

# DES News

## Department of Engineering Science

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### Dear Alumni and Friends

As usual the year is flying by - I can't believe it's nearly the end of April already. A large group of top quality undergraduate students joined the Department at the end of February. One of the Associate Deans remarked at the end of the summer that he expects the group will be a pleasure to teach. I will also enjoy the May graduation ceremonies when we see our latest group of students awarded degrees - more about that in the next issue. In the interim keep your fingers crossed for good weather for the procession etc. on May 9th.

I am particularly pleased with the significant growth in our PhD student numbers. Our floors at Uniservices House are bursting at the seams with PhD students (both from NZ and from all over the world), with more due to enrol later this year. Our taught postgraduate programs are also popular with strong interest in the Postgraduate Certificate in Geothermal Energy Technology and the Master of Energy degree.

We're always on the look-out for interesting topics to set students at any level working on - if you've got a good problem that could do with an Engineering Science approach do let us know.

### Professor Rosalind Archer, Head of Department

des-hod@auckland.ac.nz

### 2013 Senior Scholars

Alex Donaldson and Jack Dunn are our 2013 Senior Scholars.

Alex is now studying for a PhD on artificial intelligence, with the Department of Computer Science and DES.

Jack is working as a Teaching Assistant in DES, while continuing his Part IV research with Golbon Zakeri and Tony Downward. He heads over to the United States around mid-August, to commence a PhD at the MIT Operations Research Center (ORC). His advisor will be ORC co-director Professor Dimitris Bertsimas.

### 2013 Part IV Project prizewinners

The Auckland Bioengineering Institute (ABI) Prize for Best Biomedical Engineering Project was awarded to:

Zhinuo (Jenny) Wang for her project  
*Characterising mechanisms of human heart failure.*

Jade Kwong for her project  
*Gearboxes for high-volume needle-free injection.*

Jenny is now studying for a PhD with the ABI, characterising human heart failure with clinical imaging and structure-based modelling. Jade is a Product Development Engineer at Fisher and Paykel Healthcare, and is in a team that is developing reusable breathing circuits for developing countries.

### Academic staff promotions

As of the first of February, Dr Andrew Mason (Class of 1987) and Dr Thor Besier are now Associate Professors. Dr Vinod Suresh is now a Senior Lecturer, and Peter Bier has been promoted up the Professional Teaching Fellow scale to PTF4.

Photos left to right: Andrew Mason, Thor Besier, Vinod Suresh, Peter Bier.



### In this issue

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### News in brief...

#### Nicolas Smith: Top engineers need more than No 8 wire mentality

The above titled article appeared in the Herald on Wednesday April 16th, and mentions Andrew Mason's work with ambulances. To read the article, go to (or click on)

<http://www.nzherald.co.nz/nz/news/article.cfm?cid=1&objectid=11239150>

The Cecil Segedin Prize for Best Engineering Science Part IV Project was awarded to:

Alexander Donaldson for his project  
*Design and implementation of an exploitative computer poker player.*

Peter Mills for his project  
*Optimal dairy farming strategies during drought.*

Peter Mills is with MRCagney as a Analytics Consultant. He is currently working on a web application to analyse bus networks in Australia, and will be for the next few months.



## Featured Alumni

### Therese Clark, Class of 2008

Following completion of my Bachelor of Engineering (Biomedical) in 2008, I began at Fisher and Paykel Healthcare as a product development engineer. I joined a team responsible for developing a product to treat patients suffering from chronic obstructive pulmonary disease.

In this role, I was involved with design, testing and regulatory compliance of the device. My work involved laboratory instrumentation, product performance testing, and documentation of test procedures and results in the form of internal and external documents for regulatory bodies including the FDA. At F&P Healthcare I learned much about the medical device industry and was fortunate to have the opportunity to work with many highly knowledgeable experts in the many and varied aspects of the company, from product development, operations, production, stores, to regulatory affairs, marketing, legal and document control.

In 2012 I returned to the Auckland Bioengineering Institute to begin a doctorate in the Implantable Devices Group. My research project is based on development of novel instrumentation for measuring pressure, temperature and flow suitable for implantation.

