

This issue includes updates from a 2007 biomedical engineering graduate, a 2006 mechanical engineering graduate and a current student. There's also a report on new biomedical engineering research in NUI Galway, and a look at some of the engineering issues behind the recent air accident in New York.

NUI Galway offers level 8 degree courses in **Mechanical Engineering (GY405)** and **Biomedical Engineering (GY408)**. Both degrees are also available through the Undenominated Engineering entry (GY401).

More information is available at www.nuigalway.ie/mechbio. Don't hesitate to contact us at (091) 492723 or mechbio.eng@nuigalway.ie if you'd like to talk to teaching staff or arrange a visit to the campus.

Jacqueline O'Gorman is designing a life-saving device in Galway.

Jacqueline O'Gorman is a Research and Development Engineer at Novate Medical Ltd., developing devices to protect patients with deep vein thrombosis (DVT), a common condition in people who have undergone prolonged bed rest or periods of immobility. In DVT, clots form in the veins of the lower legs. They can break off and travel via the vena cava to the lungs, where they can cause a potentially fatal blockage (pulmonary embolism). Since completing a Biomedical Engineering degree in 2007, Jacqueline has worked on new technology for vena cava filters that catch these clots and help to break them down before they reach the lungs. Here she writes about her education, her current work and the direction her career has taken so far, working in large and small medical device companies.

Working in research and development for a smaller company like Novate, I've had opportunities to develop my skills in a range of areas. I design products, create prototypes, develop test methods, oversee manufacturing and perform presentations. With Novate I've worked with the design of the filter for its whole lifetime - from concept stage through to design verification and validation testing (one of the major steps before approval of any product for sale).

The biomedical engineering course in NUI Galway was a good starting point. The course enables you to start your first job as a graduate with a good understanding of the medical device industry and the skills and education to be an asset in any sector – research and development, manufacturing engineering, process development, etc. There are lectures and labs in a wide range of subjects including elementary engineering and medical subjects along with tailor made biomedical engineering subjects.

I performed my PEP (professional experience programme) in a very large company, Boston Scientific in Galway. There is a lot to learn about how medical device companies work – how they are divided into different departments, how they are controlled and regulated and also how a medical device is produced. During my placement there I worked with a team developing new manufacturing methods for stent systems used in minimally invasive treatment of coronary artery disease. My final year project was a continuation of some of that work. My project also helped me to understand how a project runs and how best to manage time and resources. Almost everything I learned during my final year project can be used in my everyday working life.



www.nuigalway.ie/mechbio

Brian Diskin
puts his designs to the test in the Gulf of Mexico.

Brian Diskin works in the projects department of MCS Advanced Subsea Solutions, a Galway-based company with worldwide offices providing services for the offshore oil and gas industry.

My Mechanical Engineering degree gave me the skills I need for my job at MCS and the ability to approach an engineering problem. I was introduced to MCS at the end of third year, when all students are sent on a 5-month placement in different companies. This introduced me to the working life of an engineer, and led to a final year project working with the same company, analyzing different offshore oil systems based on their cost and their performance in cyclone conditions.

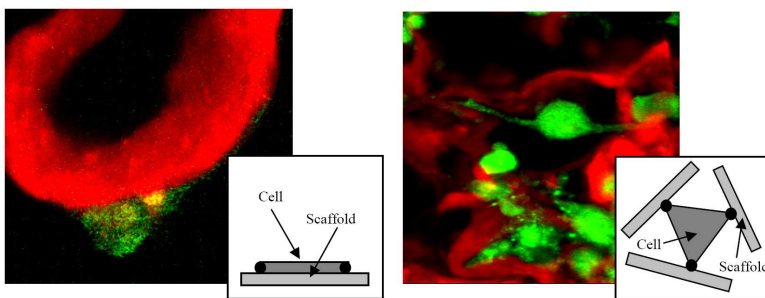
I've been employed by MCS since shortly after graduation in 2006, and since then I've worked on several projects with clients in the offshore oil and gas industry. For each project, I first talk to the client and gain an understanding of the design problems they are encountering. Then I use specialised software developed by MCS to simulate these scenarios and, working with other MCS engineers, we can devise a solution and report to the client.

On one project, I spent 8 months in the Netherlands on contract to Heerema, an offshore installation company. My job was to develop a procedure to recover several flowlines that were lying on the seabed more than 2000 metres underwater, using the various cranes, winches and vessels available. I then spent a month and a half offshore to oversee my procedure being implemented on the Thunderhorse oil rig in the Gulf of Mexico.



