Career **Profiles**

more maths grads
multiplying opportunities

maths careers
endless opportunities

What about a career in mathematics? Do all mathematicians go into a career in accountancy or banking? Finance is, in fact, just one area out of a huge number of exciting, innovative and challenging career opportunities available to students of the mathematical sciences.

This booklet has been designed to highlight the versatility of the subject and to prove that a degree in the mathematical sciences can take you anywhere; it can open all sorts of doors, from developing software technologies to being a professional rugby league player. Working on exciting and innovative projects, mathematicians are highly valued and an essential element of any successful team.

This booklet has been produced by *more maths grads*. *more maths grads* (MMG) is a three-year project funded by the Higher Education Funding Council for England to develop, trial and evaluate means of increasing the number of students studying mathematics and encouraging participation from groups of learners who have not traditionally been well represented in higher education.

MMG has also been working with the Higher Education Funding Council for Wales to translate and disseminate its resources throughout Wales. This booklet is just one example of the translated resources.

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Bob **Hornby**

Job Title: *Principal Scientist, Dstl*
Qualifications: *BSc (Hons 1st Class) Mathematics, PhD Fluid Mechanics, CMath, FIMA, CSci*

Dstl is part of the UK Ministry of Defence and my job is to build a detailed understanding of the world underneath seas and oceans to assess the performance of underwater sensors.

I need a good knowledge of oceanography, which is a wide ranging science encompassing everything from plate tectonics to marine organisms, currents and waves to the various changes in chemicals and substances present in the sea. But I combine this with my mathematical skills, using measurement, mathematical modelling and computing to work out which sensors will be most suitable in which environment.

I have also worked in the telecommunications and nuclear industries and as an academic researcher in a university. I enjoyed mathematics from an early age and have always been good at it. At first, I found doing mathematics for the sake of it the most interesting and rewarding but later on I became fascinated with the power of mathematics and computers to predict the motion of fluids and objects in the real world. What a magical combination!

I still love validating theoretical predictions with experimental measurements, not least because doing this means I get to travel, perhaps to sea or a site where an experimental rig is based. I also travel to conferences in the UK and around the world to present work and meet up with other researchers.

Outside work, I like sports such as sailing, football, swimming, cycle riding and walking but I also enjoy music and finding out about history, in particular Rome and mathematics.

"I became fascinated with the power of mathematics and computers to predict the motion of fluids and objects in the real world. What a magical combination!"

Gail **Iles**

Job Title: *PhD Student, University of Leicester*
Qualifications: *BSc Physics, BTEC Management, FE and Adult Teacher's Certificate*

Maths is the purest language of all. It can describe how a cell replicates, why a galaxy spins and which notes sound good together in music.

It is the ultimate creation of humankind because it encompasses and governs all life. My career choice was influenced by my abilities and my dreams. I love science and the mysteries it holds and my dream is to one day carry out experiments in space.

I am based in the Condensed Matter Physics group at the University of Leicester, which has one of the best physics departments in the UK. My research looks at how magnetic clusters of iron behave with rare earth metals and in different gases.

On an average day I will fill my magnet (9 Tesla – that is a very strong magnet indeed!) with liquid helium, which is at a temperature of –269°C or 4K. I then take magnetic measurements of my samples. If it is a sample-making day then I use an ultra high vacuum system to make clusters of iron which contain just 200 atoms. These clusters are smaller than the wavelength of light and may one day be used on computer hard disk drives to store information.

The best part of my job is the variation. I have learnt to use an electron microscope and a synchrotron and regularly handle cryogens (liquefied gases). I make measurements using some of the best facilities in the world and then analyse the data on my computer. Understanding and using maths is like second nature in my work and Microsoft Excel is my best friend!

The skills required to be a good scientist are logical thinking, methodical working, the ability to accept results no matter how surprising, clear and concise written communication, motivation and perseverance.

The next step for me is a move to France as the European Space Agency (ESA) has offered me a post-doctoral research fellowship based at the European Synchrotron Radiation Facility in Grenoble. I will be characterising metallic powders for catalysts, working with other scientists and presenting results at conferences. There may even be the opportunity to perform an experiment on one of the parabolic flights run by the ESA.

Maire **O'Neill**

Job Title: *Research Fellow / Lecturer, ECIT, Queen's University Belfast*
Qualifications: *MEng Electrical and Electronic Engineering, PhD Digital Signal Processing and Telecommunications, PGCHET*

I lead the cryptography research team at the ECIT Institute, Queen's University Belfast. Our research looks at techniques for encrypting data to ensure it can be sent and received securely in applications such as email, online shopping and banking, set-top boxes and satellite communications.

All security techniques are based on mathematical principles and so a thorough understanding of these mathematical principles is vital for my research work.

Like many academic jobs, as well as carrying out research, I also have to secure funding to support the research area, publish papers on my work and cultivate national and international links. I lecture in the School of Electronics, Electrical Engineering and Computer Science at Queen's and I supervise undergraduate and postgraduate student projects.

"I thoroughly enjoyed being able to research new ideas and designs using cutting-edge technologies."

I first became aware of electronic engineering when I was still a small child. My father decided to build a hydroelectric scheme on the river running by our house. At secondary school, I enjoyed mathematics, physics and technology and, with two older brothers in engineering, I decided that it was also the career for me.

During my engineering degree course I took all of the mathematics modules. In the final year, I was sponsored by a local electronics company to carry out a research project on data security. I thoroughly enjoyed being able to research new ideas and designs using cutting-edge technologies, and this led me to my career as an academic researcher in data encryption.

Mark **Hilton**

Job Title: *Professional Rugby League player, Warrington Wolves Super*
Qualifications: *BTEC HND Electronics, BSc (Hons) Mathematics*

When I was 18, I was lucky enough to have a full-time job as a professional rugby league player, so I didn't have to search for a job through the normal apprenticeship or youth training routes.

However, I was smart enough to realise that sporting careers do not last long. It was important for me to use the free time I had available to study and develop another career for when my present one finishes. I chose to study mathematics at the University of Bolton on a part-time basis and graduated with first class honours in summer 2004.

Although the main reason I chose to study maths was because I enjoyed the subject, it was also because I knew that having a BSc in this well-respected subject would give me an advantage for my future career. So, when I finish playing rugby, I am hoping to go into teaching mathematics at school.

"Although the main reason I chose to study maths was because I enjoyed the subject, it was also because I knew that having a BSc in this well-respected subject would give me an advantage for my future career."

Martin **Smith**

Job Title: *Administrative Officer (LMS Council) and Secretariat (Council for the Mathematical Sciences)*
Qualifications: *BSc Mathematics*

I really enjoyed my mathematics degree but, whilst many of my colleagues started careers in accountancy, banking and other traditional number-crunching areas, I was keen to try something different when I graduated in 2005.

My job involves supporting some of the many committees of the London Mathematical Society (the learned society for mathematicians in the UK) and the Council for the Mathematical Sciences (CMS, a grouping of five organisations which is the voice of the mathematical sciences to policy makers). I am involved in policy work and that means meeting with a wide range of people. Quite early on in the job, I was involved with preparing the agenda for a CMS meeting with the then Secretary of State for Education, Ruth Kelly, where we discussed topics concerning mathematics in higher education. My work at the LMS involves organising meetings, planning agendas and gathering papers for the various committee meetings as well as writing minutes and carrying out the work agreed by the committees.

"I can get involved with the processes that will shape mathematics education."

The LMS were keen to recruit a mathematics graduate, not just for the passion for the subject, but also for the problem-solving and analytical skills needed to do the job.

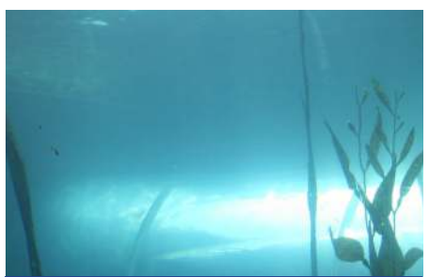
The best thing about my job is the feeling that I can get involved with the processes that will shape mathematics education to ensure there are plenty of graduates like me in years to come!

Robin **Hankin**

Job Title: *Uncertainty Analyst, National Oceanography Centre*
Qualifications: *BA, MA, PhD*

The National Oceanography Centre in Southampton is a centre of excellence devoted to understanding marine science from an interdisciplinary perspective. Engineers, biologists, mathematicians, chemists and physicists work together to study all aspects of the oceans.

Currently, I am studying uncertainty in climate prediction models, with an aim of better understanding global warming. This work involves using a wide variety of mathematical techniques that I can bring to bear on the issue of global climate change. I enjoy the challenge of writing academic papers: the wording must be precise, yet cautious; objective, yet exciting; clear, yet not oversimplified.



