## **ENGINEERING, COMPUTING AND MATHEMATICS**

## Bachelor of Engineering & Master of Professional Engineering

## Final Year Project Descriptions

**Semester 2, 2015**

To find a project description, search (Ctrl + F) using the Supervisors surname. The project title and description are listed below each Academic’s name. Please ensure that the project is applicable to your discipline.

# Aman, Zachary, Dr

**Co-supervisors: May, Eric, Professor; Johns, Michael, Professor; Graham, Brendan, Dr.**

## Flow Assurance and Natural Gas Hydrates

**Disciplines: Chemical Engineering, Mechanical Engineering (Oil and Gas Major), Mechanical Engineering**

Natural gas hydrates are ice-like solids that form and can often suddenly stop the flow during oil and gas production. The cost of their prevention during design and production is high and the removal of hydrate plugs is expensive and dangerous. Today hydrates are still a major flow assurance concern especially as production moves to deeper water, and many of Australia’s major new gas field developments are considering innovative approaches to this long-standing problem. These projects aim to provide the knowledge needed for a risk-based approach to hydrate management by establishing quantitative model to assess plugging potential, optimize inhibitor doses, and develop methods to detect hydrate formation and location using novel technologies. The outcomes will help reduce chemical use by the industry, provide better methods to locate plugs and provide safer methods for their remediation, ultimately allowing for the reliable and economic development of marginal oil and gas fields. Students working on these projects will measure and/or model hydrate formation, agglomeration and dissociation processes. Naturally-occurring gas hydrates also represent a tremendous energy reserve: in early 2013, first production was reported from a naturally occurring hydrate reserve located offshore the coast of Japan. Projects will also be available in which various properties of these natural hydrates are quantified, such that more informed decisions regards the exploitation of natural hydrates can be made.

# Baillie, Caroline, Professor

***Mining Communities***

**Disciplines: Chemical and Process, Civil, Environmental, Materials, Mechanical, Mining, Oil and Gas, Petroleum**

**Prerequisite skills: An interest in the social, economic and political context, preparedness to read behind the scene and learn new skills of social science research.**

In this group we will be exploring approaches to enable mining companies to work in more equitable, sustainable ways with locally affected communities, paying attention to land rights, environmental issues and community interests and needs. Focusing on cases in different contexts, particularly in Latin America and Western Australia we will conduct research which will ultimately create outcomes to support better practice in the future of mining worldwide

# Basarir, Hakan, Dr

***Preliminary estimation of rock mass strength properties using drilling information***

**Disciplines: Mining**

**Prerequisite skills: MINE4401, MINE4404**

The purpose of this project is to try to establish a link between rock mass strength (as estimated by parameters such as RMR and GSI) and operational parameters of diamond bit drilling (such as RQD and UCS). A database compiled from exploration drilling and the laboratory tests conducted on the samples taken from drilling will be used. Rock mass classification and characterization systems such as RMR and GSI will be used to calculate rock mass strength properties. The calculated strength parameters will be used to check the performances of empirical equations using RQD and UCS, then an attempt will be made to find out the link between calculated strength parameters and recorded RQD and UCS values.

# Beckett, Chris, Dr

**Co-Supervisor: Guzzomi, Andrew, Dr**

***Tracking wear on plough tines***

**Disciplines: Civil, Environmental, Mechanical**

**Prerequisite skills: Experimental and numerical work, dependent on the chosen topic**

Soil properties have a strong effect on the flow of soil around a plough tine. This project comprises an experimental and a numerical study of particle flow as a tine moves through controlled soil samples. A test rig and testing procedure have been developed by a previous student. This phase of the project calls for conducting more tests, concentrating on a wider range of variables. This work is in collaboration with an external industry partner and will help to inform better, more wear-resistant tine design, which will have a significant and positive impact on the Australian agricultural community. Students should be confident in geomechanics and numerical analysis (depending on the selected project component) and be willing to participate in regular meetings with the industrial partner.

# **Bluteau, Cynthia, Dr**

***Sediment mobilisation on the continental shelf***

Disciplines: Chemical & Process, Civil, Environmental, Ocean Systems

Prerequisite skills: Some knowledge of matlab is preferred

A 50-d field programme, aboard the RV Roger Revelle was undertaken from January 9th to early March 2015, which was focused on the internal wave climate on the eastern Tasman continental shelf. As part of the programme, fifteen deep-sea moorings were deployed with various sensors to collect velocity, temperature, salinity, and some biological data.

