An Interview with Professor John J. H. Miller

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ABSTRACT. This interview with Professor John Miller gives an overview of his mathematical experiences from his childhood to his current research on wave energy. He provides some detail about his undergraduate days in TCD, his graduate studies in MIT, his extensive international collaborations, and his research in numerical analysis and its applications. Throughout, the reader will appreciate his passion for research and his strong engagement with researchers in Ireland, America, Europe and Asia.

INTRODUCTION

On 6th March 2023, I recorded an informal interview with John Miller about his mathematical life, at his home. After transcribing the audio recording (with the help of Otter software), John reviewed my edited version of the transcript, and I prepared the final version for publication in the Bulletin of the IMS.

EARLY EXPERIENCE OF MATHEMATICS

MOR: *Good morning, John. It's a great privilege to talk to you about your decades of work with mathematics.*

JJHM: Thank you very much for suggesting it, Maurice.

MOR: *Would you like to say a little bit about how your interest in mathematics began, your earliest memories of mathematics?*

JJHM: Well, I remember my mother telling me that a teacher in Park House School, my kindergarten, remarked that "numbers mean something to that fellow". That's my earliest memory.

MOR: *Right, so your teachers had an important influence on you?*

JJHM: Oh, definitely, yes. My next school was Avoca School, Blackrock, now Newpark Comprehensive School. In those days, it was a small private school, run by Mr Parker, who was an engineer from Trinity. He liked mathematics, so I had a good teacher for the four years that I was there, before going to a boarding school called Kingswood School in England at the age of 14.

MOR: *What was the mathematics like in the boarding school?*

JJHM: It was good, but I studied it there only for the first two years. This was due to the English school system, which required pupils to specialize in three subjects after O-levels. It seemed then that modern languages would be a good choice, especially if I was to enter the family business, which was focussed on office machinery. The business had been founded by my grandfather, and my father built it into quite a well-known company. He was the sole agent in Ireland for IBM, and he was later invited to be the Managing Director of IBM (Ireland) Ltd, when they opened their first office here. I want to stress that there was never any pressure on me from either of my parents to choose this as a career. It was always made clear that I was free to choose whatever I wished. But I found, as time passed, that I had no particular ability in languages, and I didn't particularly like studying them. I took mathematics and applied mathematics in O-levels. But then I stopped all mathematics during the formative years from 16 to 18. It wasn't accidental that they turned out to be rather unsatisfying years for me. In the subsequent and final two years at Kingswood, the subjects I was studying did not inspire me. I had no serious goals, because the O-level results I'd got — I think I had eight subjects — were enough in those days for entry into Trinity College. I was just hanging around waiting to be 18 years old, which was considered appropriate to enter university.

Undergraduate years in Trinity

MOR: *And then you had a couple of years of Modern Languages.*

JJHM: Yes, to be precise, a year and a half of Mod Lang. And, just from a chance remark by a family friend, I suddenly realized that maybe I should be learning mathematics and science. The key thing then was that I was advised to get grinds from Mr Victor Graham, who was both a teacher of mathematics in the High School and a lecturer in mathematics to the engineers in Trinity College. He taught mathematics to many generations of schoolboys and engineering undergraduates — a brilliant teacher! It was a recommendation through one of the administrators in Trinity College, who said, "Oh, if you want to do mathematics, there's just one person to go to, and that's Victor Graham". And that was absolutely correct.

MOR: *And that really changed the trajectory of your study.*

JJHM: And my life! And, of course, as you know, INCA [the Institute for Numerical Computation and Analysis] created a perpetual trophy in his honour.

MOR: *Okay, while we're talking about that, do you want to say a little bit about that trophy?*

JJHM: That happened much later, when INCA funded the Victor Graham Trophy.

MOR: *Which was to be awarded to an Applied Mathematics schoolteacher, every year?*

JJHM: Yes, and you have done great work in promoting that.

MOR: *So, you're in Trinity now, and you're studying mathematics, at last. What was the study environment like in Trinity for mathematics at that time?*

JJHM: Well, I was tremendously happy and totally goal orientated. I simply worked as hard as I possibly could at two degree courses, one in mathematics, the other in natural sciences. Prior to this, in the final six months of my second year in College, I was catching up with the two years of school mathematics that I had missed. Mr Graham was teaching me calculus and all the preliminary stuff that was necessary to bring me up to first year Trinity level of mathematics. These were individual private tutorials. I think it was a couple of times a week. And I used to go up to his house, mainly in the evenings, and would have an hour's grind with him. He was a brilliant teacher, and I just absolutely loved the work. And I loved the first few years in Trinity doing science too.

