THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

DES News

Department of Engineering Science

November 2012 | **Alumni and Friends quarterly newsletter** | Number 16

Dear Alumni and Friends

The academic year 2012 is rapidly coming to a close. Lectures have ended and students are completing their final exams. Our Part IV students have treated staff and guests to two days of outstanding project presentations at the beginning of October. You will read about the winners of the Biomedical Engineering and Engineering Poster and Talk Prizes inside this issue.

This year we also let the students vote for their choice of best talk. They voted for Kyron Marsh's talk 'Give batteries the boot!' The talks were followed by celebrations during a dinner at Langham's on Friday the 5th of October. Like last year, I presented an 'Engineering Science Supreme Service Award'. This year's award recognizes Dr Jon Pearce for always volunteering for any duties that I may have to allocate and for being there to help students day and night.

Jon Pearce at the Langham with some of the Part IV Project students

I am very proud to report that the intake into the Engineering Science specialisation for 2013 has been raised to 42. This is equal to the largest class before the establishment of the BME degree.

At the September graduation John O'Sullivan was awarded his PhD in Engineering Science, the third O'Sullivan junior to gain a PhD and the fourth O'Sullivan (Mike, Michael, and Matthew) to be currently working for the department – John is lecturing modelling and design and energy related courses.

It was with much sadness that DES farewelled technical officer Michael Byrne on October 12th. Michael, Ruth, and baby Cillian have decided to return to Ireland to be closer to family. More on page 5 of this issue.

Professor Matthias Ehrgott, Head of Department
hod_des@auckland.ac.nz

In this issue

News in brief

Zabin Farishta was admitted to the Masters in Management and Regulation of Risk at the London School of Economics, and has now commenced study there.

Zeke Pullan has won the Chancellors Award for Top Maori and Pacific Island Scholars Scholarship. He will receive three years tuition and will be studying up at the School of Medicine.

Dr Michael O'Sullivan, Professor Mike O'Sullivan, Dr John O'Sullivan

Introducing (another) Dr O'Sullivan

My thesis was supervised by Rosalind Archer and Richard Flay. The aim of my research was to develop more physically accurate models of the highly turbulent wind flow that occurs in complex terrain so that more accurate predictions can be obtained.

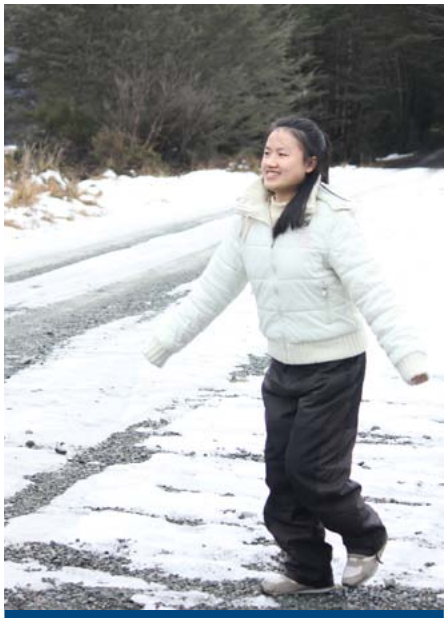
My work resulted in a number of novel approaches and improved simulation results, and my results can be used for simulations of wind flow for many applications including energy production, pollution dispersion and building design.

During my studies I initiated collaborative projects with Stanford University, TU Delft and the University of Cyprus which are ongoing.

Since finishing my thesis I have finally fulfilled a lifelong dream and joined the staff at Engineering Science where I teach on the Engineering Modelling and Design course and contribute to both the MEnergy and PGCert programmes.

I also work in the geothermal modelling team, continuing my research into turbulent flows and am looking forward to many departmental bbq's, dinners, field trips and bush walks.