The project aim is to produce a fully implantable sensor for both acute monitoring of brain injuries, and long term monitoring of patients suffering from hydrocephalus. Further work will involve extending the scope of the technology to other chronic clinical conditions. My doctoral research project is supervised by Associate Professor David Budgett and Professor Simon Malpas.

## Young teaching staff doing well in student eyes

### Faculty of Engineering Top Teacher awards

Three of the fifteen staff members voted as Faculty of Engineering 'Top Teachers' for 2013 were from DES - Peter Bier, Keri Moyle and Jon Pearce.

These awards are made to staff solely on the basis of student votes, and the voting forms recommend that students "...nominate teachers who have presented the subject matter in a well-ordered and structured manner with clarity and relevance; those who have best helped you to grasp the ideas and principles, who have given you clear insights, knowledge, and problem-solving ability to master the subject".

It is of particular note that Jon Pearce has been included in the top teachers list since 2011 (he joined us in 2010). One student has said of Jon, "Jon Pearce, he is the most helpful person ever. Best lecturer". (Annual University Student Survey).



Left to right: Peter Bier, Keri Moyle, Jon Pearce.

## Associate Dean, Student Experience

### by Keri Moyle

When Martin Shepherd (Director, Undergraduate, Faculty of Engineering) left last year, the Faculty divided his position into three. I was approached and asked to be Associate Dean (Students). A second Associate Dean (AD) role was created alongside; AD (Undergraduate), which was taken up by Michael Hodgson from Chemical and Materials Engineering. The balance of Martin's position was used to create a new Student Engagement Manager role.

So my part of the job is to look after student issues, including academic standing (tracking at-risk students), student issues (running the Staff Student Consultative Committee), mentoring for students in the High Performance network (nationally recognised athletes, musicians, performers who are studying whilst pursuing these activities at an elite level), and anything else that comes up! Because the role is recently established, both Mike and I are currently feeling our way through it.



### New Staff: Jessica Costa

Jessica Costa is our new Professional Teaching Fellow. She replaces Amy McLennan, who is now teaching chemistry and science at ACG Parnell College. Jessica's role is to co-ordinate, lecture and tutor ENGEN 140, the Part I "Engineering Biology and Chemistry" course.

Jessica holds a BSc in Molecular Biology & Biotechnology, and completed a PhD in Biology in 2005. She then joined the University of Auckland and performed biological and bioengineering research in the Departments of Physiology, Medicine, and at the Centre for Brain Research, as well as in DES beginning in 2012. She has held fellowships from the Auckland Medical Research Foundation and the former Ministry of Research, Science and Technology.

## Hood Fellow visit and lecture

### by Richard Clarke

Professor Oliver Jensen, Horace Lamb Professor at the School of Mathematics at the University of Manchester visited DES as a Hood Fellow from 27th January to 8th February this year. Professor Jensen is a world renowned applied mathematician and theoretical mechanist who works in a number of research areas, including modelling physiological flows such as those occurring in the lungs and vasculature, and models of regenerative medicine and plant mechanics.

During his visit Professor Jensen gave a public lecture entitled *Bringing Mechanics to Life*, and a research seminar on *Modelling plant cell and tissue growth*. He then attended the Australia and New Zealand Industrial and Applied Mathematics (ANZIAM) Meeting in Rotorua, where he spoke on *Instabilities of flexible channel flow* in the context of compliant vessels in the body.



Photo: Professor Jensen in front of a portrait of Horace Lamb.

# EngSci/BME Part II Field Trip 2014

## by Rachel Boswell, Part II

**Short report:** "What goes on camp, stays on camp."

**Long report:** Seventy excited EngSci/BME students were milling around 70 Symonds St at 8.30am on Thursday March 13th, ready to bunk two days of lectures in order to head down to Rotorua. Thursday morning was spent in Auckland, visiting Auckland engineering companies Derceto, Callaghan Innovations and Stretch Sense. Interesting things were told and shown at these companies (if I told you what we saw at Callaghan Innovations, I'd have to kill you), but the best part of the field trip was still to come.

Friday morning was scheduled for our visit to the Wairakei geothermal power station. Hindered by a broken down bus that meant the BME students left 45 minutes late, we arrived at Wairakei to see how engineering science is relevant in this topical industry. We also made a fashion statement in our fluoro coats and hard hats.