MOR: *Who stands out as lecturers in Trinity, in those years?*

JJHM: Well, in the Freshman years, I can't remember any specific, outstanding lecturers. But, in the two Sophister years, there were two main lecturers. They were both outstanding, Mr Broderick and the Provost, AJ McConnell. I would still regard AJ McConnell as the best mathematics teacher that I ever encountered. His lectures for advanced undergraduates were simply brilliant, and they were held in lovely surroundings, too. We sat in the private library of the Provost's House, with French windows opened, in the summer, onto the lawn. There were fewer than ten of us, and we felt very privileged to be listening to lectures by the Provost. His pet cat was often in attendance too, curled up and asleep on an armchair.

MOR: *And were the lectures very interactive?*

JJHM: Not really. In general, Irish undergraduates then were quite timid. He was so brilliant; he was a master of his subject and we listened.

MOR: *And you essentially sat at his feet and took notes ...*

JJHM: ... and loved it.

MOR: *And they were all very clear notes afterwards?*

JJHM: Superb! He introduced us to relativity theory, quantum mechanics and so on; all sorts of modern fields like that at the time. And you got the impression that it was so simple [laughs]. And yet he was teaching us material from, really, the forefront of science.

MOR: *And what about Mr Broderick?*

JJHM: Mr Broderick was quite different. He was very thorough. He wasn't inspiring, but he was very thorough. And he was conscientious, because he took account of the interests of each of the students in the two Sophister years. Both McConnell and he were the backbone of the Sophister instruction in mathematics in those days. Broderick took account of what each student was interested in, especially if he was going to continue with his studies, which I think most of us did. He would teach us all a little bit of relevant material that each student was interested in studying.

MOR: *So, what subject matter did he teach that you were interested in?*

JJHM: He didn't tell us that at the time, he just did it, without comment. And, by the way, we all found out that he devoted one day a week to stay at home when he taught himself new topics. So that was the way he kept himself up to date, and presumably learned that new stuff to teach us. So, to answer your question, the relevant topics for me turned out to be stability theory, especially in numerical methods and differential equations, including norms, and a little bit of functional analysis.

MOR: *Yes. Going back to McConnell. Were there other areas that you associated with him?*

JJHM: Relativity and quantum mechanics, as I mentioned, but also fluid mechanics, aerodynamics, tensors — a broad range of topics in applied mathematics and mathematical physics.

MOR: *And what about books at that time? Did you use books much? Or did you rely mainly on the lecturers' notes?*

JJHM: We had to rely mainly on the notes we took ourselves at the lectures. There were no handouts from the lecturers. Books were a problem, because, well, I suppose you could buy them, but the more advanced we got, the harder it was to purchase books in Dublin. They had to be ordered from abroad. There was a good collection, of course, in the College Library, but the catalogue in the library was dreadful; it consisted of big volumes with each page having many little pieces of paper, one for each book, stuck onto it. I don't know if you ever saw those? And then you couldn't take any book out. So, it took you a long time to find the book in the catalogue, and then you had to wait maybe a day or more, before the book would appear, after you had filled in the request slip.

MOR: *And was the library up to date?*

JJHM: Yes, because it's a copyright library. So, it was a brilliant library. Well, I mean, up to date with, probably, a two-year delay.

MOR: *What about your peers? Did you tend to work together, or individually?*

JJHM: No, absolutely not. We didn't work together [laughs]. It was cut-throat competition!

MOR: *Thinking of things like Schol and all of that.*

JJHM: Exactly. Yes. And I was lucky, I studied and got Schol, and that meant a great deal to me, at the time.

AMERICA WAS THE PLACE BE

MOR: *So, as you finished in Trinity then, how did the options for research emerge for you?*

JJHM: Well, again, Mr Graham, he was the guide. He told me what to do, just as he did for many of his other students. He was a very strict teacher, a very good teacher, very thorough, and he insisted that I write eight or ten letters of application to universities in America, because we had determined that I didn't want to go to Oxford or Cambridge, which were the standard choices for Trinity maths students in those days. I felt that they were too like Trinity, and, anyway, America was the place to be. It was an exciting time — the time when the Russians had sent up their first satellite,

and the Americans were panicking that they were slipping behind in space research. It was 'all go' in America, and many young Irish students wanted to be part of that. Mr Graham made sure that we wrote those letters in the Christmas holidays of our final year.

MOR: *America was the place be!*

JJHM: Yes. I heard a 'grand old man' in Britain being asked where he would like to study, if he were young again. It was quite a casual radio interview. He replied that he would want to be a PhD student at MIT. So that was one of the influences that determined me to go to MIT rather than another university. I received offers from three or four top universities, and I chose MIT, because I knew it was excellent, and I imagined it would be a totally different experience from a 'posh' university.