John was awarded his doctorate at Spring Graduation



Winner: Best Talk, BME

Kejia Wang

I came to Auckland in January 2010 from Hillcrest High School in Hamilton (cue the unoriginal insults from Aucklanders). About mid-year 13, I discovered BME on the university website. You should have seen the look on my face… something new that combined maths with science, medicine with technology, cutting edge research with improving people's health and saving lives – it sounded perfect! With my mind already made up about my engineering specialisation, I hopped on the Accelerated Pathway and began my undergrad journey with MM1 in summer school. First impressions of university involved a juggling, unicycling lecturer - so you can imagine how excited I was about the next few years.

Some say the BME degree is 'challenging'. I say that is an understatement. Between assignments, hobbies such as Ceroc and violin, and a course in German Literature, helped keep some balance. Yet, to this day, I assert that I wouldn't rather have chosen any other career path. The BME discipline is as fascinating as it is diverse, and what can be achieved is inspirational – it's great to be a part of it.

My time in the department has been thoroughly enjoyable. In particular I love the way the class meshes together and how integrated the Engsci and BME crews are. We've come a long way together and I will surely miss my classmates as we part ways. My current plans for the future involve postgraduate studies in the UK, US or Australia.

Congratulations Spring 2012 graduates

Doctor of Philosophy in Engineering Science

John O'Sullivan Thesis: *Modelling wind flow over complex terrain*
Javad Khazaei Thesis: *Mechanism Design for Electricity Markets Under Uncertainty*

Master of Engineering in Engineering Science with Second Class Honours Second Division

Laura Abraham
Jefferson Villacorte

Bachelor of Engineering (Honours) in Engineering Science with Second Class Honours First Division

Dustin Philip
Anthony Jarvis

Bachelor of Engineering (Honours) in Biomedical Engineering with Second Class Honours Second Division

Nicholas Donovan

Bachelor of Engineering in Engineering Science

Hendrick Lim
Alexis John
Thomas Gubb

Bachelor of Engineering (Honours) in Engineering Science (Conjoint) with First Class Honours

Paul Robertson (BA BE Honours)

Our alumni who studied within the Auckland Bioengineering Institute:

Master of Engineering in Bioengineering with First Class Honours

Jee Lean Lim (BME, Class of 2010)

PIV Project 2012

Part IV Project reached its culmination on October 5th at the Langham, where the project winners were announced:

Best Talks (nearly a clean sweep for the women)

Biomedical Engineering		Engineering Science	
1st	Kejia Wang	1st	Emily Du
2nd	Sue-Mun Huang	2nd	Alan Lee
3rd	Xinxin (Helen) Li	3rd	Ula Alward

Best Posters

Biomedical Engineering		Engineering Science	
1st	Marco Tien-Yueh Schneider	1st	Michelle Ye
2nd	Nathan Deacon	2nd	Li Wang
3rd	Qi-Wern (Chi Chi) Lim	3rd	Esther Lloyd

Abstracts and information about the winning students follow. For more, go to www.des.auckland.ac.nz/uoa/partivprojects-1

Best Talk, Biomedical Engineering

Kejia Wang, Winner

"Optical Methods for Characterising Bovine Pericardium Microstructure"

Abstract: Bovine pericardium, the fibrous membrane around the heart of cows, is used to make bioprosthetic heart valves. Current designs don't really take account of its anisotropic and inhomogeneous mechanical properties, which are determined by its collagen architecture, and this often results in early valve failure. Ideally we'd like to be able to non-destructively characterise the collagen – and therefore the mechanical properties – of pericardium samples, so that we can select the optimal regions within a sample for better leaflet construction and valve durability.

continued overleaf...

Winner: Best Talk, EngSci

Emily Du

After finishing high school, I enrolled in a BE(Hons)/BCom conjoint degree. I've always enjoyed working with numbers and solving puzzles, so Engineering Science was a natural choice for me. Over the last four years, I learned that a good study-life balance is really important. I've tried to maintain this balance by keeping up with my passion in flute and piano as well as being in the Engineering Revue every year.

I now still have one more year left of BCom papers for my conjoint degree, majoring in Economics and Finance. Thereafter, I hope to be able to utilise both components of my degree in my future career, whether it be in academia or in industry.

