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Image: NASA/PL/Space Science Institute

Letter from the Editor

Welcome to the third edition of our special Science, Technology, Engineering and Mathematics (STEM) series of OnQ. Our aim in this issue is to highlight the career opportunities open to STEM graduates and we also explore how mathematics is used in these subjects. Students are often studying more than one STEM subject at A-level and can find it difficult to choose which to study; to help them with this we give advice on the advantages and disadvantages of single honours courses versus joint honours.

In this issue you'll also find a mixture of student and graduate profiles to give a flavour of what our students think of university and what our graduates have gone on to do.

If you would like any extra copies to distribute please contact us, otherwise you are welcome to photocopy the articles to give to your students.

Laura Thomas
Outreach Officer

Newly-found moon may be source of one of Saturn's rings

The Cassini spacecraft is currently in or – bit around Saturn studying the planet, its moons and rings. A moonlet has recently been discovered embedded within Saturn's G ring. Professor Carl Murray of the Astronomy Unit at Queen Mary and the only UK member of the Cassini Imaging team, said: "The moon's discovery and the disturbance of its trajectory by the neighbouring moon Mimas highlight the close association between moons and rings that we see throughout the Saturn system. Hopefully, we will learn in the future more about how such arcs form and interact with their parent bodies."

The G ring was the only dusty ring which did not seem to have a moon associated with it. However, the moon is too small to be seen by Cassini's cameras – it is thought to be only a half a kilometre across.

2009 is the International Year of Astronomy, celebrating the 400th anniversary of Galileo first looking through a telescope. There are also a number of events going on at Queen Mary; to find out more visit www.ph.qmul.ac.uk/schools and for UK-wide activities see www.astronomy2009.co.uk

Eye to eye: humans and jackdaws

Dr Nathan Emery of the School of Biological and Chemical Sciences recently undertook a study of 10 hand-reared Jackdaws which highlighted some interesting results about how they communicate.

The birds took longer to retrieve the food if the person looking at the food was not known to them, but if they knew them then there was no hesitation. Their eyes are similar to those of humans in that they have a distinct difference in eye colour between the iris and pupil.

Dr Auguste von Bayern, the lead author on the paper, commented: "We believe that the jackdaws were so sensitive to human eyes because eyes also play an important role in communication between peer and partner jackdaws. Our results not only indicate that jackdaws recognise human eyes as 'eyes', but also suggest that jackdaws might have understood something about the eye's role in visual perception, i.e. eyes that 'see'".

2009 is also Darwin Year – it is 200 years since Darwin's birth and 150 years since the publication of his Origin of the Species. Visit www.darwin200.org to find out more about events taking place in the UK.

Careers prospects for STEM graduates

Looking ahead

How would you like to earn £40,000 as a Head of Customer Service for Aggregator? Or how does £32,000 as an IT analyst for Morgan Stanley grab you? Or maybe you would prefer to earn £26,000 as a Product Supervisor for Baxter Healthcare Pharmaceuticals or £31,000 for being a Dividends Analyst at Nomura International? These are just some examples of the diverse range of well-paid jobs that graduates from Queen Mary science and engineering courses have secured over the last year.

Opting for a degree in a science-related subject doesn't mean a lifetime of laboratories, beards and test tubes; indeed by studying a science you are more likely to widen your options later in life rather than narrow them down. Few subject areas are as challenging and interesting or put as many of your skills to the test, which is why graduates from these subjects are so highly sought after in the job market and feature so frequently among the highest earners. In his inaugural speech, Barack Obama recently pledged to "restore science to its rightful place" and has even named some esteemed researchers among his key advisers.

In the money

In the Destinations of Leavers from Higher Education Survey (or the First Destinations Survey as it is more commonly known), the mean starting salary for graduates from 2006/07 (the most recent year for which we know the figures) was £20,000, up from £19,500 the previous year. However graduates in STEM subjects have even higher earning potential. In the Independent's Complete University Guide, What do Graduates Earn?, graduates in Engineering and Mathematics were among the highest earners with an average starting salary of £23,876 for engineers and £22,882 for maths.

Job prospects

Despite the recent economic downturn, career opportunities for STEM graduates still look healthy. According to the latest Graduate Recruitment Survey from the Association of Graduate Recruiters, engineering is expected to see an 8.3% rise in jobs in 2009 and estimates suggest that there will also be over 185,000 new jobs created in Computer Science between 2007 and 2012. The government has recently pledged £250m to create a new wave of scientists and engineers for Britain. The initiative will generate over 2000 PhD students and create 40 new training centres across the UK to tackle the big problems facing the country such as climate change, the energy crisis and crime and terrorism.