This field programme was complemented by a project on sediment mobilisation from internal waves, involving the collection of sediment and turbidity related data such as optical backscatter, acoustic backscatter sediment profiler, and a laser to analyse sediment particle size distribution in the water column. A number of sediment sample grabs were taken from the seafloor, in addition to water samples to provide "in-situ" observations of sediment concentrations and sediment particle size distribution. The purpose of these measurements is to calibrate and validate some of the other sediment data streams, particularly the optical backscatter.

Hence, the goal of this final year project would be to analyse in the laboratory the sediment and water samples from the field programme, whilst relating them to other data streams that have been already processed and perhaps even placing them in the context of the background oceanic conditions.

For more information on the entire project: <https://scripps.ucsd.edu/projects/ttide/2015/02/12/revelle-breaking-undersea-waves-make-you-a-fish-sandwich/> .

# Boukpeti, Nathalie, Dr

**Co-Supervisor: Carraro, Antonio, Associate Professor**

***Behaviour of artificial soil and offshore sediments***

**Disciplines: Civil**

**Prerequisite skills: Basic geomechanics**

The project aims at creating an artificial soil with a similar mechanical behaviour as silty carbonate soils found offshore. To achieve this aim, a series of laboratory tests will be conducted on various mixtures of clay, silt and sand, focusing mainly on the compression response. The observed responses will be compared with the available databases and literature on the behaviour of silty carbonate soils. The possibility of creating an artificially bonded soil will also be explored.

# **Boussaid, Farid, Professor**

***Efficient energy harvesting interface circuits***

Disciplines: Electrical & Electronic

Prerequisite skills: ELEC5503

The ever increasing demand for portable and miniature yet computationally powerful electronic devices has put stringent size and weight requirements on the power source or battery, whose capacity is in turn being increasingly limited. The proposed projects will tackle the issue and explore ways to design efficient interface circuits to extract (harvest) the maximum power from available ambient energy sources (e.g., solar power, thermal energy, or kinetic energy). During the project, you will further develop your analog circuit design skills in the area of energy harvesting and power management.

# **Cardell-Oliver, Rachel, Associate Professor**

Co-Supervisor: Wang, Jin, Dr

***Revealing Household Characteristics from Smart Water Meter Data***

Disciplines: Civil; Computer; Environmental; Software

Prerequisite skills: Statistical Tool Skills (such as MATLAB, R); Programming; Knowledge of data mining techniques an advantage

Water and energy utility companies would like to use smart meter data to enable personalized and scalable water efficiency programs for private households. In order to do this, it is desirable to identify the characteristics of the household (e.g., family or single, senior or not) using only smart meter data from the household, rather than expensive and intrusive surveys. This is a machine learning classification problem. Beckel et al (2014) propose a method for inferring knowledge about a household from its energy data. The proposed project is to investigate how well this approach could work for smart water meters, and to tune the approach for the water industry. This is an industry-focused project with the CRC for Water Sensitive Cities, and the project will use data sets from the Water Corporation of WA.

[1] C. Beckel, L. Sadamori, T. Staake, and S. Santini, “Revealing household characteristics from smart meter data,” Energy, vol. 78, pp. 397–410, Dec. 2014.

# Chua, Hui Tong, Professor

**Co-Supervisor: Srinivasan, Kandadai, Adjunct Professor**

***Methane cracking, storage and synthesis of inorganic nanoparticles***

Disciplines: **Chemical & Process, Materials, Mechanical, Oil & Gas**

Prerequisite skills  **Heat and mass transfer, thermodynamics**

(i) The zero emission use of methane to produce industrial hydrogen and high value added graphitic carbon. Students can work on the catalytic process of cracking or the downstream characterisation and functionalization of the graphitic carbon for catalysis and electrochemical applications.

(ii) The storage of methane, short-chain hydrocarbons, and other gases via adsorption. The student will analyse isotherm data and with which predict calorimetric heat and specific heat data. This is important for Chemical Engineering gas separation processes.

(iii) The student will work on a state-of-the-art high flux bright light driven chemical reactor to synthesise inorganic fullerenes and nanotubes, and graphene. The former are excellent materials for lubrications, both for engines and medical applications, while the latter are excellent for electrochemical applications, such as batteries and supercapacitors.