MOR: *And was it clear early on that numerical analysis was the way you wanted to go, or were there different options open to you?*

JJHM: Well, in retrospect, I didn't understand what numerical analysis was. There was a lot of confusion in those days, because people didn't really make a clear distinction between computer science and mathematics. So, it was all the one to me. I don't think the term computer science was in use then. So, numerical analysis seemed to encompass everything interesting about computers, and the programming of computers was not regarded as a serious academic subject. I remember mathematicians being quite disparaging about computers, and saying that the only intellectually interesting thing about computers was to use them to solve mathematical problems. There was no concept of the internet or computer languages being intellectually interesting. It was a snobbish approach, and a rather degrading attitude to the people who had designed computers. But I didn't understand any of that at the time.

MOR: *You wanted to be involved with these wonderful machines, in some way?*

JJHM: Yes. I suppose that was due partly to the fact that the IBM company magazine, *Think*, was left lying around our house, maybe deliberately, in those years. It was a beautifully produced magazine, full of discussions about the future prospects for computers in business. They were not used in business at that time, but they were coming. One of the most advanced machines for business at that time was the IBM electric typewriter. There were no computers or word processors.

MOR: *It's interesting, just going back to your father now, since you mentioned him in this context, that earlier on he thought your future was in languages rather than in some technical aspects.*

JJHM: Possibly because he had no specific technical training himself. He was always more interested in the overall system rather than the nitty gritty technical details.

MOR: *Or maybe he felt that languages would be more rewarding?*

JJHM: I remember that he told me once that he would have liked to be able to talk with his business associates in their own languages. He thought that would be useful to me, if I were to take over the family business. I was thinking of that too. But once I got hooked on mathematics through Mr Graham's influence, probably I was thinking more and more about an academic life. I never gave much thought to my future. I never planned it. I thought everything would just happen. I always felt things would work out well [laughs]. I don't know why.

MOR: *Let's say a little bit more about your time in MIT. How did your experience there evolve over the four years?*

JJHM: It was great flying to MIT in one of Aer Lingus's beautiful new Boeing 707s. In those days, people were proud that Aer Lingus had Boeings, and that there was a direct flight from Dublin to Boston, on an Aer Lingus Boeing, and I was proud to arrive at MIT as an Irish student. Of course, I was very proud of being Irish, and it was at the height of the Kennedy era. This was a time when academics across America were optimistic that many problems could be solved. People in general were very positive, and there was an air of excitement. The one disappointment was the discovery that I had to do two more years of courses and exams in MIT. I wanted to do research. I was ready at that stage to do research, having been an undergraduate for six years, which was far too long. But it was delayed by two years because MIT's new numerical analyst, Gilbert Strang, was not due to arrive till two years later. So, it fitted in quite nicely, although I could have started research had he been there. I spent a lot of that two years, going to lectures on different topics. I really went to lots of introductory lectures on a variety of subjects.

MOR: *Which ones did you find particularly interesting?*

JJHM: I went to lectures on astrophysics, mathematical logic and meteorology, for example. Of course, there were a lot of famous scientists there. I took courses in mathematics and physics, which would count towards what I had to do for the PhD. For example, plasma physics applied to tokamak devices to generate electricity. That was still an unsolved problem, even though it was said then that it would take just twenty years for it to become commercial. Nowadays, the period to commercial application is still claimed to be twenty years.

MOR: *Who do you remember from those famous scientists?*

JJHM: I remember Charles Townes, who later received the Nobel prize for the invention of the laser. He offered me a position as a student on his team. I also saw, from a distance, Norbert Wiener and one of the Browder brothers. An interesting encounter was with John McCarthy, author of the programming language, LISP. At that stage he was not well known publicly, but he has now become extremely famous as one of the founders of artificial intelligence. That meeting turned out to be a remarkable coincidence. A few years later, at a party in Boston, I met and, later, married an intelligent and beautiful young Kerry nurse called Mary O'Reilly. Many years passed before we learned that she and John McCarthy were first cousins.