And now we were free to get on with the real purpose of the trip – finding out how much pizza you can really eat at the dine-in Pizza Hut. Some of us were sadly disappointed, while others surpassed expectations. This was worked out in a friendly game of soccer: EngSci vs Bme (EngSci may have won, but BME was sadly outnumbered).

The people at Crash Palace were absolutely fantastic, putting on a barbecue for us that night, keeping the music going all day, and playing favourites such as Bohemian Rhapsody before taking us out to town. Well, Rotorua's version of town. The drinks were flowing, and the conversation was going even faster, so it was a great opportunity to meet heaps of other people in the department. This is evident in the obviously higher noise levels in lectures after we returned.

For most of us, the highlight of the trip was white water rafting. Going over waterfalls, swimming through rapids and standing in the boat through rapids, with instructors who knew what they were doing, and liked a good laugh (like holding the raft against the bottom of a small drop, so the front of the raft was getting drenched), meant that we were guaranteed an awesome time. We even have the photos to prove it (see below).

A big thank you to Richard Clarke, Poul Nielsen, Justin Fernandez, Andrea Raith and Rosalind Archer, the staff who made this trip possible.



Above: group photo of those who went white water rafting.

Below: progress of one of the boats.



Photos courtesy of River Rats.



### Featured Alumni

#### Ju Zhang, BME Class of 2009

After finishing my BE(Hons) in 2009, I went on to do a doctorate with the Auckland Bioengineering Institute (ABI). My research was supervised by Poul Nielsen, and focused on the development of statistically-based computational methods for characterising the natural variations of femur morphology, as presented in CT images.

The motivation was to create tools to understand how one of the most often replaced bones in the body (in terms of hip and knee) varied across and between populations. I was also inspired by the idea of a vast database of bone models, a virtual bone bank, allowing researchers to carry out simulations on models of real bones of all shapes and sizes.

Upon completing my doctorate in 2013, I was appointed at the ABI as a post-doctoral research fellow. The vision of a digital bone bank continues as a part of the FDA-funded Musculoskeletal Atlas Project (MAP) headed by Associate Professor Thor Besier.

As a part of MAP, I am expanding my work in statistical shape modelling and image analysis to other organs, particularly bones of the lower limbs. In addition, my computational methods are being made publicly available so that other researchers around the world can benefit from and contribute to the MAP.

I am looking forward to presenting my work on shape models of the hip at the World Congress of Biomechanics in Boston this July, followed by a visiting fellowship at Imperial College London.

See overleaf for more on the MAP project.

## The Musculoskeletal Atlas Project (MAP) by Associate Professor Thor Besier

Our ageing and increasingly overweight population is giving rise to an epidemic of musculoskeletal and movement disorders, such as osteoarthritis, osteoporosis, and stroke. The demand for joint replacement surgery, for example, is predicted to skyrocket by 673% in the United States by 2030. The associated health care cost of these disorders is tremendous, so we must look towards novel approaches to tackle these problems. Medical devices offer one way to improve the diagnosis, assessment, and treatment of musculoskeletal disorders and New Zealand has a growing medical devices industry (see [www.cmdt.org.nz](http://www.cmdt.org.nz)). The Medical Technology Association of New Zealand (MTANZ) estimates that New Zealand's medical devices sector contributes \$1.4 billion to our economy, which is projected to double in the next 3 to 5 years.

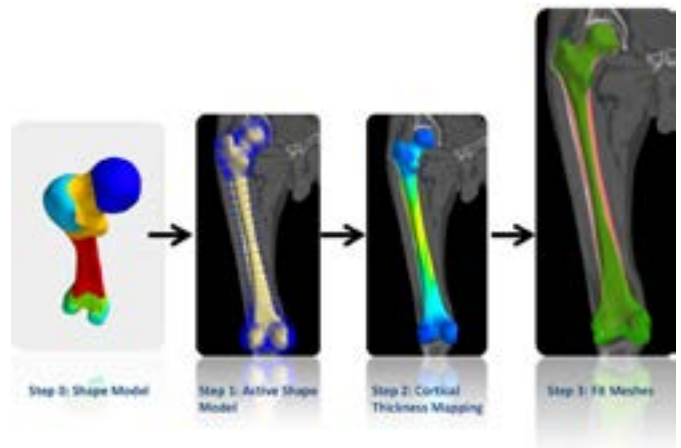
Computational modelling plays an important role in our understanding of the form and function of the musculoskeletal system. Just as mathematical modelling revolutionised the aeronautic industry, computational modelling is dramatically influencing the design and validation process of medical devices, particularly in the field of orthopaedics. Computational models also have tremendous potential to complement clinical trials, reducing the cost of bringing a new product to market through *in silico* testing across a virtual population. Herein lies the concept of the *Virtual Clinical Trial*.