# **Chua, Hui Tong, Professor**

Co-Supervisor: Srinivasan, Kandadai, Adjunct Professor

*Geothermal engineering and waste heat desalination*

Disciplines: **Chemical & Process, Mechanical**

Prerequisite skills:  **Heat and Mass Transfer, Thermodynamics.**

i) The realistic and optimal scheduling of the geothermal submersible pump to shave pumping power consumption and maintain comfort and specified temperature in Olympic size swimming pools.

(ii) Design of a geothermal air conditioning system for the Australian International Gravitational-wave Observatory (AIGO), in collaboration with the Gravitational Wave Observatory.

(iii) Development of an industrial waste heat driven desalination system as a holistic energy/emission reduction and water management tool for refineries.

(iv) Development of a microturbine-desalination system for combined power and water supply solution to mine sites.

# **Doherty, James, Dr**

***Experimental investigation into the mechanical behavior of mine backfill***

**Disciplines: Civil**

**Prerequisite skills: Suitable for civil engineering students with a strong interest in soil mechanics and geotechnical engineering**

Underground mining creates large voids known as stopes. To ensure regional stability of the mine, stopes are backfilled with a mixture of tailings (waste from ore processing) and cement. Water is added to the material to achieve a slurry-like consistency to aid transport to the stope via a reticulation system.

Two key questions that arise at all backfilling operation are

* How much cement must be added to the backfill?
* How fast can the stopes be filled?

Obtaining accurate answers to these questions has a significant economic impact on virtually all underground mines in Australia. To properly address these questions, the mechanical (and chemical) properties of mine backfill must be clearly understood. The aim of this project will be to undertake laboratory studies on backfill samples from Australian mine sites.

# **Doherty, James, Dr**

***The numerical/experimental studies on deep and shallow foundations***

**Disciplines: Civil**

**Prerequisite skills: Suitable for civil engineering students with a strong interest in soil mechanics and geotechnical engineering**

The aim of this project will be to conduct a range of experiments on the stress-strain and creep strain response of sands using advanced element testing, a newly developed uwa mini pressuremeter, as well as developing new testing equipment that can measure the load displacement response of miniature footings and piles. The results will be back analysed with engineering software package.

# Doyle, Barry, Dr

## Vascular Engineering

Disciplines: Chemical & Process, Computer, Materials, Mechanical, Software

The vascular system is essentially a pump connected to a network of elastic pipes. However, this pump system can become impaired via disease with heart disease killing 1 Australian every 12 minutes! These projects will investigate different forms of cardiovascular disease through computational and/or experimental modelling. For example, you may use patient-specific CT images to reconstruct a diseased aorta and use the FEM to examine the stress within the wall of an aneurysm, or how the blood flows through a device that treats the aneurysm. Or you may need to work with animal aortic tissue to discover the forces required to burst the vessel.

Please see the VascLab website for much more info on the collaborative research we perform.

<http://vasclab.mech.uwa.edu.au>

# Doyle, Barry, Dr & Sercombe, Tim, Professor

## New applications for 3D bioprinting

Disciplines: **Chemical & Process, Electrical & Electronic, Materials, Mechanical**

Bioprinting has the potential to revolutionise the way we think about organ and tissue replacement. Currently, it is possible to harness the power of additive manufacturing (eg. 3D printing) and combine this with biomedical sciences to create living tissues with incredible geometric complexity.

In this project, you will use our current bioprinting technologies to bioprint new structures for different applications. For example, you may bioprint synthetic membranes to replace burst ear drums, or bioprint patient-specific tracheas to replace diseased airways. These are just some potential applications; the possibilities are almost endless....

# Dyskin, Arcady, Professor

## Modelling of rock bursts in underground mining

## Disciplines: Civil, Mining, Petroleum

## Pre-requisite skills: Finite Element Analysis

## Rockbursts in miming case considerable damage to the excavation, financial loss and in some cases loss of life and injuries. Similar failure mechanism, but at smaller scale, is observed in borehole breakouts.

