THE INSTITUTE OF MATHEMATICS
AND ITS APPLICATIONS

Interview with David Abrahams CMath FIMA

David Abrahams took over as President of the Institute from January 2008. He is Beyer Professor of Applied Mathematics and Head of Applied Mathematics at the University of Manchester. He was Chair of the IMA's Journals Board of Management for over ten years and the Journals Task Force before that. David is enthusiastic about applied mathematics and about the mathematical societies. He is also a keen runner and he owns and rides some impressive motorbikes. I met him at our London office to talk about his career and research interests.

How did you become a mathematician?
I see myself primarily as a scientist. Some mathematicians see a strong distinction between the physical world and the mathematical world but I certainly do not. When I was in my teens, I had a strong fascination for all things scientific. I picked up textbooks on the mathematical sciences, particularly in the areas of electronics, relativity theory, mathematics and particle physics. I remember being pretty good at mathematics at school and wondering whether it was an end in itself or whether the applications of mathematics were more important. I think I have struggled with that all of my life.

I went to a fairly mediocre school. The teachers were not great, nor very inspirational, in contrast to the experience of others you have interviewed. Therefore, I suppose my enthusiasm for things scientific carried on in spite of them rather than because of them. I did find out, years later, that one other person from my school became an academic; he is Professor David Riley from Nottingham University, now Pro-Vice-Chancellor there. He was a pupil at the school before I started, so I did not know him at that time, but his recollections are certainly very similar to mine. Needless to say, we are now very good friends.

It was whilst studying for A-levels that going to university to do a degree in engineering, mathematics or physics started to appeal to me. I changed in the sixth form in that I started to have belief in myself and in my abilities. I realised that to be good at something is primarily about hard work, and rarely about native brilliance. Very few people are able to succeed through intellect alone. I have always held the belief that we are all pretty much the same, and it is just a case of being really motivated to succeed. That is why mathematicians find it so easy to undertake research with people of all ages and backgrounds, especially enthusiastic PhD students. Once I had the motivation and passion for study, my career path was fairly well mapped out.

Your education indicates an interest in aeronautical engineering. Did you imagine designing aircraft at one time or did you always have a more abstract interest in fluid mechanics and acoustics?
That question actually gets to the heart of what I was looking to do. I had a big collection of university prospectuses but no clear idea of which courses would stimulate me. I felt that the way physicists thought was a bit too vague whereas mathematics is very elegant but I wanted something applied. Of all of the engineering disciplines, aeronautical engineering is by far the most mathematical. I went for a specialised course at Imperial College, which really explored the deeper aspects of the subject. The emphasis was less on engineering and more on the phenomenological aspects of such topics as fluid mechanics, thermodynamics and structural mechanics. At the end of my degree, it was clear that the sort of PhD that I wanted to do was really a theoretical one, not computational or experimental. This led me into applied mathematics.

Ultimately, it is the bigger questions that drive you on and I knew enough to understand that to design an aeroplane required a lot of deep mathematics as well as a sophisticated physical understanding.

You received two Imperial College scholarships in the late seventies and the Finsbury Medal for top undergraduate. Would it be true to say that you were marked out for an academic career from those times?
The fact that I got a few awards shows that I was motivated and that I did very much enjoy the course. My lecturers at the time were pretty supportive. In particular, there were two professors, Peter Bearman who works on vortex flows, and Peter Bradshaw, now emeritus at Stanford University, who is an expert on turbulence modelling. Bradshaw had a strong team around him, from whom I learned about the process of undertaking original research. However, I felt that there were no opportunities in engineering departments to develop my analytical skills, so changing to mathematics was the logical move. I found the perfect supervisor in Frank Leppington from the Mathematics Department at Imperial College who was a really terrific inspiration. I did briefly consider going into the aircraft industry but it did not appeal to me.

