



Queen Mary
University of London

**OnQ: Special Edition Science, Technology,
Engineering and Maths (STEM)**

on



Issue 4

Image: NASA/PL/Space Science Institute

Letter from the Editor

Welcome to our 4th Special Issue of OnQ on Science, Technology, Engineering and Maths (STEM). As the popularity of these subjects continues to rise, we are aiming to highlight the career opportunities in these areas to current A-level students. In this issue you will also find a subject profile on Chemistry and an industry focus on the Space Industry.

We also give a round-up of recent research developments in a variety of areas where specific degree programmes are available: these range from computer science to medical engineering. Details on our exciting competition with the Metro newspaper – Cosmic Futures – is also included for you to pass onto your students.

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 Manager

Bumblebees find New Careers as Travelling Salesmen

Researchers from the School of Biological Sciences at Queen Mary, along with colleagues at Royal Holloway, University of London, have found that bees learn to fly the shortest possible route between flowers. This is a solution to a complex mathematical problem called the “Travelling Salesman”.

In this problem, the salesman has to find the shortest route between locations whilst still visiting each one. Computers calculate solutions to this by measuring the length of all possible routes and comparing them. Bees have shown the complexity and potential of their seed-sized brain by learning to fly the shortest route quickly.

Professor Lars Chittka said: “In nature, bees have to link hundreds of flowers in a way that minimises travel distance, and then reliably find their way home – not a trivial feat if you have a brain the size of a pinhead! Indeed such travelling salesman problems keep



supercomputers busy for days. Studying how bee brains solve such challenging tasks might allow us to identify the minimal neural circuitry required for complex problem solving.”

By understanding better how bees can solve their problem so quickly, we could improve our management of everyday networks such as road and web traffic without using so much computing power.



Queen Mary Launches Joint Competition with the Metro Newspaper: Cosmic Futures

With tips and advice from experts, students are challenged to create their own article, poster or photo essay that tells the general public that the British Space Industry is going places. The work created will be judged by an expert panel and there are an exciting range of prizes available, including books signed by British-born astronauts Piers Sellers and Richard Garriott and the chance to see how a real newsroom works at the Metro. Our first prize is the opportunity to create an exciting new magazine. For more information and guidance on what we're looking for visit the competition website: www.cosmonline.co.uk/cosmic-futures

Materials Physics Breakthrough Could Lead to Single Computer Chip for Processing and Memory

The technology used by computer hard disks and computer processing is different. Whilst hard disks use something called “Spintronics” (spin transport electronics) which involves using the magnetic properties of an electron (called spin) to detect the data stored in bits, computer processing relies on electrons flowing around a circuit etched onto a microchip.

“This is especially exciting, as this discovery has been made with flexible organic semiconductors, which are set to be the new generation of displays for mobile devices, TVs and computer monitors, and could offer a step-change in power efficiency and reduced weight of these devices,” said Dr Alan Drew, from Queen Mary's School of Physics, who led the research. He explains: “While in theory, devices that combine electron charge and spin are conceptually straightforward, this is the first time that anybody has shown it is possible to proactively control spin with electric fields.”

Career Prospects

For Science and Engineering Graduates

Gone are the days when a science degree meant a lifetime of lab coats and test tubes. Did you know that graduates from Science, Technology, Engineering and Mathematics (STEM) are some of the most sought after employees in the country? Few subject areas are as challenging or put as many of your skills to the test, which is why graduates from these subjects are still in such demand, and feature so frequently among the highest earners in the country, even in the current challenging job market.

The importance of STEM graduates is linked to the UK economy and its ability to be competitive internationally. According to the CIHE report (Council for Industry and Higher Education) *Demand for STEM graduates*, the workforce of the future will increasingly require higher-level skills as economic circumstances force businesses to adjust what they do and how they do it. These jobs of the future will require people with the qualities that a STEM degree provides. A report on STEM graduates, by Robert Wilson from the Warwick Institute for Employment Research, suggests that “apart from medicine, the demand for most STEM subjects is likely to grow faster than for other disciplines over the coming decade.”

However, what does all this mean in terms of actual jobs? Although the graduate job market has experienced tough times recently due to the world-wide recession, according to the

report Graduate Vacancies 2010, by High Fliers, employers have recruited 17.9% more graduates to start work in 2010 than in 2009 and within this growth, there have been substantial increases in finance, and accounting (always popular areas with mathematics graduates). Even more encouraging for STEM students is that the IT and Telecommunications sectors are set to recruit three quarters more graduates in 2010 than in 2009.