"This work involves using a wide variety of mathematical techniques that I can bring to bear on the issue of global climate change."

Mathematics is a very desirable skill, always in demand by a wide variety of employers. I have worked in academia (lecturing in environmental modelling), actuarial science (consultancy), regulatory organisations (health and safety) and now oceanography. There is a huge diversity of careers open to mathematics graduates, and this is one of the many reasons I chose (and continue) to study this fascinating subject.

Pat **Bellamy**

Job Title: *Statistician/Systems Analyst, Cranfield University*
Qualifications: *BSc Mathematics and Statistics, MSc Biometry*

I am involved in a wide assortment of research projects, carrying out statistical analyses and giving advice on statistical design. I talk to research students about the application of statistics to their projects and do some teaching of applied statistics.

I really like the range of applications I come across, as you never know what is going to come up next. Recently, I have analysed data from an onion taste panel, helped design an experiment on fish movement and analysed how carbon in the soil is changing.

"I really like the range of applications I come across, as you never know what is going to come up next."

I have been interested in maths since school and went on to do a masters in applied statistics after my first degree as I wanted to apply mathematics to the real world. One of the skills that is essential in my job is the ability to put across what a statistical analysis can do in non-mathematical language.

Carole **Proctor**

Job Title: *Research Associate, Newcastle University*
Qualifications: *BEd, BSc, MSc, DPhil*

"The aim of our project is to try to understand the cellular mechanisms of ageing and how these processes are affected by nutrition."

I have always enjoyed maths but, back in 1972 when I left school, I could not find a career in maths which appealed to me and decided to train as a primary school teacher. After a career break, I studied maths and science with the Open University and obtained a BSc.

I then went on to apply my mathematical knowledge to biological problems when I studied for a DPhil at Sussex University. My project involved building spatial models of anti-predator vigilance behaviour in flocks of birds. After completing my DPhil, I got a job as a research associate at Newcastle University, where I have been working for the past five years.

I am currently based at the Centre for Integrated Systems Biology for Ageing and Nutrition and work within a group of mathematical modellers, experimental biologists and computer scientists. The aim of our project is to try to understand the cellular mechanisms of ageing and how these processes are affected by nutrition. My work involves building mathematical models based on experimental hypotheses.

Systems biology is a rapidly growing field and there is currently a demand for trained mathematicians. If you are interested in this field of work, I would advise you to do a degree in maths and, if possible, to include a course on biology and computer programming. Choose to study the areas of maths which interest you most, but make sure you do at least one course on probability and statistics.

Rob **Eastaway**

Job Title: *Author, Speaker on maths, cricket and creativity, Self-employed*
Qualifications: *MA Engineering and Management Science*

My life is a series of projects which intertwine with each other. I love the diversity and stimulation of being self-employed, despite the fact that the insecurity is sometimes unsettling.

Although 'author' is a convenient label, in practice I probably only spend about 20 per cent of my time on book projects. I frequently give talks, design and run seminars, and record interviews and other pieces for radio. I am also responsible for the international rankings of cricketers, which requires frequent contact with the International Cricket Council in Dubai. (Alas I don't get to travel there.) On a typical day, I might spend some time working on all of these things.

"Pursue what you love doing but always keep one eye on things that will make you employable in the longer term."

I was always interested in maths and puzzles but, when it came to taking a degree, I opted for Engineering because the applied nature of the mathematical problem solving appealed to me. I combined those skills with my love of communicating, first working in management consultancy and now in the diverse activities that I undertake.

My career advice? Pursue what you love doing but always keep one eye on things that will make you employable in the longer term.

Saskia **de Groot**

Job Title: *PhD Student in Bioinformatics*
Qualifications: *BA (Hons 1st class) Mathematics (University of Oxford), MMath*

My undergraduate degree taught me how to think in a very logical way and I really enjoyed discovering the beauty of pure maths. I loved the idea of devising an abstract world which obeyed certain laws and was, simultaneously, the very basis of the real world we live in.

However, when the time came to choose an area of research for my PhD, the applied sciences seemed more relevant and thus attractive. I spend my day working by myself and in collaboration with colleagues, developing models for the evolution of viral genomes, which generally involves a lot of reading, programming and blackboard scribbling. I have even recently submitted an article as a first author.

I very much enjoy doing a PhD since research teaches you a whole new set of skills from those you learn in an undergraduate degree: independent thought, communication, collaboration and, most of all, self discipline. It allows you to manage your time and work layout yourself – I even took two months out to participate in, and subsequently win, the Channel 4 reality TV show called "The Search"! We had to travel around the world solving clues and cracking codes and, having a mathematical background, I saw how my analytical training helped me enormously towards winning.

Even though I will probably not continue in academia, I still think that the set of skills I have learned during my time as a mathematician is an invaluable asset for continuing in pretty much any career path. And it really is the most beautiful of the sciences – in my opinion!

"Maths really is the most beautiful of the sciences – in my opinion!"

Mark **McCartney**

Job Title: *Lecturer in Mathematics, University of Ulster*
Qualifications: *BSc Mathematics, MSc, PhD Theoretical Physics, PGCE*

Think of the whole world of novels, poems or newspapers which would be closed to you if you couldn't read.

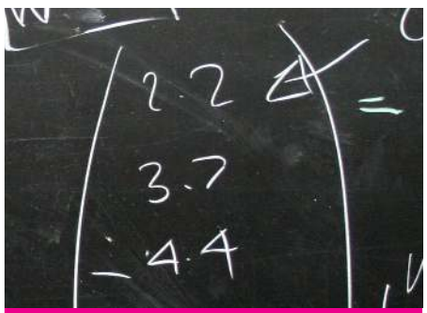
Being able to speak the language of mathematics opens up a world which is just as big. It is a world filled with things like quantum mechanics (the mathematics of atoms and particles), Einstein's relativity (the mathematics of whole universes), socio-dynamics (the mathematics of social behaviour), financial mathematics (for predicting the stock market), digital image processing (the mathematics behind your camera)… The list is a very long one, and all those books of knowledge are written in mathematics.

I teach mathematics in a university, but not just to students reading for a maths degree. Students studying subjects like computer science and engineering also need to know some mathematics, so I actually teach a wide range of maths to a wide range of people.

My research interests include mathematical models of traffic flow. I try to boil the problem down to a set of equations, then think about how to solve the equations. Sometimes this means good old pencil and paper and sometimes it means writing a computer program. I then have to think about whether the solutions make physical sense – does traffic actually behave in the way my model says it behaves? And, if the answer is 'no', then how can I change my model to make it better?

I love the job I do. I get to teach maths and play around with equations and solve problems. Both sides of the job can be challenging but they are both very rewarding.

To be a maths lecturer, you need to do a PhD which is a further three years' study on top of your undergraduate degree. But the great thing about mathematics is that, because it pops up everywhere in science and engineering, having a maths degree opens lots of career doors. So even if you don't finish up where I did, there are still loads of opportunities.



"Both sides of the job can be challenging but they are both very rewarding."

Liz **Ainsbury**

Job Title: *Data Analyst, Health Protection Agency*
Qualifications: *BSc Physics, PhD Physics (submitted)*

I work in the Radiation Protection Division of the Health Protection Agency. The group carries out research into how to protect people from radiation and it provides advice to individuals and organisations.

I enjoy it very much as the work is extremely varied. We analyse blood samples to determine radiation dose in the case of suspected exposure – requests come in from around the world and no two cases are the same. I like using mathematics in my work as it is a sound logical basis for analysing problems. The statistical work that I do often has real implications for people's lives, for instance when I am working on dose estimation. My job requires the quantitative precision of analysing a problem using statistics but, because we are using real data, I also have to be able to approach the problem practically using qualitative assessment. So my physics background comes in handy.

I would advise anyone studying a quantitative subject such as the mathematical sciences or physics to also learn a programming language. Being able to use a computer to build models is an amazing time-saver!

Aaron **Sugarman**

Job Title: *Head of Operational Research, TUI Travel, Luton*
Qualifications: *BA Mathematics (University of Oxford), MSc Operational Research (University of Warwick)*

Operational research is about applying analytical techniques to solve organisational problems.

One typical task here is forecasting holiday demand. In order to do this, we look at trends in historical and recent data across different variables, such as season of the year. We then carry out an optimisation of demand against capacity. This leads us to the price which we should charge for the holiday which will be best for the company in terms of profit.

My team uses mathematical techniques to find working models and solutions to problems like this and others such as scheduling, optimisation of processes and analysing the efficiency of various procedures.

One of the most important things in my job is being able to decide what is important and what is not. Equally, it is important that you are able to

"Operational research is about applying analytical techniques to solve organisational problems."

communicate results and make others understand the ideas. And of course, it is vital that you can do this whilst working to a deadline.