Naturally, some science and technology graduates will opt for further study or a job in a science-related field after they finish their degree. Irrespective of the area of science or technology that they study, many graduates find jobs that are directly or indirectly relevant. For example, many environmental scientists become environmental officers or technicians, biology graduates might become biomedical researchers or forensic scientists or electronic engineering graduates become broadcast engineers or go into the field of electrical supply and distribution. Indeed, studying science can open up opportunities unavailable to those studying other subjects – you can't be a forensic scientist without a biology or chemistry background, while a degree in physics is an ideal starting point for budding sound engineers.

Other directly relevant jobs for STEM graduates include: manufacturing engineer, metallurgist, research scientist, quality controller, analytical chemist, meteorologist, toxicologist, nature conservation officer, web designer, multimedia programmer, network engineer, medical physicist – to name but a few!

However, one of the many great advantages of studying a science or technology subject is that it opens doors to lots of other careers, many of which you might not have considered (or even heard of). Did you realise for example that graduates in science and engineering often go into areas like sales, marketing, business and finance, the health service and the media? Since around two thirds of graduate jobs are open to all graduates, whatever your degree subject, you will still be eligible for a wide variety of careers.

Transferable skills

What makes science and technology graduates so highly sought after by employers? It's all about 'transferable skills': throughout their degrees, students in these subject areas will develop qualities such as communication skills (both oral and written – you will have to give presentations and produce lab reports and so on), interpersonal and team-working skills (most science and engineering degrees involve group projects), analytical ability and logical thinking, time management, attention to detail, numeracy, decision-making and the ability to think independently. These skills plus the fact that you are intelligent enough to succeed in an academically challenging subject, are what make science and technology graduates so employable in a huge range of careers.

So a student in biological and chemical sciences will not only gain some very marketable knowledge in cutting-edge areas like biotechnology and environmental issues but will also develop good problem-solving skills, and be adept at handling a mass of diverse data. If mathematics or physics is your passion, then you will have a very high level of numeracy and the ability to process data clearly and accurately. This is why careers in the City (financial modelling, trading, accountancy and so on) are very popular options for Maths graduates. Engineering graduates will be similarly sought after, as they combine high levels of numeracy with the ability to apply this to practical problems in all sorts of contexts.

Commercial awareness

Finally it is worth bearing in mind that employers like students who have 'commercial awareness.' Universities are keen to make their graduates as employable as possible and therefore many now offer degree courses with an opportunity for some real work experience.

The CBI Director General, Richard Lambert recently stressed the importance of gaining vital employability skills and experience while at university. This will mean students are better equipped to compete in the increasingly tough jobs market after graduation. Indeed, if you choose to do an engineering or computer science degree, you may have the opportunity to do a sandwich year which will involve spending some time working in industry. If this is the case, then you will gain valuable experience – working on real projects using practical engineering or computing skills and being involved in managing time and resources – all of which will prove very useful for your CV.

Undergraduate and Graduate profiles

Crazy about biology? Love physics? Does mathematics fascinate you, but are you unsure about the sort of job that you will be able to get with such a degree?

When choosing your degree course you have many options. We've interviewed some of our current students and recent graduates about their courses and their careers. They found their degrees challenging and enjoyable. So push the images of lab coats and boring sums from your mind, and instead think about how much you might enjoy working at the pinnacle of science and technology. STEM graduates often go on to pursue the most diverse, dynamic and downright cool careers! Furthermore, STEM graduates are among the most highly paid graduates in the country.

Helen Manna

1st Year undergraduate student, Maths, Business Management and Finance

"During college I did an internship with UBS investment bank. This changed my focus for my choice of course to study at university. As I was interested in the financial sector, I wanted a rounded degree to help broaden my understanding of how businesses operate. I believe my degree at Queen Mary will give me a wide range of knowledge and improve my analytical skills.

"Whilst studying Maths, Business Management and Finance I have thoroughly enjoyed the manner of teaching, the lecturers create a friendly atmosphere and get the students really interested in the subject.

"Once I graduate from university I want a career where I can apply the knowledge and skills I have acquired at university. I have enjoyed taking part in group projects because I have been able to develop my interpersonal and communication skills. At this point in time, I have my heart set on a career within the financial/banking sector. I hope to acquire the knowledge and skills which will enable me to perform to my full potential in whichever career path I choose to pursue."

Jenny Baker

3rd Year undergraduate student, Astrophysics

"I have always loved astronomy and I decided that I would love to study the subject in more depth at degree level. Astronomy is a fascinating field with many new and exciting discoveries. I understand the value of having a degree and chose Astrophysics as I am really passionate about the subject.

"I chose to study at Queen Mary after attending an Open Day. Besides having a great academic reputation I found that it had a really friendly and positive environment.

"The astronomy modules are particularly enjoyable as they are taught by researchers active in the field. Therefore they keep us up to date with new advances and are always enthusiastic about what they teach. In addition, the practical workshops are really enjoyable and a good way to learn.