In the most recent First Destinations Survey, the median salary for graduates in 2008/9, for both male and female qualifiers, was £20,000. However, for graduates in STEM subjects, the figures were much higher. In the Times Good University Guide, Engineering and Computer Science featured frequently in the top twenty for graduate salaries with graduates in General Engineering earning £25,455, Mechanical Engineering £24,446, Aeronautical Engineering £23,464, Electronic Engineering £23,276, Physics £23,275 and Computer Science £22,276.

So what kinds of jobs do STEM graduates do? Naturally, some STEM graduates will opt for further study or a job in a science related field after they finish their degree. Indeed, science graduates, especially those from physics, chemistry and biology are more likely to enter further study and training than those from other disciplines

However, irrespective of the area of science and technology that they have studied, many STEM graduates find jobs that are directly or indirectly relevant to what they studied, for example environmental scientists become environmental officers or technicians, biology graduates might opt for careers as biomedical researchers or pharmacologist; or electronic engineering graduates could become broadcast engineers. In fact studying science can open up opportunities unavailable to those studying other subjects – you can't be a geneticist without a chemistry and biology background!

However, one of the many great advantages of studying STEM subjects is that they open doors

to a variety of sectors, so everything from sales and marketing to business and media. Since around 60-70% of graduate jobs are open to all graduates, whatever their degree subject, STEM graduates will still be eligible for a variety of careers. The DIUS report *The Demand for Science, Technology, Engineering, and Mathematics Skills (2009)* found that less than half of STEM graduates go into STEM related occupations.

The reason that career opportunities for STEM graduates are so varied is largely due to the transferable skills that students will develop during their time at university - qualities such as communication skills, (both oral and written – you will have to give presentations to your fellow students and write up lab reports), interpersonal and team work skills (most courses 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 demanding field are what make STEM graduates so employable.

So if mathematics or physics is your passion you will naturally have a very high level of numeracy (which is why the finance industries love mathematicians). Biochemistry graduates will have knowledge of biotechnology and environmental issues. Engineering students will have high levels of numeracy combined with problem solving ability.

According to a recent CIHE pilot survey of member companies' preferences, employers also value industrial experience in graduates. So when you are researching university courses, you should seriously consider those that offer you the opportunity to do an industrial placement year. Gaining practical experience working on real projects will make your CV more attractive and ensure you stand out in a competitive job market. Recent Queen Mary, University of London STEM graduates have gone on to become investment bankers, medical engineers, energy consultants and analytics application developers, so the world is literally your oyster!



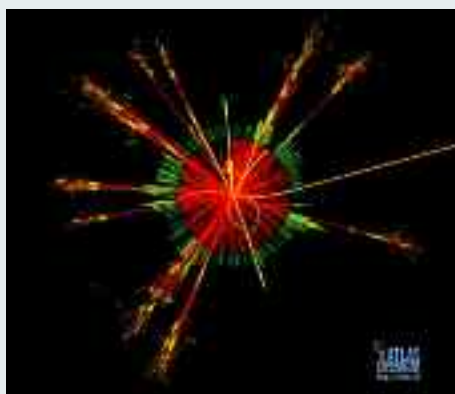
Research-linked Degrees

We have a broad range of degrees available across science and engineering. In this article we highlight some options which are linked to specific research topics at Queen Mary. It is important to realise that the option is there for you to specialise in a certain area, rather than covering a subject more broadly.

Medical Engineering: Students Develop Shocking New Medical Treatment



A group of final year medical engineering students are working on a project to investigate whether shock waves can be used to clean and unblock metallic stents implanted into patients. The stents are used when a patient's ureter (a tube that carries urine from the kidneys to the bladder) or urethra (the tube that drains the bladder) become blocked or damaged. The stent is a cleverly designed coil of metal that goes inside the ureter or urethra and keeps it open allowing the urine to flow naturally. However the stents can sometime become blocked with mineral deposits from the urine. The group of students are investigating whether shock wave lithotripsy (SWL), which is used to destroy kidney stones, can be used to blast the encrusted mineral deposits from the stent thereby allowing it to function again. The group are working closely with one of the stent manufacturers, PN Medical, as well as a team of urological surgeons and academic researchers from the School of Engineering and Materials Science. The students have developed a system for artificially encrusting the stents and then firing shock waves at them using a clinical lithotripter. The stents are then examined using techniques including scanning electron microscopy, to quantify the effectiveness of the treatment. If successful this new technique could transform the treatment of hundreds of patients whose stents become blocked and would otherwise require invasive surgery. www.sems.qmul.ac.uk



