THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

DES News

Department of Engineering Science

December 2013 | **Alumni and Friends quarterly newsletter** | Number 20

Dear Alumni and Friends

2013 has been a busy year in the Department. We farewelled Matthias Ehrgott and Judith Wang for new roles in the UK, and Amy McLennan will soon take up a high school teaching role in Auckland. David Ryan retired a little earlier than planned (on medical grounds). David will rejoin us in 2014 as a part time member of staff, which we are delighted about. 2013 also saw several new staff hired. We welcomed Thor Besier, Justin Fernandez and Bryan Ruddy into joint appointments with the ABI. Our labs are now very effectively supported by Yuting Zhu. The calibre of our staff was recently recognised with Thor Besier and Andrew Mason being promoted to Associate Professor, and Vinod Suresh being promoted to Senior Lecturer. Peter Bier was also promoted to the top of the Professional Teaching Fellow scale.

Interest in Biomedical Engineering from undergraduate students in Part I wishing to enter Part 2 remains strong. Applications for places in Part II of Engineering Science in 2014 are up by approximately 40%. The 2014 class in both degrees will be a very talented group of students. New Zealand's Next Top Engineering Scientist contest has run for several years now and has helped us raise our profile in schools. This year over 800 students competed in that contest nationwide – with support from Orion Health, Fonterra and Fisher & Paykel Healthcare. Our postgraduate student population is also growing with a marked increase in PhD enrolments this year.

It has been a pleasure to serve as Head of Department this year. The Department's strength is its people – students, staff, alumni and friends. I hope all connected to the Department have a wonderful Christmas/New Year break. I look forward to working with you all in 2014.

Professor Rosalind Archer, Head of Department
des-hod@auckland.ac.nz

Mighty River Power Chair in Geothermal Reservoir Engineering

Energy generation company Mighty River Power has pledged $1 million over the next five years to support the establishment of a chair in geothermal reservoir engineering at the University of Auckland.

DES is delighted that after an international search process, Rosalind Archer has been appointed to hold both the Mighty River Power Chair in Geothermal Reservoir Engineering and the directorship of the Geothermal Institute. Her appointment to the chair brings with it a promotion from Associate Professor to Professor. Rosalind is the first woman to be appointed as a chair in engineering in New Zealand.

"I want to extend my thanks to Mighty River Power for their support of the chair." says Professor Archer. "It says a lot about the company's commitment to geothermal in New Zealand."

"The Geothermal Institute is being rebuilt and re-launched after a hiatus of many years. The University's vision for the institute is that it will be the first point of contact for any external party wanting to engage with the University on matters relating to geothermal energy," she says. "I look forward to helping realise the potential the Institute has."

Faculty of Engineering Deupty Dean Professor Gordon Mallinson says, "The role of the chair is to provide leadership in research and education related to the exploration and utilisation of geothermal energy resources. A key element of this role is the Geothermal Institute of which Rosalind will be the director."

In this issue

Taniwha Launched!

Monday 9 December, Iain Anderson

We have a submarine. When we placed it on the surface it started as a kayak and slowly filled with water. Buoyancy was adjusted with a little air in containers until it was neutral.

Everybody can fit inside (one at a time), from the fat (me) to the tallest (Antoni, Daniel). And when you peddle it wants to go forward - the drive is relatively effortless!

We can make the fins BIGGER! Our immediate goal is to modify the internals to make some more room at the front. At some point we must include steering (dive planes-tail) and the 2nd mirage drive.

More will be available on the ABI website in the new year;

www.abi.auckland.ac.nz

Featured Alumnui

Salah Al-Chanati, Class of 2013

At the end of 2012. I was fortunate enough to be employed by Fonterra, and for 8 months I took up the role as a Product Mix Optimisation Intern while I completed my final semester in operations research courses. During this time, I worked on identifying product mix opportunities from the products Fonterra had to offer to its customers, assisted in generating a fortnightly optimal demand and supply plan using an optimisation tool sourced from San Francisco, and focused on adding value to the products listed within the cream portfolio.

