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mech + bio

News and stories from Mechanical and Biomedical Engineering in NUI Galway

NUI Galway
OÉ Gaillimh

In this issue

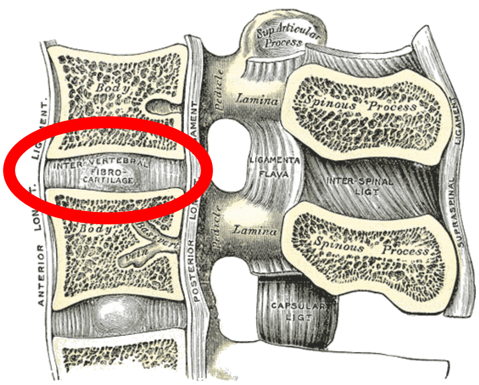
career updates from biomedical and mechanical engineers, two years out of college • mechanical engineering in the latest generation of airliners • biomedical engineering for a healthier spine

NUI Galway offers level 8 degree courses in Mechanical Engineering (GY405), Biomedical Engineering (GY408) and Energy Systems Engineering (GY413). These degrees are also available through the Undenominated Engineering entry (GY401).

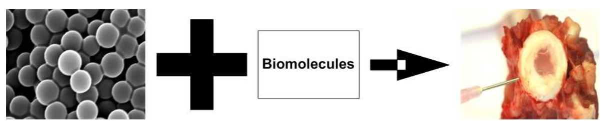
More information is available at www.nuigalway.ie/mechbio. Do contact us at mechbio.eng@nuigalway.ie or (091) 492723 if you'd like to talk to teaching staff or arrange to visit us.

Engineering a solution for back pain

Back pain is so widespread that often we think of it as an inevitable part of life, rather than a disease. Up to 80% of people will experience it, and for 20% it becomes debilitating at some stage. Biomedical engineers in NUI Galway are working to understand and treat diseases of the back by applying engineering techniques and creating substitutes for damaged body parts.



The main cause of back pain is degeneration of the intervertebral disc (IVD), the soft pad that lies between the vertebrae of the spine. The disc consists of a gel-like centre, known as the nucleus pulposus (NP), surrounded by the annulus fibrosus, a ring of fibres and cartilage. Because of this unique structure, the disc allows flexibility of the spine, but limits bending under high loads. Degeneration of the disc can be caused by abnormal mechanical stresses (due to bad posture, for example), biochemical imbalances, poor nutrition or genetic factors. As the natural aging process continues, the gelatinous nucleus pulposus region is gradually replaced by a less flexible cartilaginous disc. The current treatments for neck and back pains include short-term relief treatments (massage, heat and cold therapy or medications), conservative treatments (exercise, acupuncture or manipulation) and, for the worst cases, surgery. However, surgery is invasive and risky.



Biomedical engineers at NUI Galway are pursuing a new approach. The strategy is to develop an injectable gel containing hollow nanospheres. The gel will structurally restore the mechanical properties of the intervertebral disc, and the nanospheres can be loaded with biomolecules to provide some additional therapy. For example, a gene therapy approach may be used to simultaneously inhibit degeneration and promote normal matrix turnover in a diseased disc. The injectable gel can be delivered directly and simply into the intervertebral disc. This is a safer and much less invasive option than surgery, with the potential to make life better for many people.

Conor Allen

the missing link between kayaking and biomedical engineering

Having completed a Degree in Biomedical Engineering in 2007, and after spending four months on a J1 Visa playing GAA under the bright lights of New York City, I started working in Creganna Medical Devices. Creganna is a Galway-based company, specialising in the design and manufacture of minimally invasive devices that surgeons use to position implants such as stents and filters in the human body. The Applications Engineering Group, which I'm part of, is charged with the responsibility of bringing ideas from concept right through to manufactured medical devices.

My degree in Biomedical Engineering is hugely advantageous to me and to my employer. With the broad base of skills within the degree, you have the ability to switch in any one day between the roles of Anatomist, Mechanical Engineer, Manufacturing Engineer and at times even a Salesperson. In my current role, for any given project, we want to deliver device A which performs action B to a location C in the body. Getting device A to location C without affecting the performance of B is the tricky bit. Therefore a knowledge of the anatomy of the target area is essential, whether it's neurological (the brain), cardiac (the heart) or peripheral (the rest of the body). A knowledge of mechanical engineering is also vital so that the device is strong enough to get where it needs to go, but small enough not to affect the blood supply and cause further damage – in some cases, even in the smallest arteries of the brain. Imagination and creative thinking are also very important.