## The project will concentrate on mechanism of rockburst related to (large scale) spallation from the excavation surface. It consists of finite element modelling of the excavation shape changing as a result of spallation. Three sub-projects will deal with three different initial shapes of the excavation (circular, square, long-wall). The fourth sub-project will concentrate on the classification of rockbursts from the point of view of possible mechanisms.

# **Faiello, Cosimo, Associate Professor**

***Sustainability applied to project management & engineering practice***

Disciplines: Chemical & Process; Civil; Computer; Electrical & Electronic; Environmental; Materials; Mechanical; Mining; Oil & Gas; Petroleum

This topic will introduce students to the field of project management and engineering practice with a focus on achieving sustainable results based on a “triple bottom line” (TBL) approach: That is, achieving project objectives, while taking into account the societal and environmental implications of a project. A sustainable approach to project management and engineering practice is recognised globally by many organizations, as being vital to achieving their strategic objectives. By researching this topic students will learn how to apply theoretical concepts and frameworks to ‘real world projects’ in order to achieve sustainable outcomes using a TBL strategy.

# **Fernando, Tyrone, Professor**

***Stability Analysis of a DFIG Wind Turbine System***

Disciplines: Electrical & Electronic

Presently there is a global concern about the economic downturn and a green earth which in turn is related to a better and efficient method to generate and transmit electric power. Wind energy systems are becoming popular. Doubly fed induction generator (DFIG) is a popular wind turbine system due to its high energy efficiency, reduced mechanical stress on the wind turbine, and relatively low power rating of the connected power electronics converter. The DFIG is also complex involving aerodynamical, electrical, and mechanical systems. With increasing penetration level of DFIG‐type wind turbines into the grid, the stability issue of DFIG is of great importance to be properly investigated. The aim of this project is to study the small signal stability of the DFIG wind turbine system.

# **Fernando, Tyrone, Professor**

***Control Strategy of DFIG Wind Turbines for Power System Fault***

Disciplines: Chemical & Process; Electrical & Electronic

Doubly fed induction generator (DFIG) is a popular wind turbine (WT) system due to its high energy efficiency, reduced mechanical stress on the WT, and relatively low power rating of the connected power electronics converter of low costs. With increasing penetration level of WTs into the grid, the wind power grid connection codes in most countries require that WTs should remain connected to the grid to maintain the reliability during and after a short‐term fault. The ability of WT to stay connected to the grid during voltage dips is termed as the low‐voltage ride‐through (LVRT) capability. The aim of this project is to develop a control strategy for both the rotor and grid side converters to enhance the LVRT capacity of the DFIG WT.

# Fourie, Andy, Professor

***Optimising backfill scheduling in an underground mine***

**Disciplines: Civil, Mechanical, Mining**

**Prerequisite skills: ENSC3009**

Backfill is increasingly used in underground mines in Australia; the benefits include improved ore recovery, reduced dilution, accelerated rates of mining and reduction of surface tailings impoundments. However, current costs of some backfill operations are extremely high. This project will investigate the optimisation of a backfilling operation by improving a range of activities and inputs, including turn-around time, alternative binders (to replace cement) and improved quality control systems.

# Guzzomi, Andrew, Dr

**Co-supervisor: Walsh, Michael, Dr (Australian Herbicide Resistance Initiative)**

***Harvest Seed Weed Control***

**Disciplines: Mechanical**

The West Australian grain industry produces 45% of Australia’s wheat from farms that are often vast remote areas. Techniques for targeting weed seed at grain harvest are now well recognised by Australian crop producers as an opportunity to minimise weed seed bank inputs thereby alleviating and even avoiding the impacts of herbicide resistance. Harvest weed seed control (HWSC) systems have been specifically developed and adopted in Australia to target weed seed exiting the harvester during commercial grain crop harvest. The effectiveness of these systems is completely dependent on the amount of weed seed retained on standing plants at harvest. Additionally, many farmers rely on residue removal/burning which are not particularly sustainable. Subsequently, there are significant agricultural engineering research and development opportunities associated with: 1) evaluating the effectiveness of the state-of-the-art Integrated Harrington Seed Destructor (IHSD); 2) research and developing more effective means of targeting weed seeds during harvest; 3) removing the non-seed containing bulk (>99%) of the chaff fraction processed through the IHSD, and; 4) collecting seed shed prior to harvest during harvest.