Although I always liked maths at school, I did think I would study chemistry at university. But I realised that I enjoyed solving chemical equations more than anything else, so my passion for maths grew from there. During my time at Warwick, I completed a three-month placement at NatWest bank where I was looking at how applicants for new accounts are chosen based on past credit. I went on to work for a management consultancy company for two years. During that time I did a variety of work, including scheduling production for the Ford Mondeo car, looking at the effectiveness of the supply chain at Marks & Spencer and also the effectiveness of the Trainline call centre.

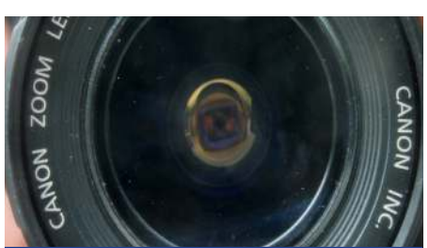
There is always a new challenge and a constant supply of fresh problems which require new models to be developed. With operational research you are not stuck within one field and that keeps the job varied and exciting.

Simon **Singh**

Job Title: *Science writer and broadcaster, Freelance journalist*
Qualifications: *BSc Physics and PhD Particle Physics*

My job is a mixture of things. Sometimes I am working in radio or TV, sometimes I am writing for a newspaper with a deadline just a few hours away and sometimes I am writing a book with a deadline two years away.

Today I might be writing about cosmology and trying to convey some complicated physics, whereas tomorrow I might be writing about mumbo-jumbo pseudoscience and talking to lawyers to make sure I am not going to get sued for libel.



"Today I might be writing about cosmology and trying to convey some complicated physics..."

Although my background is in physics, this included a huge amount of mathematics, and that part of my training was very important. To be a writer or journalist you need to think logically and creatively, and mathematics involves both these skills. If you are interested in being a journalist, then I would certainly recommend taking a degree in maths or science rather than a degree in media studies. Learning to write is relatively easy once you have a foundation and confidence in the subject you want to write about.

Brian **O'Connell**

Job Title: *Analytical Geophysicist, TGS-NOPEC Geophysical Company, London*
Qualifications: *BSc Mathematical Physics, PhD, PGCE (Swansea University)*

I use maths to help geophysicists and geologists to understand the inside of our planet. You see mathematical formulae on exam papers and here I get to apply them to real life.

My company has a strong focus on trying to find hydrocarbons such as oil and gas. Mathematical equations are used to do the seismic analysis and I'm the only one here who can do what they need. I was always interested in how the Earth works and, actually, I wanted to be a weather forecaster as I liked the idea that you could predict what the weather would be like the next day. I wondered how they did it!

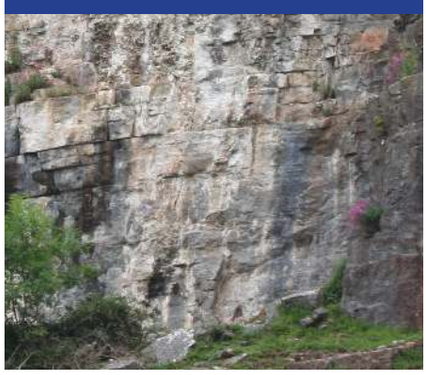
What I enjoyed about maths at school was knowing that something was definitely correct and that I knew when I had done a good job. I did a project towards the end of my undergraduate degree on the relationship between maths and music. I looked at the attenuation (weakening in strength) of various frequencies occurring in music. My PhD was concerned with analysing high frequency seismic traces.

I did take some time out to travel the world. I lived just about everywhere – America, Spain, Australia, you name it. I have had quite a variety jobs too – working behind the bar in Irish pubs, on a building site in Southampton and even in a chemistry lab testing yoghurt in Brisbane! Eventually I applied for a job at TGS-NOPEC in Houston, Texas and ended up getting my current job at the London branch.

Maths has so many applications that I'm confident there will always be jobs for me – everyone needs a phone, everyone needs oil. I'm basically using maths to travel the planet!

When I'm not working, I like to play the drums. I was in a band and we even played some gigs on the same bill as Ash and Oasis. I have also done a bit of modelling during my PhD and I did a bit of salsa dancing too. I love rugby and watch it as much as I can.

"I'm basically using maths to travel the planet!"



"I enjoy the problem solving associated with a challenge and finding the correct solution to achieve the desired result, particularly if the solution turns out to be non-obvious or 'elegant'."

Paul Johnston

Jo **Keefe** & Katherine **Byrne**

Job Title: *The Home Office, Operational Researchers*

"You need to be able to communicate ideas to others who may not have used maths for a very long time."

Jo: I always loved maths, particularly problem solving. I think there is something exciting about understanding a problem and working hard to solve it.

Katherine: My appreciation for maths has come with time. I'm not sure that I liked maths very much early on at school and every year I thought I would drop it. However, thankfully, I didn't and it has kept me very well-equipped for the real world.

J: When I was approaching the end of my maths degree, I was wondering what on earth to do with it so I did a career questionnaire and it pointed me towards operational research (OR). I was not sure what this meant but upon further investigation I found out that it involves lots of problem solving and logical thinking and I thought "That's it!" I did my masters in OR and started applying for jobs.

K: My route was a bit different. I thought I might go into industry but I found my way into OR.

J: We start out with a vague problem; we gather data and other information; we start analysing the problem and then we present our findings. In one of my recent projects, I investigated how different parts of the Home Office connect. In this sort of work, you need to be able to communicate ideas to others who may not have used maths for a very long time. I manage a team and guiding each project through requires a lot of organisational skills and good leadership.

K: A typical task in my job could be using Excel to model manned gates compared with automated gates at passport control. You need to be able to make others feel confident in the result you are presenting. I think you also need the ability to learn new things fairly quickly.

J: Sometimes there is a bit of misunderstanding about the results which we obtain. Occasionally, the people we present results to want a "crystal ball" which will predict the future in exact terms. Our task is often to warn them that these results give the solution to a problem within certain constraints and subject to several variables. A change in any of these can deliver different conclusions.

K: I think it's also important to understand that for a reliable and good analysis, some adequate notice has to be given. Occasionally colleagues will realise that they need some analysis to add to a report so they call on the "numbers people" to add some numbers to it. Of course, it's not as simple as that.

Haley **Gomez**

Job Title: *Lecturer in Astrophysics, Cardiff University*
Qualifications: *MPhys Astrophysics, PhD*

An astronomer tries to understand the universe mostly using mathematical models. I've always enjoyed maths especially when trying to understand physics.

I spend most of my day using a computer to create codes, modelling astrophysical sources and solving equations. I also investigate data gathered by using telescopes. Another large part of my day will be spent helping students and preparing lectures. I could be giving a talk at a school, another university or a conference. I might even be using an Hawaiian telescope. There are always questions to ask, problems to solve, research meetings to attend and articles to write.

I'm a curious person so doing something challenging every day was a key factor when deciding what career to choose. To be an academic, it helps to be competitive, hard-working and have excellent motivational, management and team-working skills. And of course, you need to enjoy the subject!

"To be an academic, it helps to be competitive, hard-working and have excellent motivational, management and team-working skills."

Jonathan **Hare**

Job Title: *Freelance scientist, Science communicator (TV series include BBC Rough Science, Hollywood Science)*
Qualifications: *BSc Physics, PhD Material Science*

I like solving problems, discovering things for myself and I love making things and finding out how to get them to work. I find maths essential.

At school I had reading and writing problems (the modern word processor and keyboard have really helped) and so I tended to learn things by studying diagrams, pictures and playing with machines. For example, I learnt electronics by 'reading' hundreds of diagrams and making hundreds of circuits.

Sometimes I would make what looked like a perfectly reasonable circuit but it just wouldn't work. This puzzled and bothered me. When I got to university we learnt about the theory, the maths, that was involved. Although I could often work things out by experimenting, I found that making an effort to understand the maths often made it profoundly clearer. I reworked the rogue circuits with what I had learnt from the maths and they worked! It was a very direct way of seeing why maths is so powerful – it was really exciting, in fact it was wonderful! Experimenting with electronics was a bit like finding a treasure island full of exciting things. Later, learning the maths theory was suddenly like being given the map to this treasure island.

For me a most important maths skill is to be able to make a good estimate and get a ball-park figure. In the Rough Science TV series we could easily end up pursuing experiments we might not have time to finish in the three days. So we would often try to think of a couple of ways of tackling the challenge, make estimates of each and go for the one that looked most promising.

I have zig-zagged my way through science and technology. For years I worked part-time in a radio repair shop. I got a degree in physics, went on to study for a PhD in astronomy but ended up in a chemistry department working on material science. I have worked on the development of a gas-powered car for British Gas and been a Time Lord working with atomic clocks at the National Physical Laboratory.