An orthopaedic device manufacturer might be faced with several important design questions. Firstly, who is the intended user of the device? What is their size, age, sex, or ethnicity? Secondly, what kind of loads or boundary conditions is the device designed to operate? How might the device function across a population of individuals? And lastly, how do they ensure that simulations are valid for the range of conditions tested? The ability of computational models to predict clinical or functional outcomes is dependent on the ability to accurately capture the complex geometry of the musculoskeletal system and the ability to describe appropriate loads and boundary conditions (i.e. muscle and joint forces). Image-based subject-specific models of the neuromusculoskeletal system are capable of estimating *in vivo* joint loads and show much promise for predicting functional or clinical outcomes. Unfortunately, creating such models is time-consuming, costly, and requires a very high level of expertise. Getting access to quality imaging and functional data for a large cohort also takes considerable effort and cost.

The scientific and medical device community would benefit greatly from a population-based anatomical and functional atlas to rapidly generate subject-specific models of the musculoskeletal system. Researchers at the Department of Engineering Science (Associate Professor Thor Besier and Professor Poul Nielsen) and the Auckland Bioengineering Institute (Professor Peter Hunter) have received funding from the US Food and Drug Administration (FDA) to develop an open-source software framework, called the *Musculoskeletal Atlas Project* (MAP). The long-term goal of this project is to facilitate virtual clinical trials to reduce the cost of clinical trials and streamline the regulatory process for medical devices in orthopaedics.

The project leverages from software tools developed for the *Physiome Project* (<http://physiomeproject.org>), and uses statistical shape modelling to rapidly generate accurate models of bones, muscles, and soft tissue structures from

medical imaging data. Postdoctoral Research Fellow, Dr Ju Zhang, has implemented his automated segmentation algorithms within the MAP to generate a population of more than 300 lower limb bones from CT images. Lower limb muscle and joint forces for various activities of daily living will be included in the database to provide orthopaedic researchers with realistic loads and boundary conditions. To facilitate exchange of data and models, accelerate validation and provide robust peer review, the MAP database will be implemented within the *Physiome Model Repository* (<http://www.cellml.org/tools/pmr>). Using these software tools, we will engage the biomechanics community to build the MAP database and provide a unique resource for population-based orthopaedic modelling and *in silico* testing and validation. Associate Professor Besier will present this work in July this year at an invited symposium at the World Congress of Biomechanics in Boston.



Above image courtesy of Dr Ju Zhang.

### Upcoming Events

#### Tonight! In the company of Ocean Giants

A once only opportunity to attend a lecture by world renowned photographer and explorer **Amos Nachoum**.

7:15 - 8:30pm

School of Engineering, 20 Symonds St, Room 439 439.

Entry: Free! (Sponsored by Dive New Zealand magazine and the Auckland Bioengineering Institute)

[www.abi.auckland.ac.nz/en/about/events/2014/04/29/in-the-company-of-ocean-giants.html](http://www.abi.auckland.ac.nz/en/about/events/2014/04/29/in-the-company-of-ocean-giants.html)

#### See the mighty Taniwha!

15-18th May at the Hutchwilco Boat Show. \$20 Adults, under 16 free.

[www.boatshow.co.nz/attractions/#taniwha](http://www.boatshow.co.nz/attractions/#taniwha)

### Do you have news to share?

News on current staff and students is easy to obtain, because they're right here. News on wider family members - alumni and former staff - doesn't necessarily reach us. If you have something to share, email it to [des-newsletter@auckland.ac.nz](mailto:des-newsletter@auckland.ac.nz)

### Help! for upcoming issues...

Are you involved in the energy industry?

Do you donate your time and skills to help others?

If you said 'yes' to either of the above, we'd like to hear about it - email us at [des-newsletter@auckland.ac.nz](mailto:des-newsletter@auckland.ac.nz).