Physics with Particle Physics: Black Hole Hunting

Final year students have the opportunity to probe the foundations of the Universe and understand the forces at work. The independent project sees students working under the guidance of an academic member of staff, often on an original piece of research. When the Large Hadron Collider (LHC) was launched, there were some discussions in the news and online of whether a black hole would

be created which could potentially destroy the planet. Whilst this wasn't the case (to find out exactly why not you can search online), there is still the chance that micro-black holes could be created when particles collide at high energies in the LHC. One student project looks at the different theoretical models and then compares the result with simulated data at the LHC. Through this project students become familiar with the computational tools commonly used in particle physics. Students taking this degree programme may have an interest in pursuing an academic career in particle physics or may just want to find out as much as they can about the field. www.ph.qmul.ac.uk

Audio Systems Engineering: Become an Online Guitar Hero

This subject focuses on how computers and electronics shape electronic music instruments, digital audio systems, music downloads, sound effects and games. Research students in the Centre for Digital Music have created a new online tool to help you learn to play the guitar. Mathieu Barthet explains why they came up with the idea: "You fancy giving someone a surprise by playing a guitar song for them, but lack inspiration. Or you are really full of motivation but need a little help to know where to place your fingers to make sure you're on fire at the performance. We designed HOTTABS to make it easy for you." The program is a one-stop-shop for amateur guitarists looking to learn a new tune. Songs, video tutorials and guitar chord charts are sourced from existing sites and presented to you indicating the different levels of difficulty. The knowledge and skills from this kind of degree are flexible and a creative approach to finding solutions to problems is encouraged. www.eecs.qmul.ac.uk



Focus on: The Space Industry

The UK is leading the field when it comes to Space. We have an industry worth nearly £6 billion which employs over 68,000 people – the majority of them graduates. Between 1997 and 2007, the industry grew at an average 9% each year and in the next 10 – 20 years, the sector is expecting to grow further to employ around 120,000 people with two thirds of those being Science, Technology, Engineering and Maths (STEM) graduates. There is not one subject within these which is preferred for the Space industry, many disciplines - from astrophysics and biophysics to computer science and aeronautical engineering – are required to help the sector to continue to thrive and grow.

Who is in Space?

The companies that make up the Space Industry vary from communications and broadcasting to spacecraft and satellite design.

With organisations such as NASA withdrawing funding for human spaceflight, governments are increasingly looking to the private sector to drive innovation. In 2004, SpaceShipOne carried out two flights within two weeks to reach 100 kilometres above the Earth and as a result was awarded the Ansari X prize of \$10 million. This project has evolved into the commercial concern Virgin Galactic – an extension of Virgin Atlantic run by Richard Branson – which aims to fly tourists into space for short trips. In 2008 if you had wanted to visit the International Space Station, you could go with a US company called Space Adventures for \$25 million. This would get you 10 days on board with a flight with the Russians on their Soyuz spacecraft which has been in service for decades. Within the next 20 or 30 years as more and more companies like Virgin Galactic grow, the cost for people to fly into space will decrease. To book one of the first seats with Virgin Galactic it will cost you £200,000 but as advances are made in technology this should become more and more accessible and eventually flying into space could be as easy as taking a budget flight from London to Glasgow. Graduates are required to design and build these spacecraft and the field will also require qualified Pilots and Technical Maintenance staff. As with any business, the normal finance, marketing and human

resources functions also need to be carried out. The subjects suitable for this field would be varied: physics, mathematics, aeronautical, mechanical and structural engineering would all be appropriate.

Satellites are key to many aspects of our communications and broadcasting: whether we are route-planning using GPS in our cars or sitting down watching the FA cup final on television, without satellites none of this would be possible. In order for the satellites to operate, graduates are required to design, test and build as well as operate and maintain them whilst in use. The network of satellites used by BSkyB are leased to them by an operating company. This company has to manage where they are and ensure they are working correctly. One of the dangers to satellite operations is the Sun: it frequently ejects high energy material out into the solar system which, if it hits the Earth, can damage satellites and stop them from working. However, the satellites are designed so that they can be protected and if lots of activity is detected at the Sun, action can be taken to protect them. In addition to broadcasting, there are companies such as Avanti who provide broadband connections using satellites. The most common way in which your internet connection is provided is through a cable, but there are remote areas of the UK which don't have a connection and the speed of connections can vary widely. The benefit of using satellites is that they can cover a wide geographic range without roads having to be dug up and the quality of the signal can be uniform.

Planet Hunting

There are also opportunities for UK companies to contribute to pure science research. NASA recently announced updated results from their Kepler mission. This satellite observes stars within our galaxy with the aim of identifying planets orbiting around the star. It does this by measuring the light coming from the star. If the light from the star drops with a regular pattern, then we know that it is due to a star passing in front of it. Since its launch in 2008, it has detected over 1200 extra-solar planets and 54 of those have the potential for hosting life as the temperature of the planet is such that water can exist in liquid form. The light detectors that were launched on the spacecraft were designed and built in the UK. Other companies such as Logica provide computational and planning support for missions which can involve writing software for use by the satellites and planning in terms of logistics for launch.