How would you summarise your research interests?
I am interested primarily in wave phenomena, but I should emphasise this is an interest shared equally between the physics and the underlying mathematical methods. I started out originally looking at problems in acoustics: mainly underwater acoustics and structural acoustics. The latter is the study of the interaction of sound waves with vibrating structures and relates to vehicle noise. My background in fluid mechanics gave me a head start in this area and I developed the techniques for solving several problems of diffraction and propagation of sound in the vicinity of complex boundaries. My interests grew to take in solid mechanics, with applications in seismology and in non-destructive testing of materials. Gradually I have broadened my research fields to include geophysical and electromagnetic wave problems.

Waves are ubiquitous – they occur absolutely everywhere in the physical world. The whole universe is continually vibrating at wildly different timescales and lengthscales, and the way one part of any structure feels the presence of forces or disturbances acting on another part is through waves. When you turn on a tap in an upstairs bathroom, the water particles in the pipework downstairs and in the mains feed-pipe only know of this by the action of a pressure, or acoustic, wave that rapidly passes through the fluid in the pipe. Although the mechanism or the dynamics producing waves, or the medium in which they propagate, may vary greatly, it is perhaps not surprising that the mathematics underlying these physical areas may look quite similar. I should say that wave mechanics is largely a linear process and mathematically there is a big difference between linear and non-linear problems. Usually the non-linear ones are deemed 'hard' whereas it is often assumed that the linear ones are quite 'easy' in comparison. However, I do not like the distinction made between linear and non-linear models in the mathematical world, after all, you have to fit the mathematics to the physical world and not the other way around! If a physical system is essentially linear in nature, then one has no choice as to this fact, but instead one should be thankful for the many methods that have been developed for tackling such problems! Also, it can often be the case that linear models are very difficult and lead to intractable problems whereas non-linear problems may sometimes yield quite easily.

In acoustics, non-linearity can play a big role in the mechanism of sound generation where the amplitudes are very large but very quickly everything usually equilibrates and waves then live in the linear regime. I try to use linear theory where it is appropriate. You can make good progress by keeping the non-linearity in some restricted part of the problem such as in the boundary conditions, and in this way, one may strike a happy balance between a tractable model problem and a model rich with complex dynamics. Some work I did a few years ago with Maria Heckl at Keele University on railway wheel squeal is a good example of this approach. There are areas where non-linear theory is crucially important in the wave motion, in particular in non-linear evolution equations and solitary waves. In these special cases, the physics somehow works to exactly balance terms that account for energy spreading with those that want to steepen or focus the waves. They are in fact, 'only just non-linear' in a mathematical sense, and the process of solving those is very elegant. We apply techniques like inverse scattering, which takes the non-linear equations and reduces them to linear problems. My approach has been to keep things as simple as possible and add in the complexity only where it is absolutely necessary. I should say that my work also has applications outside wave mechanics to things like mathematical finance.

The Wiener-Hopf technique appears to be widely applicable in analysis and probability as well as in many areas of mathematical physics through the solution of boundary value problems. What is your interest in this method?
The Wiener-Hopf technique is an analytical method, which exactly solves a particular class of integral equations. Wiener and Hopf, two of the big giants of applied mathematics, first developed it in 1931. The technique has found incredible application over the years in probability and statistics, finance and in practically every area of mathematical physics and engineering. Sommerfeld's half plane diffraction problem, a

classical problem in diffraction theory going back to 1896, is to determine the disturbance of a plane optical or acoustic wave due to a semi-infinite screen. You take a flat hard barrier, allow it to become very long and just look at the field close to one edge. It was found sometime toward the middle of the 20th century that this problem fitted naturally into the class of integral equations that Wiener and Hopf developed. However, the Wiener-Hopf technique has a major difficulty. It works for scalar equations and, although we can cast many physical situations into such single equations, complex physical problems lead to more complicated integral equations. Wiener-Hopf theory fails almost completely in the case of coupled integral equations or matrix systems. When you have a matrix rather than a scalar kernel in the integral equation, you cannot perform a crucial step in the analysis and it therefore breaks down. Back in the 1950's, various people looked at the problem and declared that there was very little one could do about it!