"Optimal delivery of Arc Modulated Radiation Therapy in Cancer Treatment"

Arc Modulated Radiation Therapy (AMRT) delivers radiation in one continuous gantry rotation and finds optimal beam intensities at equally spaced angles. In order to achieve an optimal delivery of a treatment plan, it is necessary to modulate the radiation intensity through a device called the multi-leaf collimator. By controlling the movement of the collimator leaves, we wish to deliver the planned intensities as closely as possible to maximise tumour control while minimising beam-on time to healthy tissue.

My project involved implementing two different methods proposed in literature for optimal AMRT leaf sequencing. These methods sequence each leaf pair independently, and we compared them in terms of computation time, delivery error, and beam-on time. We also discussed the impacts of technological restrictions on the collimator leaves that may introduce multiple leaf pair dependencies and violate the independence assumption.

Kejia Wang "Optical Methods..." continued from previous page

With guidance from supervisors, I designed, built and tested a polarised light imaging system, and was able to image pericardium samples and quantify optical properties of the collagen that relate to its density and fibre alignment. Seeing the results was quite exciting – so much so that I'm continuing on with the project over summer.

Sue-Mun Huang - Runner Up

"Modelling myocardial remodeling"

Abstract: Hypertensive heart disease (HHD) is a leading cause of heart failure. HHD is characterised by progressive changes to the ventricular geometry and the organisational architecture of the heart tissue. Our understanding of the mechanisms responsible for impaired diastolic function must be improved. For practical and ethical reasons, HHD studies are often conducted on the spontaneously hypertensive rat (SHR), a well validated animal model. My project used a novel approach to investigate the independent contribution of geometric changes to the passive pressure-volume and compliance relations of the left ventricle at key time points.

What next? My immediate goal is to further my project research over summer and hopefully have a conference paper submitted in January 2013.

Helen Li - Highly Commended

"POP mechanix: characterisation and modelling of pelvic floor support mesh"

Abstract: Pelvic Organ Prolapse is a major pelvic floor disorder in women where the pelvic organs descend into the vagina due to the loss of support from the surrounding damaged muscles. The current prolapse reconstructive surgery has a failure rate of 30%, and a new surgical procedure that has been developed to reduce prolapse recurrence, however the mesh it uses has caused complications. In order to gain a better understanding of the mechanical properties of the mesh, my project involved a range of mechanical experiments, followed by the application of rheological models to the results.

What next? My next step is to complete the Commerce component of my conjoint programme and continue with a ME in Bioengineering.

Best Talk, Engineering Science

Alan Lee - Runner Up

"Heuristics for the Cyclist Routing Problem"

Abstract: When cyclist pick a route, they try to find one which is not only short, but also suitable in some sense (i.e. has wide roads, low traffic speeds, cycle lanes etc). The aim of this project was to develop algorithms and strategies that, given a map, could identify a selection of routes, ranging from the shortest (and least suitable), to the longest (but most suitable). This could then be embedded inside a website, similar to Google Maps, to help encourage new and less confident cyclists.

What next? In terms of future plans, I hope to complete a PhD, either here or in Australia, and am currently looking for potential topics/supervisors/sponsors...

Ula Alward - Highly Commended

"Optimisation Models for Electricity Production"

Abstract: Tonga is heavily reliant on imported fuels to meet its energy demand, and has therefore been a victim to the oil price volatility and also the increase of oil prices. This has lead to Tonga's development of a "road-map" that outlines their 20 year energy plan. This project addresses the Tongan government's wish to develop a method of energy production that can decrease electricity costs while still meeting the needs of the schools. Towards this end, we developed an optimisation tool that assesses different technology attributes and determines a 10 year plan that minimises the total cost for the schools while still meeting the school's monthly electricity demand.

What next? I am looking forward to my last summer holiday before starting a graduate programme with Vodafone in their IT department. I will miss my time in the DES and am honoured to be a member of this family.