Early years in research and international collaborations

MOR: *Then Strang arrived. What thesis topic did he suggest?*

JJHM: He suggested that a recent theorem on power-bounded matrices could be strengthened. I managed to do this in two years. I considered that a great topic and I thoroughly enjoyed working on it, day and night, under Gil's expert and kind guidance. It is interesting to note that Gil is just a few years older than me and, as we speak, he has still not retired. I was lucky to encounter him for the first two years of his stellar career at MIT. We have remained in contact ever since. After finishing my PhD studies, I became an Associate Professor in the first year of operation of the University of Massachusetts at its new campus in Boston. I remained there for five years, but with several visiting positions in Chalmers University, Gothenburg, the Istituto di Elaborazione dell'Informazione, Pisa, and Trinity College Dublin. During my stay in Pisa, I

clarified and expanded my thesis work, which was published in monograph form by the IEI [2]. This is now available on ResearchGate. In 1970, I accepted a two-year position in the Economics Department, TCD, with the promise that it would be followed immediately by a permanent position in the Mathematics Department. Fellowship followed a few years later, and the number of postgraduates I was supervising began to increase. I organised three international conferences on numerical analysis, under the auspices of the Royal Irish Academy, and then I took a two-year visiting position as a professor in the University of Nijmegen with an offer that this would be made permanent after two years.

MOR: *Your involvement in further conferences was connected with events in the Netherlands?*

JJHM: Yes. I was approached by Simon Polak, a senior employee of Philips in Eindhoven. Out of the blue, he came and talked me into organizing a conference on the numerical analysis of semiconductor devices. He said that Philips, through him, would help me to set up the conference. He would put me up for a couple of nights in a hotel at Philips' expense, where I could use the telephone without limits. He expected me to spend a day or two, in my hotel room, telephoning people worldwide to find out about numerical analysis for semiconductor devices. This was such an extraordinary and imaginative offer, that I certainly couldn't resist it. It was so exciting! So, I chatted with total strangers in many countries. I formed a network using a bootstrapping technique. I'd ask the person I was talking to "Well, who else do you know?" and I'd get additional names and telephone numbers. It all just grew and grew. I think I'd covered the main people in those 48 hours of work. So here was me, sitting in Eindhoven, talking for maybe an hour to an American on the telephone. I even remember talking to a famous American engineer, who told me at the end of the conversation that he was in the shower for the entire conversation [laughs]. They thought this was an exciting project. I quickly got a picture of what was happening in an area of application of numerical analysis. This was the birth of the NASECODE [Numerical Analysis of Semiconductor Devices] conferences, most of which were held in Ireland. NASECODE I, held in Dublin, was the first conference in the world on this topic. The participants were delighted to be brought together, especially in such an unlikely place, in those days, as Ireland.

MOR: *People didn't like to divulge the latest discoveries in their research, but even more so because there was a lot at stake in the development of semiconductor devices.*

JJHM: Absolutely, yes. So, the topics that they gave talks on would, I'm sure, be vetted by their management. And especially because I had a very altruistic view of research in the Cold War era, I felt that science should be used to ameliorate the results of the Cold War, and, maybe stupidly, I really wanted to bring people together. I thought if people came together, that would help to maintain peace and so on. So, I insisted that the whole world was represented at these NASECODE conferences. I insisted that Russians, who were the only serious competitor to the US in those days, would be treated as equally as possible, and as equally as they were willing, because they were much more restricted than anybody else. I mean they were restricted by their government, whereas Americans were restricted by their companies. So, I did succeed in attracting scientists and engineers from many countries. Of course, you had to deal with the Academy of Sciences to get anywhere in the Soviet Union. And, through the Academy of Sciences, powerful people became involved. I was dealing with the top-level people in the Academy of Sciences, including the then President of the Academy of Sciences, the mathematician, Guri Ivanovich Marchuk, who had a strong interest

in numerical analysis. They were all very good communists. But we collaborated as scientists, and, at any meetings, or anything to do with the running of the NASECODE conferences, politics were simply not mentioned. It seemed to me that everybody, on both sides, appreciated the opportunity to meet each other. These experiences led, on a St Patrick's Day in Moscow, to my having lunch in his official dacha with the President of the USSR Academy of Sciences, and, that same evening, attending the St Patrick's Day party in the American Embassy.

MOR: *And so, as far as Marchuk is concerned, what are your memories of your first contact with him? And how did it come about?*

JJHM: This was on the occasion of a seminar he gave at Chalmers. The next meeting was during a visit to the Institute of Theoretical Physics in Trieste. We had both been invited there by Professor Jacques-Louis Lions to give some lectures at a summer school in the Institute. Incidentally, it was there that I was approached by a Thai student, who asked if he could become a PhD student of mine. Since he had his own funding, I agreed immediately.

MOR: *Lions was one of the founders of IRIA [l'Institut de recherche en informatique et en automatique], which became INRIA later, I think.*

JJHM: Yes. Lions was an excellent mathematician, and a very powerful man in French science. He had many students in numerical analysis. He published numerous papers and wrote many books. He was a member of the Académie Française. He was a close colleague of Marchuk; they exchanged many visits.