I was very interested at the end of my PhD as to why the method did not generalise. It meant that many interesting models in the diffraction of, say, waves in solids or electromagnetic waves, where there are simultaneously several distinct wave types, cannot be solved by the Wiener-Hopf technique. Pure mathematicians may look for complete generality but we applied mathematicians often seek special classes of problems that we can tackle. It transpired that a class of solvable matrix Wiener-Hopf equations appeared in the 1970s and 1980s. These have a commutative structure, and fortunately, a number of very interesting physical models fall into that class; but the general problem remains essentially unsolved. Trying to extend the commutative matrix form has been an underlying theme to my whole research career. About ten years ago, I finally developed a quasi-analytical approach, which requires modification of the matrix kernel in a very subtle way. With that, I can use the commutative procedure, combined with Padé approximants, to obtain an explicit but approximate non-commutative solution. The method is successful in that it offers all the physical insight that an exact solution would yield, and Padé approximants are brilliant because they allow one to improve the accuracy to any specified level. I have used this very successfully now on a number of previously unsolved problems. Recently I had a bright PhD student, Ben Veitch, working on developing a broader class of matrix Wiener-Hopf systems for which we can obtain solutions. He had to learn a fair amount of pure mathematics involving group theory to look for such a class, and we have had some success, but we are still scratching the surface. There is a long way to go. Every time we extend the Wiener-Hopf procedure, we make progress on solving other physical problems.

In recent years, I have found aspects of the Wiener-Hopf technique that impinge on finance and probability. The probabilists have developed their own particular way of looking at Wiener-Hopf problems, which in a way is almost impossible for us applied mathematicians to understand! Only when you start trying to solve problems in that area can you try to bring the two approaches together. This has led to developments, for example in relating Wiener-Hopf factorisation to Spitzer's identity and other important results within probability theory.

You are involved in a long-standing collaborative study on the development of a method to solve a class of matrix difference equations that touch on applications like wave reflection and transmission and scattering. What are you hoping to achieve in the long-term with this work?

Essentially this is looking at a range of physical problems that can be reduced to mathematical models of a particular class. One application is diffraction of elastic waves by edges, corners or conical structures. I am interested in non-destructive evaluation of materials. In the aircraft industry, you have to inspect wings and other major structural components to see that cracks are not developing; after all, you do not want your engine to drop off in flight! Usually you use a wave method for inspection of components although you can employ static approaches, such as surface current techniques. X-rays are sometimes chosen but a cheap and robust method employs ultrasonic waves. You place a transducer on the wing and look at the return signal to find imperfections. The scattered field coming from an imperfection has a particular signature. In order to solve the inverse problem, that is, to construct the location and shape of a crack from the return signal, you have to understand the forward problem of how a crack will scatter sound waves in the material. Certain problems reduce to a system of complex functional difference equations, which one has to solve by separating singularities in the complex plane. I have worked on this topic with a number of people, but primarily Jane Lawrie from Brunel University. The origin of our approach goes back to a very distinguished Russian mathematician called Maliuzhinets in the 1950s, and the generalisation of his method has been a significant activity in the former Soviet Union and in the West. The mathematical models are not as developed as Wiener-Hopf equations in terms of producing a general theory, but there are remarkable similarities in their underlying structures. The community of people around the world who work on these problems is small enough that we all know each other's research and we can have workshops together. One group of Russian scientists linked with Bath University has been looking at Stealth technologies, that is, aircraft or other vehicles that have a very low radar scattering cross sections. Stealth aircraft bodies are composed of many planar sections butted together at obtuse angles. You need to understand the way that the electromagnetic radiation diffracts around the edges and corners and this is achieved by solving models based on certain integral and difference equations related to those of Maliuzhinets.