Winner: Best Poster, BME

Marco Tien-Yueh Schneider

I am fascinated by engineering and human physiology. During my BE I developed a particular interest in bio-mechanics.

I worked at TÜV Rheinland Japan Ltd. last year testing medical electrical devices as part of my Practial Work experience. Last summer I carried out research on cardiac cells under the supervision of Dr Vijay Rajagopal during an ABI research studentship.

I am currently looking into post-graduate opportunities and will be working at the ABI again this summer for another ABI research studentship. I intend to follow the studentship with post-graduate research.

"Design and Analysis of Surgical Fixation pins"

Abstract: For long bone fractures, the main treatment methods offered by modern medicine currently focus on realigning the fracture fragments via surgical fixation of internal plates or external splints. The supports are generally made from titanium alloys to reduce stress shielding. However, as a consequence of using high-modulus, surgical-grade, stainless-steel pins to fix the supports to bone, a significant degree of stress shielding is still observed at the pin-bone interface and bone loss and subsequent pin-loosening is observed.

continued top right...

Best Poster, Biomedical Engineering

Marco Tien-Yueh Schneider, Winner

"Design and Analysis of Surgical Fixation Pins"

Abstract continued from bottom left:

The project addresses the issue of pin-loosening and provides information which should be considered in the future design and development of surgical fixation pins. The study was conducted using 3D finite element (FE) analysis of a loaded, anatomically-accurate tibia model, inserted with pins of varying cross-sectional geometries, to compute the strain energy density (SED) distribution which gives an indication of the degree of bone-remodelling at the pin-bone interface.

Nathan Deacon - Runner Up

"Modelling the Blood Perfusion to Tumorous Tissues"

Abstract: Of the current mathematical models used to model the process of tumour development, many neglect blood flow. The cellular automaton model is unique as it incorporates this aspect of cancer growth. In this project, a set of rules was implemented with the use of MATLAB, governing cell development and evolution. A colony composed of competing normal and cancer cells were placed in an array intertwined with blood vessels. Vasculature was introduced as the constant source of oxygen. Instead of using an oxygen concentration gradient throughout the tissue, a 'random walk' of oxygen molecules was put in place.

What next? I am currently working in conjunction with the Sports and Exercise Science Department on a project continuing over the summer and am also in contact with Fisher & Paykel Healthcare regarding future opportunities and employment. I have cherished my time in the department and will sorely miss the culture and environment that greatly increased the enjoyable experience of the degree.

Qi-Wern (Chi Chi) Lim - Highly Commended

"Modelling an Intra-Abdominal Pressure Sensor"

Abstract: The objectives of this project were to identify an appropriate medical grade silicone for the novel intra-vaginal pressure sensor (IVPS) developed by the Auckland Bioengineering Institute, through material testing, develop a finite element model of the IVPS to aid future design and development, investigate the effect of a range of force and pressure loading conditions on the response of the sensor to validate previously used force calibration procedures, and compare the performance of the IVPS to a rectal measurement system.

What next? I am currently unsure what I will be doing next year. Ideally, I would like to work in a healthcare company, pay off my loan and in a few years go traveling for a while before returning to work. However, I am also considering post-graduate study.

Best Poster, Engineering Science

Li Wang - Runner Up

"A Linear and Non-linear examination of Precursory Seismic Information in the Canterbury Region"

Advances in geophysics, continuum modelling and computational power now allow relatively accurate identification of high risk areas, however we are still unable to predict with a high degree of specificity when an earthquake will happen. This research attempts to address this problem by investigating the precursory seismic information for both the Darfield and the Christchurch earthquakes, using linear and non-linear methods.

Esther Lloyd - Highly Commended

"Coupling Optical and Inertial Motion Capture Techniques to Drive a Kinematic Model of a Cyclist"

This study investigated the benefits of coupling optical and inertial motion capture systems. A passive optical motion capture system was used in conjunction with inertial measurement units (IMU's) developed by the Auckland Bioengineering Institute.