MOR: *So those encounters with Marchuk and Lions really opened doors in big ways to mathematicians in the Soviet Union.*

JJHM: Marchuk was certainly politically powerful. I know that, at one stage, he was one of the Vice-Presidents of the Russian Socialist Republic. This may have been due to his position in the Academy of Sciences. He was also an author of many papers and books. It is widely believed, that he was responsible for the mathematical computations required in the building of the Soviet nuclear bombs.

Research in singular perturbations

MOR: *Were you already working on singular perturbations at that time, or did that come a little later?*

JJHM: I think Lions mentioned singular perturbations in a lecture that I attended. I would have been visiting France on an exchange programme between the Irish and the French governments. In those days, these exchange agreements, luckily for me, didn't seem to be very popular amongst Irish mathematicians, and I grabbed every one of them that I possibly could.

MOR: *From the Irish point of view, were they administered by the Royal Irish Academy?*

JJHM: Yes, and by an equivalent French organization. Lions was involved on the French side. It was on these visits that I got to know Lions quite well, and I went to a lot of his inspiring lectures in his university and INRIA. I also met people like Philippe Ciarlet, Pierre-Arnaud Raviart, Roland Glowinski and many other well-known French mathematicians. Lions had a very extensive group of his own students and colleagues. He was a friendly and helpful man. At one of his lectures, he spoke about

singular perturbations, and mentioned the Russian mathematician, A. M. Il'in, who was doing good work on this topic. Apparently, there were two Il'ins, and the singular perturbation one was hard to find. That sounded great to me — a good subject that Lions is interested in. I tracked down Il'in, the wrong one first, and then I found the right one.

MOR: *How did you communicate with them — by post? This was before the internet was available. Did you phone them, like the others?*

JJHM: It was telephoning and snail-mail. And, notably, in the early days, during one of the conferences I organized, we had a postal strike in Ireland and, I think, a bank strike too. I must say, it was interesting organizing a conference with no postal services [laughs]. It all had to be done by suitcases of letters taken on the mailboat to post offices in Holyhead, and also by phone and telex, where possible. Yes, fax, also, was very important. That was the really advanced way of communicating in those days.

MOR: *So, your early contacts amongst Soviet mathematicians were Marchuk and Il'in?*

JJHM: Yes, mainly Marchuk. I didn't meet Il'in for a long time. But I met his students. He was not an organizer. He was good academic.

MOR: *Who was the first person you actually met in Il'in's circle of singular perturbation people?*

JJHM: I think that was Grigorii Ivanovich Shishkin. This happened in Novosibirsk at the BAIL conference that I organised there. This was one of a series of BAIL [Boundary and Interior Layers] conferences. At that conference an important relationship was established between one of my Irish graduate students and Shishkin, which led to many visits to Dublin by the latter, and the publication of numerous joint papers and books on numerical methods for singular perturbation problems.

MOR: *That was the fourth conference, I think; the first three in Dublin, and then the fourth in Novosibirsk.*

JJHM: Yes. I'm delighted that the BAIL series is still going strong, independently of me. That conference led, of course, to our main working contact in Russia, namely Shishkin. He was a younger colleague of Il'in, who was the leader of the department. For the following 15 years or so, Irish numerical analysts had many happy years of collaboration with Shishkin. His long visits were almost entirely supported by the meagre funds we had available for this purpose. Shishkin was passionate about his approach to numerical methods for singular perturbation problems. He would undergo almost any kind of suffering in order to travel to promote his own methods. The Irish group involved at this time would probably all agree that he has never been properly recognized, at home or abroad, for the quality of his work. But I think most of us would agree, that this is probably due to his difficult personality.

MOR: *When one looks at citations on Google Scholar, the most cited work under your name is the book on fitted methods for singular perturbation problems, from 1996 [3]. Taking that as an example of collaboration with Shishkin, what are your memories of writing it?*

JJHM: It was a satisfying experience, because we didn't have to worry at all about the quality of the mathematics. Shishkin was monitoring, line by line, as it was being written. Nothing appeared in that book that was not approved by Shishkin. He is an absolute master of the subject. There's no doubt about that. But he is a singular person.

He is deliberately not a teacher. He doesn't reveal anything beyond the immediate question. He has done far more work on every topic than he would ever reveal to a colleague. If you wanted some help to understand an argument, or you questioned a result of his, he wouldn't go out of his way to explain it to you. He would give you some guidelines about how to do it. But it was really your business to educate yourself about what he had done. In his own papers, he quotes results that require long algebraic manipulations, which you imagine he did not have to do because of some trick that he knew. Invariably that turned out not to be the case — he had done the same calculations twenty years ago. He knew that you were wrong, but all he would say was, "Go and try again", with no possibility of further help from him.

