1984 with Frank as its first head, a position held until 1997. He also believed that the Mathematics faculty should have its own programme and was very proud in 1979 to welcome the first cohort of students on the BSc degree in 'Industrial and Management Mathematics', a title that caused much debate and explanation. All these achievements in his first ten years at NIHE were not without internal opposition and it was his tenacity allied to his strongly held views that won the day. An example of this was the decision taken at an Academic Council meeting in June 1980 to discontinue the Mathematics programme, despite having two cohorts of students enrolled. However, at its meeting the following month, the Governing Authority overturned this decision!

Despite all the time given to these developments and when, in the early years, it was not a main priority, Frank managed to progress his research activities both in Ireland and Europe. A testimony to his standing in this regard was his hosting of several major and international conferences *e.g.* ECMI in 1991 and IUTAM in 2000. He published regularly, spoke at major conferences and supervised many PhD students. (Jim Flavin deals with this area in more detail). In recognition of all these achievements, Frank was deservedly appointed as the first Professor of Applied Mathematics at the University of Limerick in 1994.

Away from his academic responsibilities Frank was very sociable and great company. His interest in sport knew no bounds and his company at coffee on Mondays was sought for his insightful assessments of the week-end games from Cork hurling to Munster rugby

and everything in between. He loved a good party and whether it was the staff at Christmas or the graduating students in summer, he will be long remembered for his rousing rendition of ‘The Bould Thady Quill’:

*For ramblin’, for rovin’, for football or courtin’
For drinkin’ black porter as fast as you’d fill....*

Ar dheis Dé go raibh a anam dílis.

Collected and compiled by Eugene Gath, University of Limerick.