Winner: Best Poster, EngSci

Michelle Ye

I have greatly enjoyed the freedom in course choices that the Engineering Science specialisation allows. For my degree, I was able to take papers in finance, maths, computer science, and civil engineering.

I found that the transportation field has many interesting problems, and Operations Research techniques are often relevant. Next year, I will be working at AECOM in their transport modelling team.

"Faster Shortest Paths for Ambulance Simulation"

My project looked at faster ways of computing shortest path problems for Optima's ambulance simulation software.

We tested the Landmarks algorithm, which uses shortest path trees rooted at ambulance bases to compute any shortest path. We found that the Landmarks algorithm was faster than the Dijkstra algorithm currently used by the Optima program.

Edmund Crampin leaving DES

I will be moving to the University of Melbourne in February 2013 to take up the Rowden White Chair in Systems and Computational Biology. This is a new position which has been established by the University as a cross-faculty initiative between the Engineering, Science and Medical faculties and in association with NICTA (National ICT Australia, Victoria Research Laboratory).

The aim of the new position is to foster collaborative research in quantitative biomedical sciences. It's an exciting opportunity. The Parkville campus in Melbourne is home to a huge variety of expertise in life sciences, along with Melbourne's major hospitals and numerous medical research institutions. There is also great depth in mathematical and computational research at the University and NICTA, along with significant computational infrastructure, including the Victorian Life Sciences Computation Initiative (VLSCI) and collocation of IBM Australia's life sciences lab.

My role in Melbourne will be to establish systems and computational biology as an interdisciplinary program of research across the University and related research institutes around the Melbourne campus, develop a graduate focus in systems biology, and of course to maintain cross-Tasman linkages with the ongoing research programs here in Auckland.

Michael Byrne farewelled

Iain Anderson

It was with much sadness that the Dept farewelled Michael Byrne on October 12th. Michael, Ruth and baby Cillian have decided to return to Ireland to be closer to family.

Michael took a leading role in relation to our lab courses, including the Bioinstrumentation courses, Mechanics of Biomaterials and Design. In Michael's last weeks, he helped all the 363 students with their turbines. His last official job was testing the turbines in the wind tunnel. Michael has also looked after the acquisition of capital items, and helped with Part IV projects

BME vrs EngSci Bake-off 2012

The theme for this years student organised Bake-Off was "Engineering at the Olympics".

The overall winner was Part IV Engineering Science student Sam Cheng (entry pictured) and we were honoured to have Patti Jessop-Pullan (Andrew's wife) as one of the judges. Pictures of all the entries are available online at www.des.auckland.ac.nz/uoa/des-2012-bake-gallery

NZ's Next Top Engineering Scientist 2012

Peter Bier

The 2012 competition was held on Saturday September 22nd, with teams working from 9am through to 6pm. Now in its fourth year, this annual competition is a problem solving event for teams of three to four secondary students, organised by the Department of Engineering Science. The competition continues to grow in popularity and this year 143 teams took part with entries from 69 schools all over New Zealand.

This year's problem centred on Felix Baumgartner's planned record breaking high altitude skydive attempt, which he successfully completed early this month on October 14th. Felix jumped from a height of 39km, launching himself from a capsule suspended beneath a balloon, at the edge of space. After Felix landed, a remote triggering system released the capsule from the balloon.

The question asked on competition day was "*In the event that electronic tracking is unavailable, what size search area is required in order to retrieve the capsule?*"

With the competition now over, judging of the submitted reports has commenced, to find out which team will be awarded the Pullan Prize and take out the title of New Zealand's Next Top Engineering Scientist.

We are also very pleased to announce that this year, foundation sponsors Orion and Fonterra are joined by a new sponsor, Fisher and Paykel Healthare.