"For me a most important maths skill is to be able to make a good estimate and get a ball park figure."

Underpinning all this exciting and interesting work was a need for a grounding in basic maths. I am not sure what the future holds; I have some research activities I am currently pursuing but, as long as I am making things, I think I will be happy.

Darren **Pennington**

Job Title: *Third Year Apprentice, BAE Systems*
Qualifications: *GCSE Maths, A level Engineering*

When I was at school, what I loved about maths was the process of working out the answers. I really felt engaged in the step by step process and loved getting the right answer.

I didn't do a degree because I didn't think it was right for me. When I left school, I did a year in industry where I was shop fitting. After that I joined the apprentice scheme which has been varied. I am always on different placements around the organisation and I learn many different skills.

"I enjoy the practicalities of the subject and knowing that it helps me to do my job."

I work with a team to come up with concept ideas for Unmanned Arial Vehicles. Currently, I am working as a lead engineer on the launch platform. I have to research and calculate how to reduce G-loading and I also work on stress loading design. I have found that maths is definitely more applicable in the work place. I enjoy the practicalities of the subject and knowing that it helps me to do my job.

Paul **Johnston**

Job Title: *Software Developer, The Game Creators Ltd*
Qualifications: *BSc Computer Science*

"I enjoy the problem solving associated with a challenge and finding the correct solution to achieve the desired result, particularly if the solution turns out to be non-obvious or 'elegant'."

My company provides easy-to-use game-creation tools that enable users to harness their imagination. They can use it to create interactive 3D games without the need to code, or by programming in our professional programming language.

My typical day depends on the progress of the project we are currently working on. It can vary from researching the latest technology, designing and implementing a code structure to handle the required data, to testing and debugging an existing or nearly complete project. Sometimes I can access online documents that help me to code the desired result and at other times I have to use my instinct and code trial and error solutions. Games need fast routines that must output the results upto 60 times per second, so optimised code and neat tricks are the order of the day.

I enjoy the problem solving associated with finding the correct solution to achieve the desired result, particularly if the solution turns out to be non-obvious or 'elegant'.

My interest in maths started at an early age whilst I was in primary school. I saw a subject that provided not only problems but also the methods of solving them. As I studied maths through A Level I saw how the mathematical methods could be applied to real world problems such as those in physics and computing.

I didn't learn about the potential of computers until I studied A Level computing, but I immediately saw an outlet to apply the maths I had learned. I took an interest in the problem of collision detection between primitive shapes and that led me to a career in game development.

The ability to break down a solution into simple steps that a computer can follow in a chosen language is essential. Also, for game development, it is helpful to be able to spot areas of a solution that can be changed reasonably to trade accuracy for performance and to be able to reorganise data to make the solution simpler.

Ben **Allison**

Job Title: *Special Needs Maths and English teacher, Northern Ireland*
Qualifications: *BSc Sports Science and Geography, PGCE*

I work in a state integrated secondary school where pupils of all abilities are represented. Maths has to be presented to low ability classes in a relevant and accessible way.

Most importantly it needs to be appropriate to the ability level that I am dealing with and what they are likely to want to use it for.

As well as teaching maths, I use it in my work too. Statistical analysis of results continues to be important, even with low ability pupils. We have looked at underachievement of boys and differences in results across the curriculum. As with all schools these days, the department is charged with evaluating the school results and achievements when the external exam results are published. I need mathematics every day to develop basic ability which allows individual pupils to acquire much-needed life skills through experiencing number-related concepts in an appropriate way.

"As well as teaching maths, I use it in my work too."

Sara **Santos**

Job Title: *Clothworkers' Fellow, The Royal Institution of Great Britain*
Qualifications: *BSc Mathematics (University of Porto, Portugal), PhD Dynamical Systems (University of Manchester)*

When I was younger, I wanted to be a painter or architect but I found myself becoming more and more interested in mathematics, particularly when a great teacher encouraged me to take my studies further.

During my PhD, I was also fortunate to be able to do some lecturing and teaching. I became involved with a project in Manchester where we would take fun science puzzles and workshops to children from deprived areas. I felt like I could really make a difference and that feeling really warms my heart. From there, I was involved with various science communication projects and then I got this fantastic job at the Royal Institution (Ri).

The Ri was founded over two hundred years ago. Its main aim is to connect people with the world of science. You may have heard of our Christmas Lectures, but we also offer the public family fun days and talks from renowned scientists.

"We collaborate with a lot of mathematicians working in industry and at universities so we need good social networking skills too."

My job is to support and run a UK-wide network of Mathematics Masterclasses for school children who give up part of a Saturday morning for some fun maths. In these sessions, we give the children background to a problem and then they work through it in groups. The children are encouraged to discuss their work and we like to emphasise the links between mathematics and other subjects such as art. We try to make clear that there is not always an explicit right or wrong answer in mathematics.

In my job, I need to have a good sense of what will appeal to young people. There is a lot of creative thinking involved. We collaborate with a lot of mathematicians working in industry and at universities so we need good social networking skills too.

I think it's important to exercise your body as well as your mind so I like to do some sports. In particular, I like to do Capoeira, which is a form of martial art combined with dance.

Martin **Crozier**

Job Title: *Teacher of Mathematics, St Antony's Leweston School, Dorset*
Qualifications: *BSc Mathematics (Durham University), PGCE Mathematics (Durham University)*

"My job is to stimulate and pass on enthusiasm for mathematics to students of all ages."

My main role is to teach Further Mathematics at A level and to ensure that the more able mathematicians have their educational needs met through enrichment and acceleration.

I am the school coordinator for the More Able and Talented Child scheme and I also work for Dorset Local Education Authority providing enrichment weekends as part of their More Able and Talented Programme.

My job is to stimulate and pass on enthusiasm for mathematics to students of all ages and so I use mathematics and its applications in every part of my job, ranging from simple algebra to matrix algebra and second order differential equations. I also complete the data and statistical returns for the school. I studied maths and further maths at school purely and simply because it excited me. The challenges appealed to me greatly and, as I wanted to teach maths, I thought it a good idea to study it!

I am a keen musician and play the viola in many orchestras including the British Police Symphony Orchestra and the National Scout and Guide Symphony Orchestra, the latter of which I also conducted for three years. I also enjoy supporting Stoke City Football Club.

James **Drake**

Job Title: *Sound Engineer*
Qualifications: *BMus Music and Sound Recording (University of Surrey)*

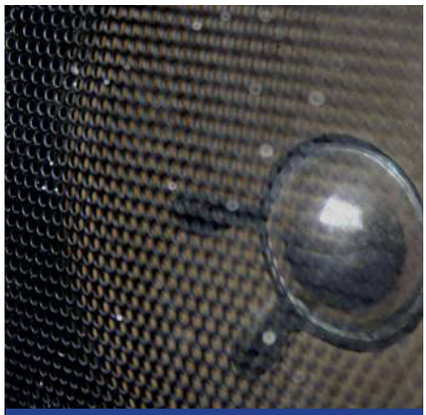
Did you go to a gig at the weekend, see your favourite band in a club or your superstar heroes at Wembley? Do you know how many hours of thought and action went into making that happen? And then think about what it involved getting that gig from the venue to your television set.

My company records music. If you watch something like Reading Festival on television, we balance the sound of the music so it sounds as good as on the album.

The theory side of how our gear works is, of course, highly mathematical. However, when it comes to actually working, it is up to you how much you really think about how and why it works.

More practically, each action taken to solve a given problem may not involve any direct sums or calculations but it will use assumptions that you take as being certain due to experience of an earlier, similar problem. The earlier problem may have been solved, again using assumptions derived from previous experiences.

On a daily basis, it is more about things like client relations as it is a service industry. There is a lot of logical thinking that has to happen: we have this amount of gear, this amount of time, we have to be in these different towns on the right day and deliver the final product at the end of gig so how are we going to make this happen?



"There is a lot of logical thinking that has to happen."

Elliot **Collins**

Job Title: *BSc student of Physics with Space Science and Technology (University of Leicester)*

Mathematics is used all the time in my course. In space science, maths is essential for calculating spacecraft trajectories, rocket and engine design and efficiency. And to plot a course through the solar system for interplanetary spaceflight, maths is vital.

Physics obviously demands a high degree of maths. I find it very fulfilling to see how some of the higher-level maths we were taught at school actually applies to real-life situations. While the basic physics of nature is understood to a certain degree, maths is essential to explore more fundamental aspects of reality – from multiple dimension universes to black holes and exploding stars. Investigating the maths behind everyday occurrences can lead to startling results: did you know quantum mechanics suggests that nothing exists for definite until someone looks at it? At a microscopic scale, if you put something in a box and close the box then, until you look at it again, it could be on the bottom of the box, anywhere inside or halfway to the moon! All of these things have a probability (however small) and, until you open the box, the thing you put in there exists in *all* these places at once!