Understanding living structures

The aim of tissue engineering is to grow parts of the body in a laboratory so that patients can have readily available natural replacements to repair an injury. The basic ingredients are cells (the building blocks), artificial scaffolds (structural support to direct the growth of cells), and nutrients. In order to prompt many billions of cells to grow into a particular tissue type (bone, tendon, cartilage or even muscle), certain conditions are required. For example, for tendon growth, the cells require an environment that matches that of native tendon: lots of stretching and pulling. When the scaffold is stretched in the laboratory, the cells on it are also stretched. But exactly how much stretch is required to signal cells to grow into tendon? What forces and stretch does a cell experience when its scaffold is loaded?



Engineers at NUI Galway are working on these questions in collaboration with a team at TCD. This research recently featured as the cover story in the Journal of Biomechanical Engineering, one of the most important international publications in the field. After developing a computer representation of cells on a scaffold, NUI Galway postgraduate student Adam Stops found that two distinct kinds of cell stretch occur. Cells that spread

over the surface of a single scaffold strut (left) undergo very small stretches. However, cells that bridge two or more struts of the foam-like scaffold (right) are subjected to very large stretches, because the struts move and bend into different orientations under the applied load, and the cells are dragged in tow. These results allow the stretch magnitudes of cells to be predicted. If a tendon is required, for example, the tissue engineer now knows how the scaffold should be loaded to give the correct cell stretch in order for the cells to grow into a tissue ready for tendon replacement.

At NUI Galway, biomedical engineering students explore these topics in projects and courses on biomaterials, tissue engineering and biomechanics, expanding on the engineering mechanics and biology of the first part of the degree programme. This research is a classic example of the crossover that defines biomedical engineering.

How to land a 77-tonne airliner gracefully without engines

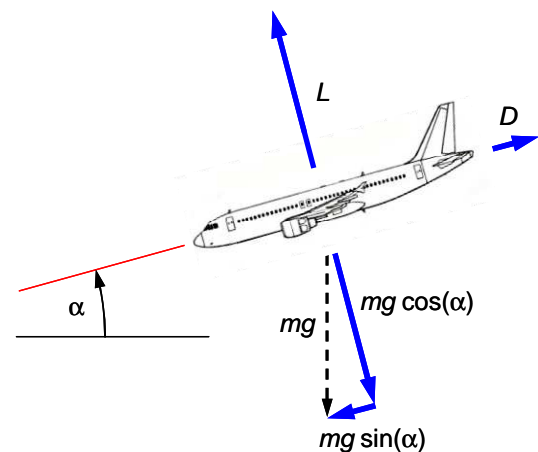
The full story of the recent Hudson River ditching won't be known until the official investigation report is published. However, preliminary reports suggest that the Airbus A320 ingested a Canada goose into each engine while climbing at a height of about 980 m, and lost all thrust almost instantly. The safe outcome of this extraordinary accident is due not only to the skill and professionalism of the Captain and First Officer, but also to the team of engineers who designed, developed and tested this aeroplane.

The role of the structural engineer in the aerospace sector is to design lightweight structural assemblies in compliance with the aircraft's performance requirements and airworthiness regulations. Normal operation, ground, failure and crash load-cases are usually considered in the design phase of a new or variant aircraft. The recent incident in New York demonstrated the remarkable skill of the pilot in that the airframe of the A320 remained intact and that one powerplant did not detach from the underwing pylon. Thus the airliner was ditched within structural design limits, and the survival of all passengers and crew onboard was assured.

– Rory Canavan

Rory Canavan holds mechanical engineering degrees from NUI Galway and is formerly a Senior Stress Engineer with Airbus UK, Filton. He was Lead Stress Engineer responsible for the structural analysis and design of the Airbus A400M wing ribs and wingtip. He has also worked on the A350, A380 and A340-600 programmes and in the Composite Wing research and development team. Rory is currently Design Manager at ÉireComposites Teo, Indreabhán, Co. Galway, where the company designs and supplies composite parts and assemblies for a range of major aerospace manufacturers.

Any object moving through the air experiences an aerodynamic force. It's useful to consider this force as a sum of drag (acting in the direction of motion) and lift (perpendicular to motion). Drag is a resistance to forward motion, while lift appears as the sideward force on a spinning ball, the downforce on a racing car, or the upward force on a wing. For a well-designed wing, lift is much larger than drag. In the diagram, an aircraft without thrust is shown descending at an angle α . The aircraft's weight vector resolves to a force $mg\sin\alpha$ acting down the slope of the flight path and a force $mg\cos\alpha$ perpendicular to flight (where m is mass and g is acceleration due to gravity). To maintain an equilibrium glide, the pilot must set the glide angle and configure the wing so that the drag D and lift L balance the corresponding components of the weight force. This can be expressed mathematically as $D = mg\sin\alpha$ and $L = mg\cos\alpha$. It then follows that $D/L = \tan\alpha$. Modern airliners have lift-to-drag ratios L/D of 15 to 20 in cruise, allowing them to glide at angles less than 3° . Gliders have L/D over 60 and the Space Shuttle orbiter (a special glider) makes steep descents with $L/D \cong 4.5$. In the process of aircraft design, engineers measure and refine both lift and drag through wind tunnel testing, computational simulation, and mathematical modelling.