I am now on a 5 month secondment as a Tactical Planning Analyst within the Supply Planning team of NZ Milk Products – Optimisation. My main focus is to assist in generating the "One Plan", a balanced, feasible plan from an optimisation, production planning and logistics planning perspective that protects, improves and ensures the delivery of shareholder value to New Zealand farmers.

In December 2013, I will commence my third role within Fonterra. Alongside 15-20 other graduates from New Zealand universities and abroad, I will join Fonterra's 2-year Graduate Technical Programme (FGTP) and be supported by the Optimisation team. The programme is designed for graduates who come from an engineering, food technology and/or science backgrounds.

For more, see Salah's full profile at www.des.auckland.ac.nz/uoa/salah-al-chanati

Spring Graduation 2013. Congratulations to:

Bachelor of Engineering (Honours) including Conjoints with First Class Honours

Biomedical Engineering
Xiaobei Dong
Gemma Goodfellow (BA/BE Honours)

Engineering Science
Isaac Hamling
Zhi Wong

Bachelor of Engineering (Honours) with Second Class Honours, First Division

Biomedical Engineering
Marco Schneider
Christopher Seo

Engineering Science
Wei Guo
Ashley Sang
Li Wang

Bachelor of Engineering (Honours) with Second Class Honours, Second Division

Engineering Science
Ula Alward
Mostafa Biglari-Abhari
Yeong Fatt Thai

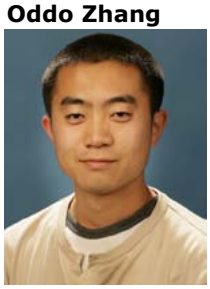
Bachelor of Engineering in Engineering Science

Biomedical Engineering
Chinnavuth Chulkaivalsucharit
Nathan Deacon
Ryan Jacob
Sudarshan Naidoo

Engineering Science
Salah Al-Chanati (BCom/BE)

Doctor of Philosophy in Engineering Science

Oddo Zhang



Thesis: Simulation Optimisation and Markov Models for Dynamic Ambulance Redeployment

Abstract:
The study of dynamic ambulance redeployment, also known as move-up or system status management, is the main concern of this investigation. Move-up is a practice of dynamically deciding stand-by locations for free ambulances in attempt to achieve quick response times.

In the first part of the investigation, we study optimal move-up policies based on three small-scale Markov models to gain insights. The first Markov model considers one ambulance and aims to maximise the benefit of move-up for just the next call. The second Markov model still considers one ambulance, but aims to the maximise the average benefit per unit time over an infinite horizon.

The third Markov model extends the second Markov model by considering two ambulances. Numerical experiments are used to gain insights into optimal move-up policies based on the three models.

In the second part of the investigation, we present three move-up models for realistic-sized problems. The first two of these models extend existing work by proposing a new simulation-based optimisation algorithm. The third move- up model is a new integer programming model which incorporates some of the insights obtained from the small-scale Markov models. Simulation-based numerical optimisation is employed to tune the model parameters and consequently, the model can also be viewed as an approximate dynamic programming model.

Artificial call data generated for the city of Auckland, New Zealand, are used for computational experiments. We find that when move-up is performed appropriately, it can significantly improve the system performance.

Moreover, the integer program proposed in this work gives the best performance.

What now?
I have started working with The Optima Corporation, which is an ambulance-logistics software company located in Auckland. Optima kindly supported my PhD research by providing their world-class ambulance simulation software. Now I am very happy to be part of the team and bring my knowledge of optimising ambulance resources to the company.

Spring Graduation continued...

Master of Engineering in Engineering Science

Simon Bull

Thesis: Scheduling families of jobs with setup times on multiple non-identical machines

Abstract: In a particular factory jobs may be categorized into families by the mold they require; two jobs in the same category require the same mold type. There are limited molds of each type, and any given machine is only compatible with a subset of the mold types. Setups are required between jobs from different families but not between jobs from the same family. This project investigates the problem of assigning jobs to machines in a way that minimizes sum of tardiness.

About Simon: I completed a BE/BSc conjoint in 2010, specialising in Engineering Science. At that time I was undecided between continuing at the University or finding a job, but the then head of department Andrew Pullan offered me a great intermediate option: a job in the Auckland Gastrointestinal Research Group.