"I have gained so much from my time here. As well as the knowledge and skills I've gained, I have also made many good friends. My degree will make it possible me for me to work in a variety of areas, for example: scientific research or business."

Flight Lieutenant Stefan Wurwal

Graduated in 2003, Aerospace Engineering

"I'm a Fast Jet Pilot Qualified Flying Instructor in the Royal Air Force. I have just completed RAF advanced flight training in the Fast Jet Stream on the Hawk. I have been selected to become an Instructor before continuing on to weapons and tactics training.

"Aerospace Engineering is ideal for flying in the military and the social side and team work were highly beneficial. Queen Mary's location at Mile End brought me into contact with a huge variety of people and cultures which built my general community and social awareness.

"If you're interested in going into this career I'd recommend that you get involved with societies and take advantage of the many exchange programs on offer whilst at university."

Rhoda Hundeyin

Graduated in 2003, Mechanical Engineering

"I work as an Information Technology Analyst for BP International. I am responsible for ensuring a streamlining of processes within various parts of the organisation. This involves extensive liaison with a range of internal and external customers to produce, maintain and update software solutions that create a competitive advantage.

"I'd recommend that whilst at university you study hard to get good grades and top class analytical skills but while doing so, remember to learn to interact with people effectively. Virtually every career path involves managing human interaction, so the better you can do this, the better it will be for your career prospects.

"Although I do not get to make direct use of my technical engineering skills, the analytical and problem solving skills I gained during my degree have proved invaluable in both my Masters degree in Information Management, and in my role at BP."

Laura Gillam

Graduated in 2005, Biology

"I currently work as a Cardiac Service Improvement Manager for the South West London Cardiac Network. I work with clinicians, managers, commissioners, patients and their carers across the sector to ensure a coordinated approach to cardiac services throughout the network.

"I loved pretty much all of my modules at university and the work was always interesting and challenging. We had teachers who taught you thoroughly yet also encouraged you to go and find out more for yourself, and they were always very approachable if you were having difficulties at all. And I definitely got value for money, because of all the hours I spent in labs doing practicals - and they were just great, I felt like a real scientist.

"I want to stay working with the NHS for sure. I find it really satisfying knowing that I can make a difference to a person's welfare."

Choosing your Degree

If you have an interest in science and engineering, more often than not you'll be taking at least two science subjects as well as mathematics at A-level. This could pose a dilema when trying to choose which of the subjects to take at university. There is a wide range of science and engineering degree programmes (as you'll see from a quick look at the UCAS website!). Many of them involve combinations of subjects, ranging from the obvious: mathematics and physics; to the less obvious: chemistry and politics.

Single Honours versus Joint degrees - which is best for you?

So if you choose to take a joint degree at university, how much time will you spend on each subject? There are some clues in the language used in the degree title – If you apply for a degree in biology then you will be spending the majority of your time taking modules in that subject, with a few other options available to you. A joint degree, such as mathematics and physics, means that you will be splitting your time equally between the two. The last variation you could potentially see will be a degree title such as chemistry with computer science where you'll be spending around two thirds of your time on chemistry and one third on computer science.

There are advantages and disadvantages to all of these different types of combinations. By taking a single honours degree you will gain an in-depth knowledge of your chosen subject. If you are considering a technical career after university, it may be more useful to have a more detailed knowledge.

A joint degree gives you a broad knowledge of two subjects and the associated transferable skills. However, unlike the single honours degrees, you will not get down to the same level of detail. But you will get a good, broad knowledge of your chosen subjects. Generally, the two subjects you will be studying are complimentary. For example, a joint degree in mathematics and physics will see you studying maths modules that will help you gain a greater understanding of the derivation of physics theories, which is very useful. Another reason for your choice could be that you really enjoy two A-level subjects and can't choose between them.

Often, there can be a more vocational aspect to the degrees. For example, a degree in Chemistry with Forensic Science will give you an excellent knowledge of organic and physical chemistry while gaining some specific knowledge of forensic science which you could apply to a job in that field.

Natural Science

Another excellent example of a degree programme involving more than one STEM subject is Natural Sciences. This course is offered as a flexible option by a number of universities, including Queen Mary, University of London. It allows you to study more than two science subjects. The areas covered include subjects such as maths, chemistry, biology, computer science, physics, materials and geography. You can choose to focus on two or three of these subjects or combine modules from all of them. You decide! This is ideal for people who enjoy a combination of subjects.

Then there are the new, inter-disciplinary degrees which combine several STEM subjects. One example is Nanoscience and Nanotechnology. This requires a knowledge of physics, but you will also be taking chemistry, biology and business-related modules as part of your studies. Nanoscience is helping us to develop new materials and solutions to problems. For example, when it comes to drug delivery, Nanoscience can help with the design of a capsule which will deliver a drug to a patient over the course of 12 hours. This removes the need for patients to take their prescription at regular intervals – something that a lot of people forget to do. More and more inter-disciplinary degrees are emerging, due to collaboration at research level between scientists in different fields.