You are also concerned with the propagation and diffraction of Rossby waves in the ocean. I understand that these planetary scale waves always travel from east to west and move relatively slowly. What is their significance?
Their significance is enormous. Essentially, they have a major effect on large-scale ocean circulation, transporting energy and redistributing momentum around the oceans. Thus, they have a huge impact on weather over many months, as well as on climatic variations. I am not an expert on Rossby waves. I got involved because the mathematics is similar to other sorts of mathematical models I had looked at, but with several important differences. It was a pleasure to work with people in the area of geophysics. In particular, Andrew Willmott, now Director of the Proudman Oceanographic Laboratory, and I had a bright postdoc, Gareth Owen, who worked with us on a Leverhulme Trust grant on this topic. We were trying to use some of the mathematical methods we had developed in other fields to analyse Rossby wave scattering problems. Rossby waves are essentially very slow waves arising from the vorticity, or spin, of fluid particles in the oceans due to the earth's rotation. To offer a very crude explanation, if these particles are pushed southwards or northwards then they will increase or decrease their spin, and so to maintain angular momentum they must shrink or stretch vertically, hence making undulations, or waves, in the sea surface elevation. It is clear that, as they rely on the earth's rotation, the waves are one-way, only travelling east to west. These waves can only exist on very large masses of fluid – you would not see them in your bath!

Rossby waves in the atmosphere are easily seen and account for the meandering of the jet stream, which has such a large influence on our weather patterns in the UK! It was widely accepted, every since they were first conjectured in the 1930s, that oceanic Rossby waves must also exist but there were no reliable means of detecting them until quite recently. This is because in the oceans they have wavelengths of many kilometres but heights of perhaps a few centimetres, and can take months or even years to cross from one side of, say, the Pacific Ocean to the other. The breakthrough came with the use of satellite altimetry data to look at the free surface elevation of the ocean and the use of sea-surface radar to measure temperature distributions. The purpose of one piece of research we did was to investigate wave propagation through the Southern Ocean and look at how currents disturb and distort Rossby waves. Another was to look at the way Rossby waves are scattered as they propagate across mid-ocean ridges. Our studies allowed us to compare theory accurately with the evidence from the satellite data.

I believe that you have a number of ongoing, collaborative projects with industry. What in particular are your current interests in wave propagation in optical fibres and composite materials?
I got involved a few years ago in work on optical fibres through the Smith Institute, which runs a Knowledge Transfer Network to bring applied mathematicians and industrialists together. The KTN has been fantastically successful and it is really down to the work of the team at the Smith Institute including John Ockendon and OCIAM. The project was to model light propagation down 'fat' optical fibres. Fatter, or multimode, fibres are much cheaper to manufacture and to splice together than conventional fibres, are more robust, and are starting to find applications in aircraft and cars. In a few years time, it is likely that the messy wiring looms in vehicles will be replaced by a single fat fibre! These optical fibres behave as waveguides and allow a number of distinct modes to propagate. In the telecommunications industry, the normal thin fibres only allow a few modes to propagate and this makes the mathematical analysis a lot easier than if you have fatter fibres, which may admit tens of thousands or even millions of modes to propagate. The modes can interfere with each other through properties of the fibre itself such as manufacturing irregularities, or through kinks and tight bends. The problem is that you send a signal at one end that is composed of many different modes, each with distinct amplitude and phase, and you get a signal out at the other end that is all 'squished' together. All the energy has leaked from the modes that you originally excited, into other modes. A postdoc, Emmanuel Perrey-Debain, and I developed an efficient method of understanding how this mode interaction takes place, which dealt with certain types of manufacturing imperfections. We did this work in collaboration with a bespoke software company called Photon Design.