Research Update: Cardiac Myometer and Needle-free Jet Injection (Andrew Taberner)

The Cardiac Myometer:

With the aid of a $830,000 Marsden Grant, Dr Andrew Taberner and his team of PhD students and post-docs are working to identify the mechanical, energetic and ionic properties of living heart muscle. The team are developing an innovative miniaturised testing device: The Cardiac Myometer. With this device, they will be able, for the first time, to measure five important sub-cellular parameters (force/length, oxygen consumption, heat production, Calcium transients, sarcomere length) beat by beat, in living heart tissue under either normal or diseased conditions. A number of past graduates of the Engineering Science Department are part of the Cardiac Myometer team:

Callum Johnston (BME, 2010) is developing new temperature sensors for the measurement of muscle heat production

Alex Anderson (BME, 2010) is developing real-time imaging techniques for measuring sarcomere length, simultaneous with measurements of calcium ion concentration

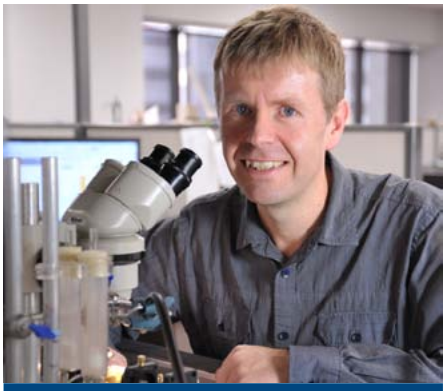
Dr June-Chiew Han (BME, 2006) assists the engineering team to prepare specimens and conduct experiments in the instrument.

Photo: Andrew Taberner and Rhys Williams with their needle free jet injector

Needle-free jet injection:

Liquid drugs can be injected through the skin without the use of needles using the principle of jet injection. Jet injectors create a hair-thin jet of fluid that impacts the skin surface at 200 m/s and can penetrate through skin and tissue to a depth of 20 mm. The Auckland Bioengineering Institute and MIT Bioinstrumentation Labs have developed the world's first jet injectors that are actuated by highly-controllable, quiet, and reversible linear Lorentz-force motors. The motion of the motor is tightly controlled throughout the entire process of injection, allowing unprecedented control over the precision of jet drug delivery. Delivered volume and jet speed are electronically selected by the user, and can be varied during delivery. The device can deliver the ampoule contents in a single injection or many smaller injections.

Andrew's work in this area has recently been published in Medical Engineering & Physics and Journal of Medical Devices and reported on by MIT News, The Economist, New Scientist,Popular Science, The Washington Post, Time, NPR, BBC, New Zealand Herald, and Television New Zealand, together with many other websites and periodicals. MIT News has also released a Youtube video highlighting this work. Andrew supervises Engineering Science graduate student Rhys Williams (BME, 2011) who is now developing new versions of this device for viscous drug compounds. The MIT Bioinstrumentation Lab is developing devices for delivering drugs to the retina, for withdrawing fluid from the injection site, and for delivery of fluidised powdered drugs.



Featured Staff

Andrew Taberner

Andrew Taberner joined the Department of Engineering Science in 2009 as a Senior Lecturer in Bioinstrumentation, having previously spent six years as a post-doctoral fellow and research scientist with the MIT Bioinstrumentation Lab in Boston.

He holds a joint appointment as a Senior Research Fellow with the Auckland Bioengineering Institute.

Andrew's research focuses on developing intelligent, novel bioinstrumentation systems and medical devices, with applications ranging from basic science to clinical medicine. Many of his projects are in collaboration with other researchers in the Auckland Bioengineering Institute and the faculties of Engineering, Medical and Health Science, and Science.

He enjoys teaching the principles and methods of instrumentation and measurement within the BE(Hons) in Biomedical Engineering degree programme and leading a team of post-graduate students in novel instrumentation design, construction and development.

He is also a director of the Bioinstrumentation lab at the Auckland Bioengineering Institute.

He heads the MIT-ABI BioInstrumentation Exchange Initiative, a collaborative research exchange programme between the Auckland Bioengineering Institute, and the MIT BioInstrumentation Lab.