Languages

Finally, you will find that STEM subjects are sometimes combined with a language. The entry requirements for these generally mean that you will need to have an A-level in your chosen language. However, if you are interested in learning a language and don't have an A-level in the subject, then this is something you can pick up at university. For example, at Queen Mary we offer modules in a variety of languages, from beginner to advanced level, which will count towards your degree.

In the end, the most important aspect to your decision making is that you choose something you enjoy studying. The vast majority (over two thirds) of graduate jobs are open to graduates with any subject, therefore it's important to perform well at university and this is something you will find much easier to do if the subject you're taking is something you're really interested in.

Why Maths Matters

As you start your research into choosing a degree, you may also be thinking about which of your current subjects to take on to A2. One extremely useful subject is mathematics. There is a vast number of areas where it can be applied and it is a requirement for some degrees. However, even if it isn't an official requirement in a university prospectus, if you are thinking about taking a science or engineering subject at university a mathematics A-level could really help you with your studies.

Mathematics is often described as the language of science – and rightly so; nature obeys mathematical rules. However, it is of course a subject in its own right and although many advances have been made, there are still some open problems. Some of these even have prize money for those who solve them. For example; the seven Millenium Prizes set by the Clay Mathematics Institute – only one has been solved, so there is plenty of prize money still up for grabs! Many of the advances made in trying to solve these problems can be applied to science. There are many uses of mathematics in science and the examples below are by no means exhaustive, just a flavour of how we could use maths.

Mathematical Modelling

"Most school maths is a total waste of time - when did you last use a quadratic equation for your Tesco shopping?" So said a politician during a recent radio interview about maths education. Any graduate engineer or scientist hearing that statement would have been totally horrified. If the limit of useful maths skills really was memorising 'times-tables' then the industrialised world and modern civilisation would grind to a halt. For example, without mathematical modelling hardly any of the products that enhance our quality of life or our economic prosperity would exist.

So what is mathematical modelling? The design of a very simple product such as a basic D.I.Y. tool will be optimised by testing a full-scale prototype and then refining it by trial and error. For more sophisticated products, small-scale models might be made. For instance, a model of a car can be tested in a wind-tunnel to measure aerodynamic drag and hence increase the fuel efficiency of the final design. However, the data obtained from such physical models is limited by errors from the scaling effects and boundary conditions. A mathematical model is the next level of sophistication above a physical model. In this case the model is generated within a computer rather than within a physical laboratory. If the engineering program has all the relevant data related to the geometry of the product and its material properties, together with accurate equations that fully define how parts interact with each other and their surroundings, then far more accurate tests can be performed.

In the case of a physical model, if the value of force, strain or other output parameter is required at a thousand different points then a thousand measuring devices must be placed around the model. In the case of a mathematical model the amount of data collected is limited only by the resolution of the engineering program and the available computer memory, so a million points could easily be investigated. When the test output data from a physical model suggests modifying the design shape or material selected then a new physical model must be made before further testing can proceed. In the case of a mathematical model such changes are easily made by modifying the input data to represent a different configuration. The engineer can rapidly investigate many different design modifications in this way without waiting for a range of different physical models to be manufactured.

Calculus

As well as mathematical modelling, there are a number of different tools used by scientists and engineers. Practical research in the field of chemistry is carried out in the laboratory and for this you will need a good understanding of fractions and decimals to help with taking measurements. When it comes to the analysis of data collected, you will need a good understanding of statistics in order to manipulate the data and draw conclusions. In terms of theoretical work, algebra and calculus are important to help balance chemical reactions and deal with equations which have multiple variables.

In the field of physics, mathematics has always been very much in evidence. The most common example you will encounter during your A-level will be making use of calculus in mechanics. However, at university, calculus is used for a wide variety of topics in physics, including areas such as general relativity, thermodynamics and quantum physics. In addition to this, probability and statistics are vital tools when you want to understand the quantum world. Nothing behaves in a completely definable way on that scale – something which upset Einstein, leading to his famous quote: "God does not play dice". He worked for a long time to find an alternative to the theory, but quantum physics has been thoroughly tested experimentally and is widely accepted. That's not to say that physicists' work is done; there are many unanswered questions and lots of advances still to be made – with the help of mathematics.

Networks

The study of networks can help us to understand some very complex relationships. There is the established "six degrees of separation" which states that everyone on the planet is connected to everyone else through six different people, on average. This means that you know someone who knows someone who knows someone who knows someone who knows someone who knows Barak Obama. However, when it comes to biology, the mathematics of networks can help us to understand how disease and infection are spread – an analysis which has become very important with the outbreak of Swine Flu originating in Mexico. Understanding how disease spreads influences how the health services and governments respond to outbreaks.