My other recent work, with two very talented young colleagues, Will Parnell and Ian Thompson, has been looking at wave propagation through composite materials. You take a 'host' material that has some of the properties you want for a particular structure; it might have strength, but it might be too heavy. You can then insert into it many inclusions to give you much lighter properties with the same strength, or some other properties to optimise the characteristics you require. Composite engineering materials have a great similarity with biological materials, such as bone, which has a complex microstructure that gives you lightness and strength but is very hard mathematically to model. As I said earlier, I am interested in wave propagation in relation to the non-destructive evaluation of aircraft wings. How do you know that the signal you are getting is due to a crack in the material or due to the carbon fibres that you have inserted in your host material? My long-term aim is to come up with simple equations that describe the effective, or averaged, material properties for a much more complicated underlying structure. The key problem I am interested in is how material microstructure affects the macroscopic behaviour of the waves propagating through it.

What would you say are the most important, or enjoyable aspects of academic life?
I think there are a number of key points to academic life that make it very good. First, and foremost, has to be the freedom to explore areas of curiosity. If academia became too prescriptive, I think many of us would leave. There are many pressures on us but we are still able to follow up our hunches and ultimately that is what leads to success and furthers the subject. I think that the second point is working in a close-knit community, extending from the local to the international, and I really value that very much indeed. As you know at Manchester, we are some three years into our merger and we are still going through the pains of doing that. It has been an enormous endeavour but it has been hugely rewarding and exciting to work with other people to create something that is much bigger and better than the sum of the two parts of the former UMIST and University of Manchester. Third, as you get older and go up the ladder in academic life, your role changes from doing your research work entirely by yourself to mostly working with other people. One has to recognise that the students' work is as important, if not more important, than your own, and in the same way as head of a group or department in a university you have to recognise that you have a responsibility to the success of the research of everyone in your department not just yourself.

I have visited a large number of countries over the years and everywhere I go is an absolute thrill. A particular highlight of these interactions has been the short trips to New Jersey to work with two very close friends, and really excellent scientists, Greg Kriegsmann and Andy Norris. But, I love the fact that my group of friends is truly international and comes from all different backgrounds. We have a common denominator, which is our interest in a particular aspect of mathematics. I think PhD students are also very important indeed. I have had some exceptional students over the years, several of whom I have already mentioned, and I currently have three great guys working with me! They have all really inspired me, and hopefully I have helped to turn them on to applied mathematics. I think the whole thing is an exercise in fun and you have to enjoy doing it. Undergraduate teaching does not get a high priority in the universities due to the Research Assesment Excercise and other pressures. In fact, it is probably more important than anything else I do. I think there is a big problem with the pressures in academic life today: we are all watched, we are all expected to produce everything yesterday, and we are expected to undertake activities that we are not trained to do! Nevertheless, this is still an environment where you can flourish and you can do very well if your research is good.

You have chaired the Institute's Journals Board of Management for around ten years and the Journals Task Force before that. You have contributed very significantly to the turn around in the journals fortunes. Now that you have given up that role to concentrate on your Presidency, how do you view those times?
For those people who do not know about the Journals Board of Management, in the 1990s the IMA felt that the journals needed some overview to make sure that they were working along effective lines. So the IMA Council asked a number of us to form a Task Force to look at the portfolio of journals, to help negotiate a new contract with Oxford University Press in order to put it on a sound financial footing, and then to try to build the programme. The experience was most rewarding but I do not think that I should take very much credit. A number of people were committed to the idea that our journals were a substantial aspect of the Institute's activities and we should bring them back to the standing that they deserved. The Task Force role was to identify what changes we could and should make to the journals and then the Journals Board had the task of implementing these changes and then helping the editors to get the best out of their journals. We ask our editors and associate editors to put in huge amounts of time and energy for little reward other than to provide the community with a vehicle to publish their work. I believe that our journals now are in good shape
financially and represent a high quality asset for the British mathematics community. My role on the Journals Board is now past, and I am content to leave it in very good hands. The Institute will benefit from a successful portfolio that will stand it in good stead for at least twenty or thirty years.