MOR: *It was quite a challenge to fill in the gaps then.*

JJHM: Absolutely, but I'm not sure that I ever found any significant mistake in anything that Shishkin has written. Unfortunately, much of what he has written is, in my opinion, almost incomprehensible. I doubt that much of the material will ever be checked by somebody else. Perhaps AI will be used to elucidate it at some stage!

MOR: *And so, his results that are not in the book on fitted methods for singular perturbation problems [3] or in the one on robust techniques for boundary layers [1] (or in other joint papers and books) may be neglected, because people won't make the required effort to understand them.*

JJHM: Exactly! Certainly, those of us who worked with him always felt that a main role of our work was to ensure that Shishkin's results were not lost. We felt that we were opening things up, and that lots of other people would follow us. But, for reasons I still don't fully understand, Shishkin's methods were not widely adopted, especially in the United States.

MOR: *And who were the other significant Irish collaborators?*

JJHM: Largely my own students and, in turn, their students, and then, of course, the highly successful group of Martin Stynes in Cork.

MOR: *And also, significant groups throughout Europe.*

JJHM: Yes. Nothing to do with me. Groups spearheaded originally by people such as Hans-Görg Roos in Dresden, and Lutz Tobiska in Magdeburg.

MOR: *You've also had very significant collaborations, I think, in Singapore and India, for example. Do you want to say something about those more recent ones?*

JJHM: Yes. I took early retirement in the year 2000, which was exactly thirty years after I had started in Trinity. That was some years before I had to retire, since I wanted to do so while I still had some energy for new ventures. I undertook a number of things, including two extended visits to Singapore, spread over a two-year period. My duties there were essentially research, and we were well treated. While in Singapore, I became aware of someone in India, who was working on singular perturbations. It turned out to be an Indian lady, Valarmathi Sigamani, known more concisely as Mathi. I got in touch with her and, one Christmas, we went to see her in Tiruchirappalli, otherwise known as Trichy. She made the important remark during our visit, that she was only interested in papers that contained theoretical analysis involving rigorous proofs of parameter uniform convergence. From that point on, I decided to support her in every way I could. She was very keen to help young female undergraduates to get a good education in mathematics. It is noteworthy that the college where she worked had been set up in the 19$^\text{th}$ century by a Lutheran pastor from Germany. I was told that they took

in children literally off the street and, if they were intelligent, housed and educated them. Some of these students later became successful academics in different colleges. She built up a large group of devoted postgraduate students. My role was to provide some guidance on suitable research problems, and, sometimes, to help with the actual details of the proofs. I often had to suggest that a proof be clarified with more detail, as I did with my own students. We published many papers together, and she always insisted on adding my name to the list of authors. Most of the credit for obtaining the results is due to Mathi and her group.

MOR: *So that was a very fruitful collaboration and an unexpected one?*

JJHM: Yes, because there was so much energy coming out of the department she was running, so many bright young Indian people. I suppose I provided some useful general direction to them, but it was their own energy and their own abilities that counted. All they needed was a little guidance in the right direction.

MOR: *Well, John, we've spoken about your collaborations in so many places, but I think there are some others that come to mind which you might like to say a bit more about. I'm thinking of Bulgaria, Egypt, Thailand, Yugoslavia and China. You had significant contacts in those countries.*

JJHM: With regard to the first three, I had various visits at different stages of my career: in Bulgaria, in particular with my friend, Svetoslav Markov; in Egypt, where our family spent a memorable Christmas and New Year on the campus of the University of Assiut; in Thailand, on many occasions with Suwon Tangmanee. The first contact in Yugoslavia was with Zorica Uzelac, when I was asked to play a role on her PhD thesis committee. This was in the late 1970s, while we were living in the Netherlands. We drove to Ljubljana, took the train to Belgrade, and were then driven to Novi Sad. My role there was entirely nominal. The candidate became a personal friend of ours. Many years later, INCA funded Zora to translate Shishkin's doctoral thesis into English. She made a particularly good job of this onerous task, and her translation later played a big part in a book in English published by Shishkin. After the breakup of Yugoslavia, the Croatian mathematician, Mladen Rogina, invited me to several of his conferences in different venues. Sadly, he passed away before his time, at a relatively young age. I became interested in developing contacts with China, when colleagues in the US told me that Chinese PhD students were coming to the US, and that they were hardworking. An early contact was Guo Ben-yu, whom I invited to spend some time in Trinity. Subsequently, the BAIL V conference was organized in 1988, in Shanghai, with his help, and the BAIL VII conference was organised in 1994 by Zhuang Fenggan in Beijing. More recently, after a lavish celebration in Shanghai in honour of Guo Ben-yu, I visited Houde Han in Beijing to complete some joint work.