Even though I was working in bioengineering, I still maintained an interest in the research being done in the Engineering Science department. After two years, I decided to return to the department and undertake a masters degree with Andrea Raith and Andrew Mason.

Today I live in Copenhagen and am a PhD student at the Technical University of Denmark (DTU), applying operations research to railway planning problems.

Anthony Ciriaco

Thesis: 3D dual porosity modelling of tracer transport in Palinpinon I, Southern Negros Geothermal Field, Philippines

Abstract: The objective of the study was to develop a 3D numerical model and simulate tracer transport in a geothermal reservoir. Using results from tracer tests conducted in an actual geothermal field wherein three different Napthalene Disulfonate tracer chemicals were injected in three different injection wells, the model will be calibrated against the following tracer parameters: arrival time, recovery profile and amount recovered. The tracer simulations will be carried out using the University of Auckland's own version of TOUGH2 reservoir simulator.

Energy Development Corporation, Phillipines: I am truly grateful to the company I have with for several years now, as they have been very supportive in my career advancement. It was through their generosity that I was able to take a post graduate certificate in geothermal technology last 2009 and earn a post graduate degree in Master of Engineering, which I have completed early this year. Being geared up to specialise on geothermal reservoir modeling, the focus of my master studies is on the development of a 3D dual porosity "process" model to simulate tracer transport. This is one aspect of reservoir modeling that has a significant contribution to the understanding of hydrological flow of reservoir fluid. After completing my thesis, I headed back to Manila and reported straight to work. What I learned from a year-worth of doing modeling studies is something I need to keep working on and advance further. The challenge did not stop after I left the University. A greater challenge is waiting for me at work.

Simon and Anthony graduated in absentia, as they were unable to return to New Zealand for the ceremony.

Dr Scott Walbran graduated with a PhD, and Anuprita Arora and John Park with MEs, all in Bioengineering through the Auckland Bioengineering Institute.

Scott, Anuprita and John came through DES as BE Biomedical Engineering undergraduates.

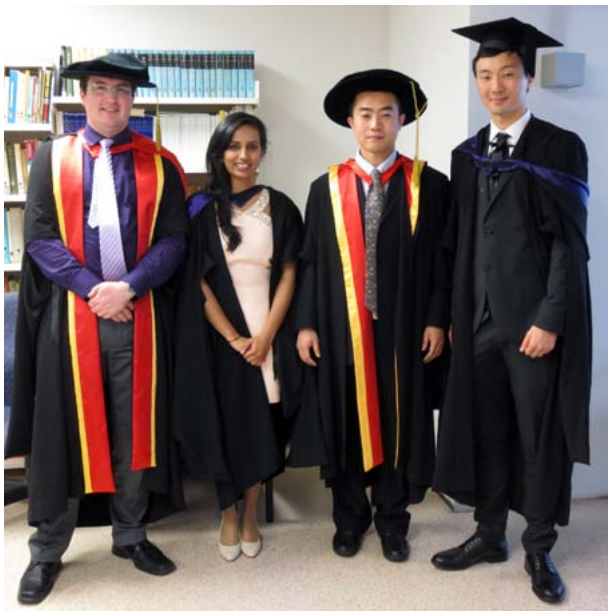


Photo left to right: Dr Scott Walbran, Anuprita Arora, Dr Oddo Zhang, and John Park

Featured Alumni

Chloe Irwin Whitney
Class of 2011

My first job after graduating was at a small medical device company, Pictor Ltd., where I worked as a design engineer. In this role, I utilised a very large range of technical skills from designing and building electronic circuits, CAD design and using statistics to calculate thresholds and analyse test results to performing biological experiments and trialling new technology. During this time I had the opportunity to understand more about what I was truly interested in and determine what I wanted to focus on for my long-term career goals. Although I thoroughly enjoyed the very technical side of being a design engineer I realised I wanted to introduce more people-oriented and management aspects to my job.

Now I work at Orion Health as a Bid Manager. Orion Health is a New Zealand owned leading provider of clinical workflow and integration technology for the healthcare sector. In this role, I am responsible for responding to tenders sent by our customers. This involves telling the customer how our solutions can solve their problems and often requires us to respond to specific technical and non-technical requirements. I regularly coordinate subject matter experts from sales, legal, finance, development and product management to assist in responding, giving me more exposure to range of areas within the business.