If you ever wanted to know why the moon doesn't just spin into the Earth or how likely it is that a black hole will suck us up at any moment, you need maths.

"I find it very fulfilling to see how some of the higher-level maths we were taught at school actually applies to real-life situations."

Eoin **Igoe** & Sarah **Coulson**

Job Title: *Operational Researchers, British Airways, Heathrow Airport*

Sarah: Maths was my favourite subject at school and I did maths and further maths A levels. I did think about studying economics or accounting at university but decided to do a degree in mathematical sciences as I believed it would give me more freedom to try different things.

In my second year my interest drifted towards more applied maths courses such as statistics and operational research (OR).

Eoin: I did A levels in maths, geography and economics and it wasn't until a bit later on that I was drawn towards working with maths.

S: I really wanted to do overseas development work and so I did a maths PGCE at the University of Manchester along with teaching English as a foreign language. I taught in London for a year before going abroad to Malawi and teaching there. I spent two wonderful years there. I still had a keen interest in OR when I returned to London so I did an MSc and sought out a career using OR.

E: I was working in world sales and often hired OR consultants. That sparked my interest in OR and in mathematical modelling.

S: We do a fair bit of work on the front-of-house operations at Terminal 5 through the construction of simulation models. These help to make decisions on things such as equipment and manpower. It is important to be good with people and to be able to identify what a client requires. I think it is often a case of remembering that a solution which is fit for purpose is not always necessarily the most complicated one.

E: We do a lot of complex data analysis. This is basically converting large amounts of data into a more manageable form. We analyse sales and revenue data and also look at methods of improving scheduling. You need to have good analytical ability and having a business head helps too. There is a degree of uncertainty with projects so the lack of an explicit schedule and shifting priorities is something which you need to get used to.

"It is important to be good with people and to be able to identify what a client requires."

S: I like that it has a lot of relevance to the real world and you can see that in action. For example, I once had to use OR to construct a simulation model of the occupancy of casualty beds in the Liverpool Royal Infirmary. Maths has a real context.

E: When you can clearly see the work we do here impacting on the company you feel like you are making a real contribution.

"I became fascinated with the power of mathematics and computers to predict the motion of fluids and objects in the real world. What a magical combination!"

Bob Hornby

Heather **Wright**

Job Title: *Management Consultant, Hartley McMaster*
Qualifications: *BSc Statistics and Law (Keele University)*

There are many more applications of maths in the real world than I imagined when I was at school. For example, operational research is used in the airline industry to plan flight schedules.

"In the retail industry, [maths] is used to work out which products customers want."

And in the retail industry, it is used to work out which products customers want, when and where they want them and how to distribute them in the most cost-effective way. Maths is used in all customer-based industries to formulate trends in business and the government uses it to analyse data in order to review how effective its policies are.

My firm specialises in using analytical and structured methods to solve business problems. We work with companies to help them understand who is buying their products, how much to invest in their infrastructure and how to make best use of their resources. We also provide expert advice to government on how best to deliver services, protect the public and invest for future health and wealth.

To do this, we often need to use mathematical analysis. Having a mathematical mind also helps to structure the problem, decide how best to solve it and to use the data available in the best way possible.

My first project involved working in a team of three to develop an online survey and analysis system for a client. I have also worked on a statistical project which sampled data sent to the Home Office to gauge its accuracy and to try to identify the main causes of errors. Other projects included looking at the best way to schedule inspection visits to check that companies are paying the National Minimum Wage and reviewing a model that the government plans to use to assess the performance of prisons.

When I was at school I mainly enjoyed dealing with statistics, such as percentages, and manipulating algebraic formulae. I did maths at A level and it also made up half my degree course. After university, I went travelling and taught maths in Kenya for two months before starting my current job.

Ben **Raskin**

Job Title: *Organic Agricultural Advisor, the Soil Association*
Qualifications: *BA Ancient History, other qualifications in Horticulture.*

Mathematics makes all things possible. Without it nothing adds up and you will never achieve what you want to achieve.

I have used mathematics in many aspects of practical plant growing. This includes simple things like measuring areas of plant beds and ensuring that we have right angles at their corners to working out the rates of seed growth and the levels of fertiliser that should be applied. I have also used arithmetic in account management. And when I have been working on a market stall, good mental arithmetic has been essential!

"When I have been working on a market stall, good mental arithmetic has been essential!"

James **Connell**

Job Title: *Civil Engineer, Morgan Professional Services, Stratford-upon-Avon*
Qualifications: *BSc Civil Engineering (Oxford Brookes University)*

"When you are studying in school you don't always see the wider context of what you are doing."

The great thing about my choice of degree was that a career was already clear for me. I already knew when I was doing my degree where I wanted to apply my mathematical skills. My firm is a design, engineering and project management business. I use mathematics in the design and construction of buildings.

I enjoyed maths at school, particularly the mechanics which I studied at A level. I originally thought I might become a pilot in the Royal Air Force, but decided to find out about some other options. I had some idea of what engineering involved as my brother studied it when he went to university so I chose civil engineering. I liked the idea that I could find out how buildings worked. I found that there was a lot of maths involved. In particular, topics such as statics, dynamics and structural mechanics are very important in designing and building structures.

I was fortunate that my degree course included an industrial placement year, which gave me valuable experience in the world of work. I was mostly based on site with the site manager and used a lot of maths in calculations.

After I graduated, I decided I wanted to work as a consulting civil engineer. I liaise with a client and plan, manage and supervise the construction of projects. A contracting engineer oversees the actual construction work on site. For me, consulting is where the more challenging maths work comes in.

An architect will come to us with their concept for the design of a building. Our job is to analyse and design the structural components, consider the overall structural stability and integrity of that building and provide a safe and viable solution so that the concept can be turned into reality. We use a lot of mechanics. There are many other skills that are very important in my line of work. For example, I need to communicate my findings to colleagues frequently, so good social skills are key. Additionally, I have to use some project management skills when I am directing a team of colleagues on specific tasks.

When you are studying in school you don't always see the wider context of what you are doing. But when I use maths at work, I get to see the finalised building and there is great satisfaction in knowing that I played a big part in its construction.

Guy **Hinchley**

Job Title: *National Managing Partner, Mills & Reeve (law firm in Birmingham)*
Qualifications: *LLB Law (University College London)*

Solicitors need maths more than you may think. For example, to qualify, they have to pass an accounts exam as part of the qualification process. The course and exam is straightforward for those who have studied maths to A level.

As a commercial property lawyer, I worked on complex documents relating to development projects. Deals are often done to share future development value. The sharing of this profit depends on various factors and is usually best expressed in mathematical formulae rather than words. Those lawyers who can only express themselves in words, but not figures, struggle to elegantly and effectively express these arrangements, or even to understand them.

"Those lawyers who can only express themselves in words, but not figures, struggle."

As a manager of a business I need to set and approve budgets, deal with capitalisation and cash flow and analyse performance against benchmarks. We use statistics, percentages, and maths in this process. Our performance as a business is usually measured numerically.

Fayezah **Sayed**

Job Title: *Trainee Actuary, KPMG, Leeds*
Qualifications: *BSc Mathematics (University of Leeds)*

My parents wanted me to do medicine at university but I convinced them that I really wanted to do maths because it was the subject which I loved.

My parents were worried about my potential job prospects with a maths degree but, after doing some research, I found that there was a huge number of options for someone with this background. As I went through my undergraduate degree, I found myself being more interested in applied maths than pure maths. I worked part-time in financial admin for Topshop while I was studying and I was delighted when I graduated with a First Class Honours degree!

I went to the university careers service and also to various careers fairs to get more information on what to do next. There was some competition for jobs but employers know when you are genuine and when your passion for the job is there. My passion for maths definitely played a big part in getting my current job as a trainee actuary at KPMG.

In my particular area, the actuaries look at the profits and losses of a company and use maths to predict the financial future of the company using lots of calculations and graphs.

It has been a bit strange moving into the world of work but very interesting. Actually seeing the application of the maths which I studied has been great. There is a lot of flexibility too. I can choose to switch office location if I want to.

I use a lot of mathematical skills but I also need to use a lot of social skills. I need to be able to explain complicated theories to a wide range of people.

"Actually seeing the application of the maths which I studied has been great."

There is also a lot of team work involved in my work which makes a nice informal working atmosphere.

I did a lot of kickboxing at university. I also enjoy swimming, badminton and films. One of my main interests is art. I have done a lot of painting and I like to make photo frames and Christmas cards.

Liz **Bentley**

Job Title: *Head of Communications, Royal Meteorological Society*
Qualifications: *BSc Mathematics, PhD Applied Mathematics*

"I especially loved the problem-solving challenge."