My students

MOR: *But even before that, you attracted quite a few Chinese students into the research group. How did that come about?*

JJHM: Most of my Chinese students were contacted through the BAIL conferences. I had plenty of money, due to the EU EVEREST contract, which involved illustrious partners such as Philips, GEC and Rutherford Appleton Laboratories. It was the largest European Commission contract that I participated in. It involved the numerical modelling of semiconductor devices in three dimensions. There was a lot of money available. That particular contract probably brought in a quarter of a million euro to Trinity. It was a huge amount of money in those days. To get the work done, I realised

that there weren't enough suitable postgrad students in Ireland. Naturally, I would automatically support every Irish student, but I had to find more. This was just at the time when China was opening up, and my US colleagues were speaking highly of their Chinese students. On one occasion, while I was in Beijing on the way to the BAIL IV conference in Novosibirsk in 1986, I met some of these candidate students. It was arranged that I would meet them, so that I could recommend them for studentships in Trinity.

MOR: *You attracted a lot of graduate students. On my reckoning, you probably had, at the period, at least half of the graduate students in mathematics in the country. When you look back, how do you see the recruitment of graduate students to mathematics in Ireland in the 80s, which was when the Numerical Analysis Group or NAG arose? How do you see that in the context of graduate students staying in Ireland, and indeed attracting students from abroad to Ireland?*

JJHM: Well, of course, I'm delighted that that happened. I'm very proud of the fact that so many of my students did well in whatever they chose to do. For example, three of my former students became heads of university departments in Ireland and at least two others in other countries. So, I'm absolutely delighted that that worked out. As for the Chinese, I don't know whether it's sad or not, but the Chinese students neither stayed in Ireland nor went back to China. One of them has done very well in Canada, and two of them have done very well in Australia. Had it not been for visa problems, I think that at least one of them would have stayed in Ireland. Nothing was ever said, but it seemed to me that, deliberately, the Department of Justice in Ireland was not allowing Chinese students to stay here. How different things are now in Ireland!

MOR: *So that was Ireland's loss.*

JJHM: In my opinion, that was Ireland's loss.

RESEARCH FUNDING

MOR: *One of the key things to consider is funding of research in Ireland, and you've got a lot of experience of that. What would be your overview of the funding from both Irish and, of course, European sources, and your experience of it all?*

JJHM: Well, my experience is very early experience, so I can say nothing about current funding — everything seems to have changed for the better. It's a completely different world now to the world then. There had been no serious funding in Ireland, for mathematics, when I was a young, or even middle-aged, academic in Trinity. There was simply nothing. Then, in the 1980s, European Union funding emerged. Of course, most academics in Ireland, of my age and generation, knew nothing about how to get or use that funding. I had been in the Netherlands for two years, as a full professor in Nijmegen. But, even there, there was no effort to teach new academics how to apply for this funding. The key problem was that you were asked to find half of the money yourself, and the European Commission would pay the other half. Finally, I learned how to do it. I think I was among the first to do so in Trinity. I probably would thrive in the present system, although it doesn't attract me nowadays. Unfortunately, Trinity didn't really understand how to make the best use of people who brought in those grants. The academics were also naïve. Now, a mathematician with a big grant would negotiate excellent terms for his students and himself, and if these were not forthcoming, he would be snapped up by another university. The concept of an academic making such a proposal and threatening to resign, would never even have occurred to any academic in

those days. But it's the way things have gone, and it's a much healthier way, because you're making the best use of the available resources.

MOR: *Looking at sources of funding that you've dealt with over the years — initially, it was primarily from Europe, and then later, I think around 2005, there was the SFI funding — how do you see the introduction of significant funding from indigenous sources at that time?*

JJHM: Irish funding was transformed by Atlantic Philanthropies. Chuck Feeney had an enormous influence and showed the way, insisting that for every million dollars that he put into research in Ireland — and it was millions — the Irish government had to match it. So, that was brilliant. Then, I think, it was Mary Harney who set up SFI. That was important as well. It was run, initially, by experienced Americans from the NSF. I worked there for six months or so, after retiring. There were still some Americans there, so a lot was done in the American way, and, therefore, it was very fair and unbiased. This funding changed everything as far as Irish research goes. It's now an environment that, if I were a young man, I'm sure I would love to be part of. People who knew me, twenty years earlier, said that I was a little ahead of my time. I suppose, because of all the travelling and international experience, I was aware of things that people back home, in more senior positions, were not.

MOR: *Yes, but that critical mass wasn't achieved until later.*

JJHM: Yes. Hopefully, some of my activities contributed to some extent to creating that critical mass. Ireland is a brilliant place now for research, and a terrific environment for ambitious people to do their research.