In addition to my day job, I manage to squeeze time in for my other passion, singing. I started singing in high school and this year will be my third year as a member of the NZ Opera Chorus, performing in their production of the Flying Dutchman. Although at times it can prove to be quite challenging to manage my time and control stress levels with lots of rehearsals and practice, it's great to have something which I can enjoy and is very different to my day-to-day work.

Human Powered Submarine Racing

Iain Anderson

Imagine having the ability to travel underwater under your own power at speeds comparable to marine mammals and large fish. There are now human powered submarines that can do this, the result of friendly competition at a biannual event, the "International Submarine Races", (ISR) that is held at the US Navy's Surface Warfare Center at Carderock Maryland. In June I attended the 12th meeting of this competition that is now a quarter of a century old. I was able to get a close look at the action as a guest with a team from Rhine Waal University, Germany who were competing against 11 other teams from around the world. My job was to take underwater photographs and videos of their submarine.

The racing subs are wet inside with no pressure hull, and the crew breathe air using scuba equipment. The subs fall into 4 categories: one or two crew with propeller or biomimetic drive. The sub I was with, "Rivershark" was a single occupant sub with a biomimetic drive, consisting of two large lunate shaped fins moving counter to each other, a swimming stroke that might be adopted by mating whales. The drive rods for the two fins were attached to a flywheel pedaled by the driver.

The race is run like a drag strip with one sub at a time. Synchronized video cameras along the 100m course provide data for the measurement of top and average speed. Each sub can get up to five trials a day. But there was damage repair, on the spot modifications and most importantly lunch. As a sub travelled forward a surface inflatable occupied by Navy Divers followed close behind. At the end of the sub's run, the Navy guys came down to retrieve the driver and sub.

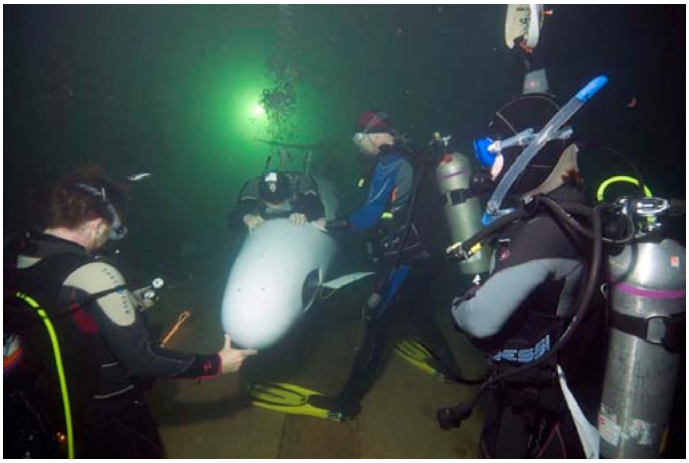
The best speed of 7.28 knots (3.8 m/s), was achieved by a single occupant propeller driven sub from Montreal (École de Technologie Supérieure). The team I was with was slower (0.5 knots) but, importantly, finished the course! There is substantial room for improvement for this novel drive and my video data provided some insight into how this might be achieved.

But speed is not a primary concern. Buoyancy and steering are more important. Without good attitude and yaw control a sub could crash into the bottom or surface prematurely. Pitching up and down or drifting from side to side also slows submarine progress.

These insights are of value for we at the Biomimetics Lab are building a sub of our own: "Taniwha". We plan to have it ready for the European International Submarine Races in 2014 at the QINETIQ facility near Portsmouth UK (www.eisr.org), and to compete in the next ISR at Carderock. Our Taniwha will also have a biomimetic drive and we are in the early stages of the build. The submarine project has already provided a platform for a Part IV project associated with an automatic buoyancy control device and we envisage the development of future devices for biomimetic propulsion. And it provides a platform for group engineering development activity.

If you want to find out more about what will be the first Southern Hemisphere entry into the International Submarine Racing scene, please drop by and pay us a visit in the Biomimetics Lab on Level 5, 70 Symonds Street.

Subs on "the beach", waiting their turn for a time trial.