For me, one my biggest inspirations in maths was my teacher at school. Further to that I thought maths was fun, it was nice and logical. I especially loved the problem-solving challenge.

I joined the Met Office in 1993 as a researcher and then went on to weather forecasting for the Royal Air Force and Army before going on to teach forecasting. I also worked at the BBC Weather Centre as a team manager of weather broadcasters before going to the Ministry of Defence to head the Environmental Research Programme.

I now work to aid the advancement of understanding of weather and climate. I work with academics and researchers, as well as educational partners, to promote understanding of the environment.

My tasks vary greatly, from answering phone enquiries from the general public to developing strategic plans. I also spend time creating publications for different audiences and target groups. My role involves a lot of different activities from being analytical, innovative and thinking strategically, to doing marketing, publicity, design and communication.

At school I did question how maths could be applied in the work place and what kind of career I would have. But now I have realised that maths can be applied in all areas of the work from statistics to modelling the atmosphere.

John **Botteley**

Job Title: *Theatre Director, Grand Opera House (Belfast)*
Qualifications: *A level Maths for Science*

A good grounding in mathematics has been of great importance in all stages of my career.

I have used it from my early days in scenery design and construction, to my later career in budget setting and monitoring, doing financial deals with visiting theatre companies, tax calculations and statistical analysis of ticket sales.

I trained as a junior school teacher, and taught for a year, but then went on to work in theatre. I started as a stage carpenter and assistant stage manager, and worked my way up to my current level as a theatre chief executive. I have managed the Grand Theatre in Wolverhampton, the Alhambra Theatre in Bradford and I am now theatre director of the 1000-seat Grand Opera House in Belfast.

Shortly after leaving school, I was a stage carpenter and we were asked to build a piece of scenery out of plywood which would sit in the centre of the stage. The piece was to be the place around which the characters congregated during their breaks. The designer of the play had designed everything on the set in perspective, so building the object in perspective involved very complicated geometry and the accurate interpretation of plans. Using my mathematical skills I was able to interpret the plans and build it. Later, the play was filmed by the BBC and they asked to use our piece of scenery as the BBC carpenters were unable to recreate it themselves.

In my current job, I manage budgets in excess of £5 million annually and I use maths to calculate potential income from sales, including detailed

"A good grounding in mathematics has been of great importance in all stages of my career."

calculations of how decreasing or increasing individual seat prices will affect potential earnings. I need to be able to understand complex financial reports produced by my commercial director, and present these to our board. However, I think the most useful skills that developed out of studying maths at A level were an ability to solve problems and an analytical way of thinking.

Louise **Forbes**

Job Title: *Solicitor*

I work for a large international practice and I specialise in insurance and reinsurance law. I am involved in insurance issues which emanate from corporate deals. I trained (degree, post-graduate year and training contract) and then qualified straight into insurance and reinsurance.

I use maths constantly on settlements. A client and the party that they are in dispute with may not be able to agree a settlement because of a difference of, say, £250,000. Sometimes, in the overall scheme this amount is small when looked at as a percentage.

"Generally the professionals I am working for are very clued up on figures."

Generally the professionals I am working for are very clued up on figures so it is more often the case that they come to me with figures.

We may have to examine arrangements retrospectively or in advance of a contract to determine how a contract should have worked or does work. We also deal with maths when working out bills, court costs, settlement agreements and when working out payment mechanisms in contracts. Also, maths is important so that you can request expenses accurately!

Tudor **Brown**

Job Title: *President of Board of Directors, ARM*
Qualifications: *BA Physics and Electrical Sciences (University of Cambridge)*

My company produces microprocessors which power virtually every mobile phone and many other consumer devices. I was part of the team that created the ARM microprocessor. Now the company has 1,700 staff in 38 offices worldwide.

After school, I went to Cambridge to study physics. But at Cambridge physics is really applied maths and maths is more like philosophy. There was even the dreaded Department of Applied Maths and Theoretical Physics for the very, very bright people! So, after my first two years, I switched to electrical sciences (otherwise known as electronics).

When I left in 1979, I became an electronics engineer in a digital electronics company, knowing almost nothing about computer science or digital electronics. I soon taught myself and designed lots of interesting bits of control electronics for nuclear reactors and nuclear fusion experiments. Despite not really liking computers, I ended up moving back to Cambridge to design personal computers at Acorn. Graphics display controllers became my specialty and then I became part of the company that created the ARM microprocessor. I led the engineering departments for many years and then became the chief operating officer in 2001.

" There is a close linkage between the physics to set up the situation and equations and actually solving the equations."

High speed electronics includes solving many different types of equations from simple ones like resistor ratios to more complex ones to do with how much light is lost down a long fibre optic cable or how much peak current will be taken every time a computer switches (which happens hundreds of millions of times a second). There is a close linkage between the physics to set up the situation and equations and actually solving the equations – I guess you call that applied maths! How much does the filament in an electric heater cool down during each cycle of the mains (that is 100 times a second)? If you are transmitting an ethernet signal by infrared LED between two buildings on a misty day, how powerful does the light source need to be? Share options – if you pay income tax now or capital gains tax later, when is the best time to sell your shares? These are the sorts of problems that my mathematical background has enabled me to tackle.

Ivie **Aroko**

Job Title: *Graduate Engineer, National Grid*
Qualifications: *BSc Production Engineering, MSc Engineering*

I work on a national project that is researching the way that renewable biogas can be injected into the National Grid to meet the government's targets by 2020.

For me, the best thing about maths at school was that there was always a right or wrong answer. I didn't understand then how maths could be used in the workplace but I now realise that the analytical processes and the logical mindset is used in the workplace every day. I studied in Nigeria, where I did GCSE and A level equivalents in maths and science. I went on to do an undergraduate and then a masters degree in engineering. I worked in civil engineering before beginning the graduate scheme at National Grid in 2008.

There is a lot of business analysis in my job and I have to give presentations to high-profile players in the industry regarding our project. I also project manage and seek ways to raise stakeholder engagement. So I use more than just maths at work! I have to use analytical, interpersonal, presentation, people and project management skills.

I have a huge passion for football and also enjoy keeping fit by going to the gym. Another hobby of mine is singing and I always love meeting new people.

"For me, the best thing about maths at school was that there was always a right or wrong answer."

Leslie **Cram**

Job Title: *Museum Archeological Curator (retired)*
Qualifications: *BA Archaeology (University of Cambridge)*

I have used my mathematical background in a variety of ways. Firstly, being able to use statistics makes study of the past available to all, rather than having to depend upon the judgement of an expert.

More directly, I used it to work out questions such as 'How big were Roman dogs?' Height at the shoulder can be found by measuring a long bone such as the femur (upper leg bone) and using a formula already in existence. Another way is to measure the width of the track left by the foot of a dog in the wet bricks and tiles of Roman times before they were fired and then used in buildings. I went to a dog kennels with slabs of wet clay and got the dogs to walk over the clay and leave me their paw prints and then measured the height of the dogs at the shoulder. Some Roman dogs were the size of a Pekinese, some approached wolf size. Of course the largest bones could be of wolf but there is no way that wolves wandered over drying tiles.

"I used maths to work out questions such as 'How big were Roman dogs?'"

Alasdair **Dawson**

Job Title: *Army Officer, Royal Engineers*

I have served in Germany, Bosnia and Iraq and am currently training to be a bomb disposal operator. Everything to do with military engineering uses maths – not necessarily exact maths but certainly rule of thumb stuff.

For example, to bring down a bridge explosively you need to know how much 'bang' it will take to shatter or cut a steel beam of a certain thickness: a 23g stick of plastic explosive will shatter about 4–6mm of steel. You can increase the effect of explosives by using shaped charges. Copper cones, which once explosively inverted form a plasma jet, cut far more steel than just explosives alone. Therefore the amount and type of explosive required will depend on the thickness and construction of the bridge.

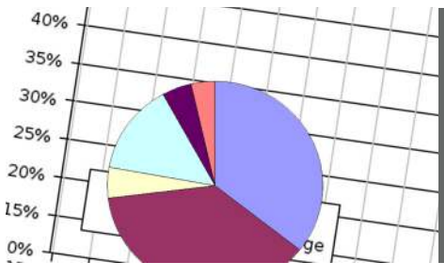
But military engineering is not just about making things disappear in a puff of smoke, it is also about building and providing support to others, civilian and military alike. After the recent earthquakes in Pakistan some of the only people who could get to the remote mountain regions were Army Engineers. There they built basic shelters out of corrugated iron and wood – they would have had to calculate wind loading factors for their shelters to ensure they would withstand the harsh mountain conditions. We can also supply water. The calculations for the water supply equipment are quite mind blowing and are all based on planning assumptions like how much water a pump can suck up, how long it takes special chemicals to purify a tank of water and what the end delivery rate would be. You then need to see if this rate matches with what you have been told to supply and if it does not you then need to rework the process to produce more.