It is probably worth mentioning that I have learned to respect people who have to undertake jobs that require a continuous and sustained input. In particular, *Mathematics Today* requires a great deal of time and effort from a number of dedicated people such as Gayna Leggott in the IMA Secretariat and of course, Dave Broomhead as editor and Paul Glendinning as a regular contributor. I should say that Dave and Paul are terrific colleagues to have in Manchester and staunch supporters of IMA.

I would say that you are as enthusiastic and hard working at promoting mathematics as you are about doing it. What thoughts do you have about becoming President?
I realise that it is very important to promote mathematics and a number of individuals have really shown me the way over the years including of course David Crighton. David was a top-quality scientist who had a very important role within Cambridge but he put in an enormous amount of time to the community and everyone could see clearly the benefits of that effort. Just to maintain what we have now is a real effort. To improve

the lot of mathematics requires another substantial effort on top of that. I think that the societies offer us a way to do it; the Institute of Mathematics and its Applications, the London Mathematical Society, the Society for Industrial and Applied Mathematics all have a role to play. The community endorses the societies so they are the right place for us to be lobbying government, assisting universities and trying to reflect change.

I think that the great success of the IMA is its broad membership. Ironically, this can also present its biggest problem. People from diverse backgrounds like industry, academia or the teaching profession tend to look to the Institute to address their particular interests and issues. We have to show IMA members that our Institute is homogeneous and that we are all facing the same range of problems. I see my role as President being to carry on the work of previous Presidents in improving an understanding within our community both in industry and the teaching profession, and in academia, that our Institute is relevant to them. The issues that are affecting us are more pronounced and more worrying than they have been and therefore we need to work together to overcome them. One such problem is pre-university mathematics education, i.e. GCSE and A-level syllabuses, and the number of mathematics teachers without mathematics backgrounds. Membership recruitment is always an issue but the intention should be to win hearts and minds rather than just increase subscriptions. I would also like to see the IMA improve its status in international affairs, that is, to be the voice of applied mathematics external to the UK. I believe that we need to have a more coherent process for dealing with pressure groups outside the mathematics community. We are improving this with our close links with the LMS, and through the formation of the Council for Mathematical Sciences, but we need to double these efforts. I think that having a tried and tested route for responding to government edicts that affect mathematics is very important. Overall, I would just like to find a way of making all groups and members feel that they are getting something important (as well as value for money) out of the Institute.

As an active member of the London Mathematical Society and the Society for Industrial and Applied Mathematics, as well as the IMA, what similarities and differences do you see between these organisations?
I have done a lot of work with and for the LMS in recent years but not so much for SIAM although I have been a long-time member of both organisations. I have been heavily involved in the European Mechanics Society (EUROMECH) over the last six or seven years, which again I think is a very important organisation to try and forge links with and organise conferences between the European countries. The way the LMS and the IMA operate is quite distinct in that the LMS is an organisation for practising mathematicians within academic circles and the IMA has a much broader membership. Consequently, the LMS has, until fairly recently, focused on this aspect of the work and they have done it remarkably well with their grant awarding section and the journals which have always been well respected and very successful. However, they recognised in the last ten or more years, as the IMA has, that we have to do much more to speak for mathematics outside in order to protect the lot of mathematicians in all aspects of life.

The relationship between the IMA and the LMS has grown enormously. We are converging because we have to focus on all aspects that impact on our community. Certainly, the LMS now realises that they have to look at the issue of school level mathematics if they want to maintain standards at university teaching. Similarly, they have to ensure that mathematics degrees provide training for careers both inside and outside universities; otherwise we cannot justify the numbers of graduates that we currently produce. The mathematics community is a continuum, from school kids through to practising mathematicians and retired mathematicians. In that regard I passionately believe that the LMS and IMA talks on merger are essential for the long-term health and vitality of our community.