STUDENTS AND TEACHING

MOR: *When you look back over your career, how do you see your teaching and the readiness of students?*

JJHM: I must be frank about this. Up to a point, I quite enjoyed teaching, but teaching was never an important thing to me. I mean, I knew teaching was important, because I'd had such good teachers, and I knew who my good teachers were. The two outstanding teachers that I came across were, as I said, Provost McConnell and Victor Graham. They were both gifted teachers, especially Victor Graham, whose life was devoted to teaching. He was inspired to teach, and, I think, he loved teaching. He influenced so many people. As well as a natural instinct to make things simple, because of McConnell and Graham, I wanted to make my teaching simple. So, I hope my lectures were easy to understand, even though I sometimes lectured on complicated things. That's the nice thing about mathematics, once you really understand it, it's simple. If you don't think it's simple, I think you haven't fully understood it.

MOR: *So that's your perspective as a teacher. How did you find, overall, the preparedness of undergraduate Irish students?*

JJHM: I do want to stress, by the way, that I don't regard myself as being a particularly good teacher, and I wasn't motivated to become a brilliant teacher. But I knew I wasn't a bad teacher. Certainly, I could have given better lectures than I did. But what was your last question?

MOR: *How did you find the preparedness of students?*

JJHM: I was very impressed with the Irish students. I found that most of the Irish students, that I encountered, were very well trained and prepared. I admired their self-motivation, as well. They were great.

MOR: *These were the graduate students that you had?*

JJHM: Yes, the graduate students. But the undergraduates too were well prepared. The basic training in mathematics, I thought, in my day, was very good. Although I never taught first year students, I was impressed, always, by the students I met in the higher classes in Trinity.

My current research

MOR: *The last topic that I want to make sure to ask you about is your current research. Can you say something about that, John, and how it arose?*

JJHM: Well, when I retired early, I studied renewable energy, especially wind and wave. Then, luckily, through activities in INCA, I got to know Lawrence Crane much better than previously. He and I had been colleagues for about thirty years in Trinity. Strangely, we didn't really know each other well, in our Trinity days. He retired a little later than I did, even though he was a little older than I was. I retired in the year 2000. He retired a few years later. We then worked constructively for about twenty years together, getting to know each other very well, in the context of INCA. After trying several things, we finally became interested in renewable energy, which was a hot topic twenty years ago, and still is. After looking at wind, we realized that wind was well understood, and that a lot of the interesting research had been completed. Then, we found that there were many open research problems related to wave power. Lawrence and I both felt that two retired professors, like ourselves, with no money, would still be able to contribute. We made a decision not to worry about funding, but just to set up an organization that would survive, whether or not we got funding. So, we set up a company called Waveforce Energy Ltd, which still exists. It has never had any significant funding, and it pays no salaries. But we regard ourselves as extremely lucky to have found this research topic. We have learnt a lot about it, and we are passionate about the work. Sadly, Lawrence passed on two years ago. We had a very productive collaboration, and now the work is continuing with a colleague, in Limerick, who is a mechanical engineer. Recently, we have added an electrical engineer to the team. We have a digital model of a complete micropower device designed to produce electrical power from ocean waves. This device is ready to be built and tested. We hope to complete that in 2024. The device has a number of novel features. It is small, inexpensive, robust, efficient and simple. We hope it will produce micropower more cheaply than any previous micropower device. There are currently no successful large wave power devices.

Conclusion

MOR: *The public at large can find it difficult to see how mathematics works through numerical analysis, modelling, and cutting-edge technology. You've got an overview of all of that. What would you say to a youngster who hasn't seen this, maybe to spark their imagination, and to get them to see how mathematics can be really useful in the way that you've applied it over the years?*

JJHM: Well, I think I have been very lucky in life, and I cannot give any advice on how to find a project like the one Lawrence and I found to work on, in our old age. It

was something that we were passionate about, and I still am. It meant that we were as busy as ever during the Covid pandemic, and we did not have to meet in order to work closely together — email and the telephone were sufficient to keep the work going. When you are young, the key thing is to concentrate on what you are good at and what you enjoy the most. If you can find a job that involves these things, then you are in luck. Later in life, you will probably realise that as long as you have sufficient money, it is your health, both physical and mental, that really matters. In short, ensure that you have an interest that inspires you, and the good health to pursue it.

MOR: *So, passion and inspiration really matter.*

JJHM: That's the right way of putting it.

MOR: *John, thanks very much. I really enjoyed talking with you.*

JJHM: Thank you very much, Maurice, for organizing it. Without your initiative and drive, it wouldn't have taken place.

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