"I use mathematics every day to work out how to protect people from the effects of explosions."

So I use mathematics every day to work out how to protect people from the effects of explosions. Although I would rather the thing did not go bang in the first place…

Dominic **Fielden**

Job Title: *Co-owner and founder, Rocky Mountain Flatbread Pizza restaurant and manufacturing company (Canada)*



"I need mathematics every day to make sure we are making money from every transaction we do."

As a business owner, I use maths every day. I have to do everything from daily sales/cost evaluation to business strategy. The restaurant and food manufacturing business is high volume, low sales and therefore margins are fine.

What is important is managing your gross profit (the sales compared with the cost of sale). Cost of sale is food, drink, cleaning supplies and packaging. A good business will have a gross profit of between 60–65%. From that you take off rent, operating expenses, labour and depreciation and eventually end up with your pre-tax profit. It is all about managing clear and defined ratios. Although our computer works out most of this for me, without maths I have no way of interpreting the data and making good business decisions from it.

Here's a simple one. There is a table of six people and they want the bill split six ways but each of them want to put a separate tip on. The first wants to put 10%, the second 11%, the third 12% and so on until the last one puts a 15% tip. The bill is $187 + tax at 6%. What does each person put on their credit card?

I need mathematics every day to make sure we are making money from every transaction we do. And if we are not making money, I need to be able to work out how to correct that for the next transactions.

Chris **Lawn**

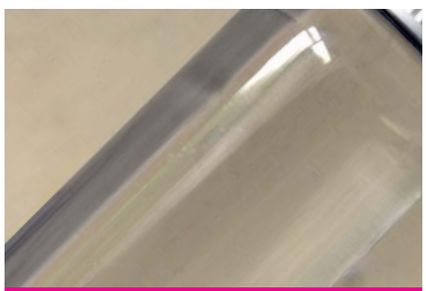
Job Title: *Professor of Thermofluids Engineering, Queen Mary University of London*
Qualifications: *MA Theoretical Physics, PhD Engineering (University of Cambridge)*

I need mathematics every day to describe the engineering processes that I am researching so that improved designs of equipment can be suggested. And of course I also use it to teach the next generation of engineers!

I spent nearly 30 years in industrial research, mostly with the Central Electricity Generating Board. After a short time at Rolls-Royce Aerospace, I decided to get back to my own research and took up my current position.

One of my current interests relates to the large industrial gas turbines that are being used increasingly to generate power. A persistent problem has been the generation of high intensities of sound by the flames in the combustion chamber. These can resonate in the system and produce vibrations of the turbine blades that are potentially damaging. By solving the equations describing the propagation of acoustic waves, together with ones describing the processes of interaction with the flames, we are able to predict the frequencies of excitation and suggest remedial measures.

The theoretical core of engineering research is, of course, mathematical. In particular, the solution of differential equations is part of constructing a mathematical model. Therefore, I have used maths fairly intensively throughout my career, apart from a middle period when the tasks were primarily managerial.



"I have used maths fairly intensively throughout my career."

John **Marsham**

Job Title: *Academic Research Meteorologist/Cloud Physicist*
Qualifications: *MPhys Physics, PhD Meteorology (University of Edinburgh)*

There are many unanswered questions about clouds, which are important for our predictions of both weather and climate change. We don't even understand how rain forms yet!

Answering such questions makes use of computer simulations, field observations and laboratory experiments. Maths is essential for designing and running the models, processing data, interpreting the results and understanding how (in)accurate you expect your answers to be!

Recently, climate change has pushed atmospheric science onto the front pages of newspapers on a regular basis. The models used for climate prediction are essentially the same as those used for predicting the weather – using large computers these models solve the equations which control the flow of air within the atmosphere. Solving these equations and finding ways to calculate the effects of solar heating, clouds, mountains, turbulence, etc. requires a lot of maths. (The effect of clouds is now the largest uncertainty in climate change.)

"If you do a maths degree you are very valuable to many employers – they will be happy to train you."

I really enjoy applying mathematics to these processes that you see every day out of the window. I am currently working on why summertime storms happen when and where they do – we are currently not very good at predicting them at the moment!

There was an international field study in England in 2005 (a similar one took place in the USA in 2002 and another will take place in Germany in 2007). The results of this study showed, for example, that on one day one storm created waves that propagated through the atmosphere – and that these waves initiated further storms downwind of the original one. We found this using both computer models and observations from radars, satellites, balloons and surface instruments. We now know that it can be important for weather forecasting models to represent these waves. Other experiments have shown that the dramatic Boscastle flood in Cornwall in 2004 was actually (using modern computers) relatively predictable.

Most atmospheric scientists did maths, physics or chemistry degrees at university. It is increasingly hard to find graduates with the fundamental mathematical skills – especially as people are tending to do more applied degree subjects. If you do a maths degree you are very valuable to many employers – they will be happy to train you in the details of whatever they need you to know. It is much easier for someone with a maths degree to learn those details than it is for a non-mathematician.

Nicholas **Mills**

Job Title: *Specialist Charge Nurse in Children's Intensive Care Unit*
Qualifications: *BSc Applied Biology and General Nursing, BSc Health Science*

Mathematics is a vital part of intensive care. During the course of our work we observe and record lots of data. This then needs analysing and presenting. This can involve anything from simple plotting of graphs to complex calculations.

For instance, drug doses in particular need careful calculation to take account of body weight, surface area, rates of uptake and/or elimination. This helps ensure effective dosage without undue side-effects or toxicity.

Drugs used in resuscitation need doses specific to a child's weight. These need calculating quickly yet accurately and this is a potential source of stress and delay at any resuscitation. So I designed and introduced a simple spreadsheet that calculates resuscitation drug doses for all drugs concerned by doing nothing more than entering the child's weight. I am glad to say this is now in frequent use and on its fourth edition.

"I designed and introduced a simple spreadsheet that calculates resuscitation drug doses."

Alastair **Page**

Job Title: *Operations Analyst, Network Rail Enquiries*

National Rail Enquires is a government-regulated information service for the national rail network. My role incorporates three main responsibilities within a team of 20 people.

The first is to manage the operations side of the contact we have with two companies who supply four call centres to answer calls to our enquiry line. The second is to manage the call-routing platform to deliver the calls to the right place at the right time. And the third is to analyse statistics both from the call centres and our other information channels, like the website, in order to increase productivity, forecast future volumes and improve our service through trends in the users' activities.

"In meetings where we are debating the best course of action, the data often shows you the right path to take."

I could not do my job without the use of spreadsheets. I use complex formulae to work out trends within data, work out forecasts and variances and use percentages as benchmarks to measure performance and service-level agreements.

Being able to handle statistics is very important. In meetings where we are debating the best course of action, the data often shows you the right path to take.

I need mathematics every day to show me how my suppliers are performing. As in most industries, our business is driven by money. And we have service-level agreements in place to make sure they perform to the standard expected – if they don't, then they don't get paid.

Paul **Sweetenham**

Job Title: *Project Director (Financial Risk Systems) SunGard Software and IT services*
Qualifications: *MA Mathematics (University of Cambridge), DPhil Mathematics (University of Oxford)*

My job involves overseeing the installation and running of computer systems to calculate banks' credit exposure. I need mathematics every day to work out my customers' risks and hence keep them trading.

"My colleagues and I ran a computer simulation and discovered something which surprised even the fire brigade."

A typical system calculates a bank's exposure to each party in a financial transaction in the event that the party is unable to fulfill its obligations. The exposure is updated in real time for 300,000 trading positions, with several thousand new trades each day.

Quite advanced mathematics (probability distributions and calculus) is fundamental to working out the value of each trade and how that value may change as the market (currency exchange rates, interest rates and share prices) changes in the future.

Back in 1987, I was working at the nuclear power research centre, Harwell Laboratory, and having a mathematical background enabled me to take part in an important project. That year, there was a serious fire at the King's Cross underground station in London.

Following the fire, investigators were unable to explain why the fire had changed so rapidly from a very minor fire on an escalator, which people walked past with little worry, to a major problem that shot up the escalator faster than someone could run, killing several people in the booking hall above.

My colleagues and I ran a computer simulation of the fire and discovered something which surprised even the fire brigade. We saw that, as a fire in a sloping tunnel grows, at some point the tunnel starts to act like a chimney and the fire then sucks in air from below and suddenly rushes up the tunnel. These results were initially doubted by the experts in fire safety but were later confirmed by experiments run by the UK Health and Safety Executive.