Airbus engineers equipped the A320 with a "ditch switch" that automatically seals off all external valves and ports to delay flooding. Like most airliners, it also has an auxiliary power unit (a small gas turbine engine mounted in the tail), a battery system and a ram air turbine (similar to a small external wind turbine) to power critical hydraulic and electrical systems (such as the flight controls) in an emergency.

The issues of mechanics, aerodynamics and control highlighted in the Hudson River incident are central themes in the mechanical engineering programme. Courses in mathematics and physics (experimental and mathematical) in the earliest stages lay a foundation for advanced courses on mechanical analysis and design, fluid dynamics (including aerodynamics), turbomachinery, automation and control systems. Biomedical engineering students also take many of these courses, but focus on medical applications as the course becomes increasingly specialised in the third and fourth years. Full details of the degree course are available at www.nuigalway.ie/mechbio.

Caoimhe Sweeney
is three years into her
mechanical engineering degree.

I always enjoyed mathematically based subjects in secondary school. As well as maths I did applied maths, chemistry and physics, so science or engineering seemed to be the options for me. I chose engineering because it seemed more practical with a broader and more useful range of topics. Other than that, I didn't know much about the engineering courses and so I chose undenominated engineering for my first year. This is a great option if you don't know what kind of engineering you want to do, but if you do have an idea, I'd advise you to go straight into your chosen course. While I did get a better all-round knowledge of all the engineering courses, I missed some of the practical work that mechanical engineers take in first year.

Before I started the course, I was worried that I wasn't very knowledgeable about computers and technology – but the programme starts from the basics and builds up a good foundation for the following years. Some of the first year subjects were less challenging because I'd had a lot of science at school, but others were totally new to me. There were a lot of theoretical subjects, so when in the second semester in our Fundamentals of Mechanical Engineering course we were given the task of designing and building a small vehicle to transport a load over a small distance, it was a change and a challenge. We had lots of fun with it and it was the first taste of the mechanical engineering design process.

In the second year I chose to join the mechanical engineering programme. It seemed to me to cover a broad range of subjects and offer a lot of opportunities. Second year built on first year's material. Each year has fewer timetable hours but more lab work, projects and assignments than the last year. Engineering is very project-based. Third year is a lot of work – it's a big step up from second year. You have a lot more responsibility to get the work done on time but that's an experience you need before you go out on placement.

Important dates for 2009 school-leavers

1 February	Closing date for initial CAO applications
25 April	NUI Galway Open Day
1 May	Closing date for late CAO applications
19 June	End of Leaving Certificate
1 July	You're free to change your CAO preferences at any time up to 1 July, at no extra charge.

The mechanical engineering course in NUI Galway is quite broad. So far it has covered analysis and design, fluid mechanics, thermodynamics, electronics, metal and polymer materials, programming and computer aided design. To my surprise, the area I find myself most interested in is the computer programming side of things. Before the course I would have cringed at the thought of it! This involves writing code to create a program for engineering tasks like iterative calculations, plotting graphs, sorting data, displaying images to screen, altering data and images etc. Every piece of software on a computer has lots of code written behind it. In the course so far we've covered Fortran, C (very widely used), Matlab and Visual Basic.

In the summer between third and fourth year all NUI Galway engineering students go on a work placement for 5 months. Placement is usually in companies all over Ireland, but some are overseas and you have the option to organise your own placement. Mine will be with Dassault Systèmes in Providence, Rhode Island, USA. Dassault develop software for computer-aided design and simulation, which are vital tools in designing products and solving real life engineering problems. While on placement I will be contributing to the code behind the software and testing it. I'm really looking forward to the trip and the engineering experience.

NUI Galway is a friendly campus. There is something for everyone to get involved in. Engineering is one of the busiest courses but a lot of the engineering students I know are really involved in the clubs and societies, taking positions on committees and going on trips. I got a taste of loads of different sports like aikido, kayaking and climbing, and I'm on the swimming committee this year. The social life is full, though there's less time for it this year. All the students in mechanical and biomedical engineering get to know each other well, and I've made friends for life out of the course.

After I finish my degree I might immediately start a job in industry, do a postgraduate degree or do some travelling. I don't know yet exactly what I will do, but I hope to do all three at some stage and maybe combine travelling with getting some work experience abroad. I don't know the exact area I want to specialise in yet, but I get closer to that every year.