Rivershark team getting ready to start. The driver is entering the sub in this image.

Rivershark at the starting line.

Above: Safety inflatable with Navy divers aboard follows a sub.
Top left: Iain with the Rhine Waal team.

New Zealand's Next Top Engineering Scientist 2013

After much deliberation and thought, the judges finally reached their decision, and we are pleased to be able to announce the results of the 2013 competition as follows:

The Pullan Prize winner for first place ($6000):

Team 1152 from Westlake Boys High School (Year 13)
Kevin Howe, Guy Hermanoche, Callum Lamont and Eugene Fong

Runners up, in second place ($2000 for each team):

Team 1045 from Botany Downs Secondary College (Year 13)
Tzu-Jui Lin, Daniel Cheah, William Teng and David Long

Team 1141 from Matamata College (Mixed)
Timothy Gray, Liam Nelson, Kelly Petersen and Renae White

In addition, there were 8 teams which were highly commended, and came from Rangitoto College (Mixed), Macleans College (Mixed) St Peter's School (Year 13), Otumoetai College (Year 13) ACG Strathallan College (Mixed), Kristin School (Year 13), Burnside High School (Year 13) and Bayfield High School (Year 13).

ORSNZ Annual Conference

Andrew Mason

This year's ORSNZ annual conference was run jointly with the NZ Statistical Association under the theme: Analytics for a Changing World: From Data to Decisions. This joint activity of the two associations proved to be very successful with over 130 talks and 175 attendees, and is likely to be repeated next year. This conference is, to our knowledge, NZ's first general conference on Analytics. See https://secure.orsnz.org.nz/conf47 for the conference details.

EngSci students Max Biggs and Jack Dunn both won $300 undergraduate prizes in the Derceto Young Practitioners Prize (see http://www.orsnz.org.nz/Prizes/#YPP). Antony Philips (EngSci PhD) won the $400 postgraduate Derceto YPP prize. Prizes were awarded by EngSci graduate Vessie Pencheva, from Derceto.

See https://secure.orsnz.org.nz/conf47/index.php?DOC=program/Papers/Proceedings.html for the YPP papers.

I awarded David Ryan a Presidents Lifetime Achievement Award. it turned out to be a good night for the extended Ryan family: David's sister Judi McWhirter, was also also recognised at this conference for her ongoing contributions to the NZSA.

I retired as President after 18 years as Treasurer, Web master, Vice President and President. Golbon Zakeri is taking over this important role. Andy Philpott thanked me for my contributions, and gave me a very generous thank-you gift.

Top left, left to right: Andrew Mason, Jack Dunn and Max Biggs (YPP undergraduate winners), and Vessie Pencheva.

Top right: Andrew Mason, Vessie Pencheva and Antony Philips (YPP postgraduate winner).

Bottom left: David Ryan and Judy McWhirter with their awards .

Andrew Mason with Andy Philpott.

Bier wins AUEA Award

from the AUEA Newsletter, September 2013

Peter Bier has received an AUEA Teaching Excellence Award. Peter was encouraged to apply for the Teaching Excellence Award by a colleague who recognised that his teaching has had a real effect in preparing students to join the engineering community.

Peter said that receiving the award is an honour. He will use part of the grant to attend international education conferences and workshops, which are rich sources of new ideas to improve teaching. These ideas will be shared with other engineering academics to improve teaching practices across the faculty.

The grant will also fund the purchase of tablet hardware and software to help with his current investigation into how new mobile and tablet devices can be used to improve students' learning.

In addition to teaching, Peter runs the New Zealand's Next Top Engineering Scientist Competition.

Help! our next issues...

Energy theme

Are you involved in the energy industry? If so, we'd like to hear about it.

Social contribution

Do you donate your time and skills to help others? If so, we'd like to hear about it.

des-newsletter@auckland.ac.nz

Photo credits

Peter Bier with David Carter from Beca (above) taken by Godfrey Boehnke.

Alumni profile photos provided by the alumni profiled.

Taniwha (front page) and Human Powered Submarine photos (page 4), taken by Iain Anderson.

ORSNZ Annual Conference photos 1-3 taken by Harold Henderson, NZSA, 4 taken by Guillermo Cabrera.