You are currently Bayer Professor of Applied Mathematics at the University of Manchester. People like Sir Horace Lamb, Sir James Lighthill and Sidney Goldstein held the post previously. Did you feel a weight of history behind the position?
Anybody who takes up a university chair that has been held by a string of prestigious people must feel rather daunted by stepping into their shoes. Of course, the nature of academic life is now very different, with all its administration and research targets etc., and so the role of Beyer Professor has unfortunately changed greatly from that enjoyed by my predecessors. Were that not the case, however, I would probably not be in the post today! I certainly felt incredibly privileged to take up a position that had these important figures in the post before me. They serve as role models for all that we are trying to achieve today in Manchester. I said at the beginning of this interview that I believe that most people are roughly equal in intellect, and if we are motivated and want something badly enough then we can achieve our objectives. However, I would say that Sir James Lighthill is the exception that proves the rule. He was really the genius of applied mathematics in the latter half of the twentieth century. He did so much for Manchester, for the UK community, for a huge number of branches of applied mathematics focused on fluid mechanics, for industrial mathematics and for the IMA, of course, which he created. Within the ten years or so from when he arrived in Manchester in the early 1950s, he created one of the most vibrant departments in the world. It rated alongside the Department of Applied Mathematics and Theoretical Physics at Cambridge and the Courant Institute in New York. Before him was Sidney Goldstein, who did an

enormous amount to expand the department and to bring in good people, but James Lighthill can be seen as leading by example at the time he was there in terms of his pioneering work on aeroacoustics and supersonic fluid mechanics. The others, including Horace Lamb who worked on solid mechanics as well as fluid mechanics, were also very important and influential. Horace Lamb is known to have been a fantastic lecturer and communicator, and was brilliant at creating a substantial department when mathematics as a distinct subject in universities was only just getting going at the end of the Nineteenth Century. On a personal level both Lighthill and Lamb were very important figures in my own research field, and therefore have greatly influenced my thinking as an applied mathematician.

Would you agree that 1977 appears to be the year of your greatest Triumph?
You are alluding to my interest in motorbikes, and to my '77 Triumph Bonneville T140V. I do have interests outside academic life and one in particular that I have managed to keep hold of is motor biking. I have always loved motorcycles both for the thrill of riding them and for their beauty and their elegance; and the way they solve mechanical problems in a very efficient way. Ever since I was at university in London, I have had a Moto Guzzi, a very large (1000cc) powerful rusty Italian monster. It is still on the road and I could not possibly ever get rid of it. However, I have always admired the Great British motorcycling industry, which unfortunately had more or less died a death by the time I was old enough to ride one. The machine which best captures the essence of British biking is the Bonneville, and it had always been my secret ambition to one day own a 'bonnie'. Through the wonders of eBay I managed to get hold of my machine a couple of years ago. It is terrific fun but I do not get to ride it nearly as much as I would like.

I understand that you like running. Do you enjoy sport?
I like practically every sport, especially athletics, and yes, I have always been a keen runner. The thing that I indulge myself in is distance running, and marathons in particular. I have become slower (and fatter) over the years so have to adjust my goals accordingly. Running in distance races such as the London Marathon is an interesting experience – it is both a shared and an individual activity; perhaps there are parallels with academic life? Certainly, both require exceptional hard work to do well! I have now run seventeen or eighteen marathons, but as my times are slowing down, I am looking at possibly trying 50 kilometre or other ultra-marathon distances to see if my legs will take it! I am quite looking forward to retirement, despite it being a long way off, because it will give me much more time for running, and for lots of other things that I would like to do. In particular, it has been a life-long ambition to build a little aeroplane when I retire. If I will ever achieve that, I do not know, but it would be nice to have the challenge.

Terry Edwards

A 'particle' is an arbitrary small volume or 'blob' of fluid that contains a huge number of molecules. Imagine injecting a little drop of dye into water to highlight such a blob. BACK

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