Keith M. **Treves-Brown**

Job Title: *Vet and Civil Servant (Retired), active member of Council of the British Veterinary Association*
Qualifications: *VetMB Veterinary Science (University of Cambridge)*

After I qualified, I spent just over a year in agricultural veterinary practice in East Anglia and then worked for 23 years in the veterinary division of the Wellcome Foundation, during which I travelled abroad frequently, visiting a total of 22 different countries.

In 1985, I joined the Ministry of Agriculture, Fisheries and Food in the section which licensed the sale of animal medicines under the Medicines Act 1968. I became the specialist on medicines for farmed fish.

For a medicine to be licensed, the applicant pharmaceutical company has to provide scientific data on quality, safety and efficacy. Safety includes safety to the animal treated, safety to the person administering the medicine, safety to the environment and, in the case of food-producing animals, safety to the consumer.

"I used statistical methods ... and other mathematical tools you may already be studying at A level."

Quality is normally shown by a statistical comparison of a group of animals given the new medicine and another group either left untreated, given a placebo or given the currently accepted treatment. A professional statistician normally helps to design these trials.

Establishing that food is safe for the consumer is more complicated but vital. The aim was to work out how long it took, after an animal received a medicine, for residual levels of the active ingredients to be an acceptable level for human consumption. This is where my mathematical training was important. I used statistical methods and considered rates of depletion of the concentration of the ingredients and the work involved taking logarithms, plotting graphs and other mathematical tools you may already be studying at A level.

Rhys **Phillips**

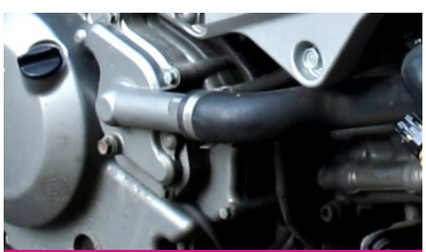
Job Title: *Corporate Graduate Engineer, EADS (European Aeronautic Defence and Space Company)*
Qualifications: *BSc Mathematics and Physics*

I have always thought that maths is a very versatile subject that opens a lot of doors in life. And in fact, I've seen that more opportunities exist for mathematicians than I originally thought.

I enjoy understanding how numbers work, and the beauty of maths is that it is not just about getting the right answer, it is about *why* that answer is correct and knowing how you arrived at it. At A level my strongest subjects were maths and physics. As I hadn't yet decided exactly what sort of career I wanted to go into, I decided to continue studying both at university as a joint honours degree, keeping my options open for job opportunities afterwards.

In my job now, I use a variety of mathematical skills: basic organisational skills to keep track of things and plan project tasks to specific timescales; problem solving skills to find solutions in a variety of situations; modelling skills based on mathematical equations and simulating them to obtain results relevant to the real world.

A typical day for me starts with a quick swim at the local pool and then I tend to arrive at work for around 8:30am. My current rotation is research based so I spend most of the day working within a team modelling and running simulations to prove or disprove various theories. Although the various graduates here work in different areas, we tend to meet up for lunch which provides a change of scene to break up the day. Outside of work, my main interest is jazz music, both listening and playing. I regularly attend live jazz events and also run my own jazz band which I started while at university. So after work I normally have some sort of rehearsal or gig with one of the groups I play with.



"The beauty of maths is that it is not just about getting the right answer."

Apart from working as a part-time waiter throughout sixth form and university, the EADS Graduate Scheme is the first job I have had.

Katherine **Agong**

Job Title: *Senior Transportation Engineer, Capita Symonds*
Qualifications: *BSc Geography, MSc Transport Planning and Engineering*

I only enjoyed some maths topics at school but I always knew that it was an essential subject so I strived to do well in maths even though it was not my favourite subject.

I ended up doing mathematics during my first year of university and then I did a lot of mathematics-based courses while doing my MSc.

Now, I'm glad I did because my work requires me to use a range of mathematical skills in my daily life – everything from simple addition and subtraction, to converting values to different units, reading and producing graphs and rearranging equations. After university, my first job was working as a research analyst in disaster management. This involved a lot of statistical analysis. I then worked as a traffic signals engineer for a couple of years before I entered my current job as a transportation engineer.

On a typical day I will be analysing traffic data. This will include looking at statistics about accidents, writing reports which are called Transport Assessments, trying to model the flow of traffic or planning various traffic and transport studies.

Over the years, my perception of maths has not changed. I still see it as a very important and essential subject. Now that I am much older and well established in my career, I am glad to know that a lot of the mathematics topics I had to learn at school and university are actually relevant to my job and life as a whole.

"I am glad to know that a lot of the mathematics topics I had to learn at school and university are actually relevant to my job and life as a whole."

Mark **Callister**

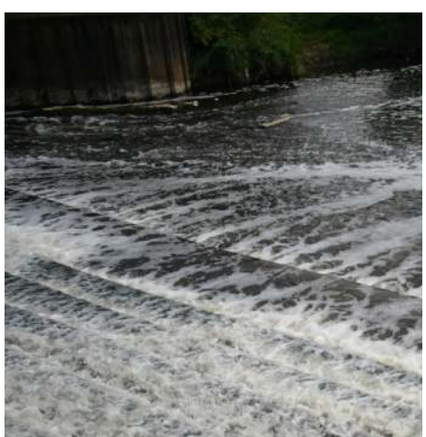
Job Title: *Graduate Engineer, Capita Symonds*
Qualifications: *BEng Civil Engineering (University of Wales, Swansea)*

I am a recent graduate and I work in the Drainage Team at Capita Symonds, Cwmbran. At school I liked maths because I could relate to the processes involved in problem solving. I preferred using numbers rather than writing essays.

I studied maths all the way through school and went on to study civil engineering at university. The course required good mathematical knowledge and I was able to build on the skills I had gained during school. I was offered a job by Capita Symonds when I graduated and have worked here since.

My role involves undertaking calculations to work out how water drains in various ways. For example, I need to be able to calculate rainfall runoff rates. When rain falls onto the earth, it doesn't just sit there, it starts moving according to the laws of gravity. A portion of the rain seeps into the ground to replenish Earth's ground water. But most of it flows downhill as runoff. I also look at things like the capacity of pipes (how much water can flow through at what rate) and storm water storage requirements.

Since I started working, I really appreciate the importance of maths. As a civil engineer, my design work is very much a maths and physics based discipline. My job also requires good organisational skills to ensure that projects are delivered on time. Working as part of a team means that good communication skills are needed to ensure that projects are well coordinated. I also need computer skills on a daily basis and use various software packages to aid design.



"Since I started working, I really appreciate the importance of maths."

Shirley **Webb**

Job Title: *Olympic athlete – hammer thrower*
Qualifications: *BSc Mathematics (University of Edinburgh)*

I remember my teacher asking me, aged five, "What would you do with £100?" My answer was that I would leave school and buy a swimming pool. She replied, "Excellent story Shirley. But what would you do without maths?" I came back with "I'd just do it at home!" Ever since then mathematics has been both my strength and my love.

After taking GCSE maths a year early I went on to get A grades at A level in both maths and further mathematics. There was no question what to study at university – I wanted maths to be my future. The choice of where to study was a bit tougher.

Sport had always been a huge part of my life. Springboard and highboard diving were my main sports at that time. I turned down the place offered to me by the University of Oxford in favour of the University of Edinburgh, where there is a swimming pool with a fabulous diving facility. I completed my BSc in mathematics in two years and graduated in 2002.

I am a strong believer in the saying 'there is a reason for everything'. It was whilst in Edinburgh that I met up with Chris Black, a two-time Olympic hammer thrower. I had enjoyed doing athletics before this but it was Chris's input to my hammer throwing which led to a dramatic improvement.

"Ensure that you never look back on your life and say 'I wish I'd...'."

So, for the past four years I have been a full-time, lottery-funded athlete. Currently I am the British Champion, Scottish record holder and European Cup winner 2005, and I have competed in Olympic Games, World Championships, World University Games, European Under-23 Championships and two Commonwealth Games.

Life as a full-time athlete is very intense. Over the past three years I have dedicated ten hours per day, every single day (with no rest days) to hammer throwing. This involves both physical training and also studying footage of myself and the best throwers in the world. I have special split-screen software to watch two throwers side-by-side. At present I do not use my mathematics qualifications day to day, though the dynamics of hammer throwing are highly complex, so my maths background gives me a clearer understanding the event.

I love being an athlete. The training is extremely tough but competing on a world stage is a massive honour and the buzz is amazing! When my hammer throwing career finishes I hope to pursue a career using maths.
My advice is to be 100 per cent committed to everything you do. Ensure that you never look back on your life and say "I wish I'd...".

"Ensure that you never look back on your life and say 'I wish I'd...'."

Shirley Webb