The application of law and insurance in space are also growing fields. As there are more and more companies who are aiming for space flights, there is a need for regulation of the industry to ensure that health and safety standards are maintained. In addition, with billions of pounds being spent worldwide on satellite systems and spacecraft, insurance against accident in transit before launch and during launch are a critical part of the mission.

For further information on careers in space and the UK space industry visit:

UK Space Agency

www.ukspaceagency.bis.gov.uk

The UK Space Education Office

www.esero.org.uk

Chemistry Connections

Chemistry is a subject which is at the heart of many industries and areas of work. Its principles are applied to create life-saving drugs (only a Chemist has the knowledge to prepare small molecules and test them as new medicines; contrary to popular belief, no Medical Doctor has ever discovered a new drug), solve crimes through forensic science, restore works of art and create new textiles, fabrics and dyes. The modern perfume and skin care industry is a huge employer of Chemists, to prepare safe new perfume ingredients. Chemistry graduates can also be found in the field of Law working as Patent Lawyers. With a degree in chemistry, you can enter a career in these and many other fields.

By studying chemistry you will gain an understanding of the connections it has with biology, medicine, physics and mathematics. You also develop important transferable skills and techniques allowing you to apply your knowledge in your chosen field. Problem solving, numeracy and communication skills are highly desirable to employers and these will be developed throughout your chemistry studies. As a chemistry graduate you will be literate – familiar with reading complex scientific papers and explaining them in simple ways, numerate – confident with mathematical concepts, practical – you will spend many hours in the practical laboratory learning manual laboratory skills and techniques and finally, you will have excellent presentation skills, through presenting your findings to colleagues and staff throughout the course. Our approach is very successful and in the 2010 National Student Survey we were ranked number 1 in London for student satisfaction.

There are many employment options outside of the field of chemistry - a large number of graduates go into a job which is not related to their subject of study. However, due to the skills gained during your degree, you are well placed to enter into fields such as business and finance where there are a wide range of opportunities.

It can be daunting when you are trying to choose which chemistry degree programme or qualification is best for you. Over 700 are listed on the UCAS website for 2011 entry and these are either single honours or combined subjects. For those looking for a solid grounding in the subject we suggest a chemistry degree programme, either as a three year BSc or four year MSci. At Queen Mary, these incorporate a foundation of organic, inorganic and physical chemistry in each year, together with interdisciplinary modules in spectroscopy, mathematics and biochemistry. The four year course is particularly suited to the professional

chemist. One of the most popular features of all the programmes is an extensive final year research project, where students have the opportunity to join research groups tackling real problems, often in collaboration with other institutions or with industry. All degree programmes offered are recognised by the Royal Society of Chemistry.

Industry Insight

There are a range of combined or specialised courses in the field of chemistry. For example, one option that is available is a four year MSci degree in Pharmaceutical Chemistry. This is suitable for those particularly interested in a research career designing and developing new medicines in industry or academia. Again, this covers the basics of organic, inorganic and physical chemistry, it has additional modules in organic chemistry for drug synthesis, medicinal chemistry, pharmacology and drug action.

It is particularly important to gain work experience and develop your transferable skills whilst at university. For some degree programmes, it is possible to gain work experience through an industrial placement in the pharmaceutical industry but this will depend on the university you are applying to. At Queen Mary, our Pharmaceutical Chemistry with a Year in Industry four year MSci programme allows you to spend the entire third year working for a company such as Glaxo SmithKline or Pfizer as a paid employee, but your work also counts towards your final degree. This can open up opportunities for employment after graduation.

Combined Degrees

You will find that there are many areas of study complimentary to chemistry. If you are interested in chemistry at the interface with biology, options include 3 year BSc degrees in Biochemistry and Chemistry with Biochemistry.

In addition, if you enjoy studying chemistry but are also fascinated by the business and financial side of industry, or fancy a career in the City, you can combine your chemistry studies with business management. At Queen Mary many of the graduates from this course have gone on to be managers in biotechnology and chemical companies.

It is important that you carry out thorough research into the universities you are interested in applying to. You should pay particular attention to the module content for the courses at each university as they will not all be the same. This can mean visiting them on an Open Day. However, academic departments have individual outreach programmes which allow you to come along and experience the environment in which you will be taught the subject. For example we run events in the summer for Year 12 students on spectroscopy. www.sbcs.qmul.ac.uk