> "Can you **design** it? "

On numerous occasions, another engineer has handed me a medical device that's been in design and testing for years. He or she says "I need to get that to this artery in the body… can you design it?" followed by "oh, and I need 10,000 of these in two months … and it will have to cost less than our competitor's device." For me, this is what engineering, and biomedical engineering in particular, is all about. It's the practical application of science and knowledge to achieve a goal. It's not always about finding the perfect solution to an equation, but rather about finding the solution that works.

In 2006, I completed my Professional Experience Programme (five-month summer work placement) with Creganna. It was also the year I joined the University Kayak Club. Since then, I have travelled all over Europe with the kayak club including the French Alps, the Italian Alps and Slovenia, experiencing some of the best whitewater rivers in Europe. Later that year, I got to combine biomedical engineering and kayaking. I undertook a biomechanics project on the forces transmitted through the shoulder during one particular kayaking manoeuvre called a high brace, which regularly leads to shoulder injuries in kayakers. With a set of bathroom scales and some trusty volunteers I was able to measure the force transmitted through the shoulder. I then used my mathematical knowledge to calculate the forces transmitted in each muscle and at which point they would be injured. Not only did this allow me to become a better kayak instructor, it also allowed me to combine a knowledge of biology, mathematics and my favourite pastime.

To this day I still combine aspects of my job as an engineer with my pastime of kayaking. A river is the perfect analogy for any engineering project. You start at the top, with the goal of getting you and your team to the bottom. You prepare well, making sure you have all the right equipment. You have to be able to communicate in difficult situations, and most importantly you have to be able to adjust to changing conditions. A surprise can come from a fellow engineer who wants to halve the cost of a medical device, or it might come in the form of a massive grade 4 rapid around the corner that you didn't think was there!

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Lana Woolley

on the flexibility of a mechanical engineering degree

I studied Mechanical Engineering because I enjoyed mathematics, science and technical drawing at school, and I wanted to study something that would encompass all these things and much more. Over four years you get to cover a very broad range of courses, from applied maths and other familiar science subjects in first year to more specialised subjects in later years such as thermodynamics, design, analysis and fluid dynamics. The course is a great platform for a wide range of careers and I liked the flexibility of the degree. Mechanical engineering can lead you into lots of sectors and in lots of roles: oil and gas, renewable energy, aeronautical engineering and biomedical engineering are just a few.

The degree programme in Galway gave me a solid platform for my career. On top of the theoretical side of things you gradually build up other important technical skills, such as CAD and 3-D solid modelling software which are essential for design. In 4th year you learn to use finite element analysis software, which can be used to analyse a prototype design before you build it and perform bench tests. The projects in 3rd and 4th year give you a chance to apply what you've learned and show how important time management skills can be.

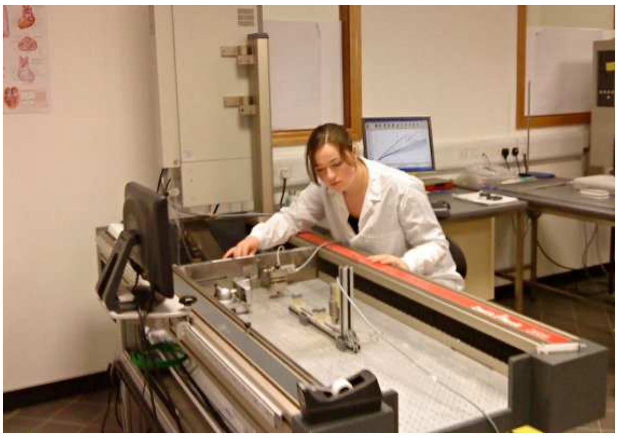
In third year I completed a 5-month work experience placement in a medical device company in Galway which motivated me to focus on a final year project with a biomedical aspect to it. When I graduated in 2007, I spent a few months on a project in NUI Galway looking at the design of paediatric hip orthotics. After this, I joined Medtronic in Galway.

Medtronic is a large multi-national medical device manufacturer. I'm one of approximately 100 people in the very large Research and Development (R&D) department which is just a part of the operation in Galway. Our primary focus is on cardiac rhythm disease management (including pacemakers) and cardiovascular products. We manufacture coronary stents, coronary stent delivery systems, peripheral stent delivery systems, angioplasty balloons, and endovascular stent graft delivery systems, among other things.

...developing a totally new product from scratch...

Since I started here I've had the chance to work on several different projects. I really like that the work I do can be totally different from month to month and year to year. I have worked on products for the coronary applications and others for the peripheral applications, and so I've been able to learn about the differences between products across various parts of the body and sectors of the cardiovascular device market.

I've been on larger high-profile projects that involved bringing a product through the design verification process, legal approval, and product launch. I've also worked on design-phase projects where the focus was on developing a totally new product from scratch.



In such a large company, where you change projects a few times a year, there's a lot to learn. I've been involved in everything from developing new and reliable test methods to overseeing the manufacture of products, process development, design of experiments, and troubleshooting the unexpected technical issues that can arise. The demands of work can vary, but the broad knowledge base from the Mechanical Engineering course prepared me for this.

Important dates in 2010

1 February	Closing date for initial CAO applications
24 April	NUI Galway Open Day – visit us at the mechanical and biomedical engineering stands.
1 May	Closing date for late CAO applications
1 July	You're free to change your CAO preferences at any time up to 1 July, at no extra charge.
mid-August	Special entrance maths course and examination (check for news in August on http://short.ie/zfexkz).

Engineering and Maths

Engineers need strong problem-solving skills and mathematical ability. Usually, to join an engineering degree programme, a C3 or better is required in higher level Leaving Certificate mathematics. As an alternative, NUI Galway offers a special entrance exam in maths, along with a short (and free) preparation course. The course and exam will take place shortly after Leaving Certificate results are released. Details will be announced during the summer.

First flight for all-composite airliner fuselage

The world's newest airliner, the Boeing 787, made its first flight on 15 December. Perhpaps nothing embodies the breadth and challenges of mechanical engineering so much as an airliner. Aerodynamics, structures, dynamics, mechanisms, control systems, ergonomics, thermodynamics and materials engineering come together in a complex system that must deliver high performance and extreme reliability without compromise. The factories that produce these machines are themselves monumental achievements of engineering.

Like most new aircraft, the 787 incorporates a range of new technology. It marks a significant milestone in that over 50% of the aircraft's mass, including most of the fuselage, consists of carbon-fibre composite materials.

The choice of materials is one of the major decisions that engineers must make in any design. In aircraft, the development of new materials is strongly driven by the need to reduce weight. Lower weight means a smaller aerodynamic lift force is required to keep the aircraft flying, which in turn means less aerodynamic drag, less fuel burn, lower emissions, lower fuel costs and cheaper flying. This is very different from the situation in a car or train on a horizontal surface, where the mass affects fuel consumption only during acceleration – once the vehicle is up to speed, mass and weight don't matter.

Aluminium alloys have been the material of choice in the aerospace industry for many years. However, the use of composite materials has increased gradually. The most important composites consist of carbon or glass fibres embedded in a polymer (plastic) material such as epoxy resin. A combination of two or more materials can give better overall properties than either individual material. Carbon-fibre composites may not have the raw strength and rigidity of classical engineering materials such as steel, but critically, they have a better strength-to-weight ratio. In other words, a composite structure might require a bigger volume of material to be as strong as the equivalent aluminium structure, but it can be lighter. The technological advances in the aerospace industry have had an impact in other fields, notably high-performance sports equipment – carbon-fibre composites are common in everything from tennis racquets to Formula 1 cars.

The rise of composite materials has created a new field of mechanical engineering. One Galway-based company, ÉireComposites, is an international leader in the design, manufacture and testing of composite materials, with products including wind turbine blades and aerospace components. (The June 2009 issue of our newsletter includes a profile of one of their engineers.) The mechanical engineering and biomedical engineering degree programmes at NUI Galway include several courses on engineering materials, including special modules on polymers and composites.

In Europe, Airbus has launched the A380, the largest airliner ever built, which first flew in 2005. Its designers made extensive use of carbon-fibre composites in the tail, ailerons and wing-fuselage fairings. The A380 also features GLARE panels in the fuselage and on the leading edge of the tail. GLARE is a material comprising layers of aluminium alloy and glass-fibre composites, and is valued for excellent performance in fatigue (long-term repeated loading) and impact (for example, in a crash). Later this year Boeing will fly the 747-8, an updated version of the famous jumbo, intended to compete with the A380. Airbus in turn is developing the A350, similar in size to the 787. With such intense competition, we are likely to see more technological innovations over the next few years.

NUI Galway mechanical engineers have held senior engineering positions at both Airbus (see January 2009 newsletter) and Boeing, as well as Rolls-Royce, who provide turbofan engines for both.

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