# Hu, Xiaozhi, Professor

**Co-supervisor: Jiang, Bin PhD**

## Making thin Kevlar fibre tissue for reinforcement of carbon-fibre composites for aerospace applications

**Prerequisite skills: Understanding of engineering materials and mechanical design are preferred.**

**Disciplines: Materials, Mechanical**

Carbon-fibre composites are brittle because both carbon fibres and epoxy are brittle materials. Very thin Kevlar fibres (ductile fibres) tissues can be inserted between carbon fibre layers, which will significantly enhance the impact resistance of the modified carbon fibre composites.

The key is to make very thin Kevlar fibre tissues (as thin as possible). The project is mainly experimental.

# Hu, Xiaozhi, Professor

**Co-supervisor: Jiang, Bin PhD**

***Adhesive bonding of metals and composites for aerospace applications***

**Prerequisite skills: Understanding of engineering materials and mechanical design are preferred.**

**Disciplines: Materials, Mechanical**

Carbon fibres are becoming increasingly popular for various industrial applications. Adhesive bonding of these composites with metals can be critical to the composite structures.

We will test various methods to improve the adhesive bonding of composites and metals. The project is experimental.

# **Huang, David, Professor**

***Future generation broadband wireless communications***

Disciplines: Electrical & Electronic

Prerequisite skills: Communication systems (ELEC3302/4402)

This project is focused on promising technologies for future broadband wireless communications systems including:

• Massive Multiple-Input and Multiple-Output (MIMO) Systems

• Orthogonal Frequency Division Multiplexing (OFDM) Systems

• Multiple Access Techniques

• Advanced channel coding techniques

# **Huang, David, Professor**

***Low earth orbit satellite communications***

Disciplines: Electrical & Electronic

Prerequisite skills: Communication systems (ELEC3302/4402)

Low earth orbit (LEO) satellite communications may be the most promising solution to remote areas in Australia. However, the existing systems (such as the Iridium system and Globalstar system) only provide low data rate services, and they are expensive. In this project, we aim to design a new LEO satellite communication system that, hopefully, is better than the existing systems. To sell our new system, we will need to answer many questions. Here are a few examples:

1) What radio bands are available for use?

2) How many satellites (and spot beams) are needed?

3) What services could the satellite provide?

4) If the system is feasible from a technology perspective, how could we make it commercially feasible?

# **Iu, Herbert Ho-Ching, Professor**

***Development of memristor based relaxation oscillators***

Disciplines: Electrical & Electronic

Prerequisite skills: Excellent mathematical skills and simulation/hardware skills

In this project, a memristor based relaxation oscillator will be developed. A flux-controlled memristor emulator with floating terminals by making use of four current conveyors has been proposed. By replacing the three resistors in the positive and negative feedback loops of a typical relaxation oscillator respectively, three cases of memristor emulator based oscillating circuits can be theoretically constructed and mathematically analyzed. This new memristor emulator based oscillator will provide novel and steady oscillating behaviors.

# Liu, Jishan, Professor

## In-Situ Leaching of Minerals

Disciplines: Chemical & Process, Mining, Oil & Gas, Petroleum

Prerequisite skills: **knowledge of flow in porous media and modelling skills are desirable.**

In-situ leaching involves drilling of holes into the ore deposit. Explosive or hydraulic fracturing may be used to create open pathways in the deposit for solution to penetrate. Leaching solution is pumped into the deposit where it makes contact with the ore. The solution bearing the dissolved ore content is then pumped to the surface and processed. This process allows the extraction of metals without the need for mining. The goal of this project is to understand the mechanisms of minerals in-situ leaching and to examine the ways how to enhance the extraction efficiency. This goal can be achieved through (1) development of a mineral dissolution model for minerals; (2) simulation of solution flow in ore deposits; (3) evaluation of stimulation techniques; and (4) assessment of environmental risks.

# Liu, Jishan, Professor

## Extraction of Unconventional Gases

Disciplines: Oil & Gas, Petroleum

Prerequisite skills: K**nowledge of flow in porous media and modelling skills are desirable.**

The cost-effective horizontal drilling and hydraulic fracturing technologies, along with the implementation of protective environmental management practices, have enabled the commercial production of gas from previously unproductive gas reservoirs including shale gas, coal seal gas and tight sand gas. The goal of this project is to examine what factors affect the gas production rate and how they can be controlled in-situ. This goal can be achieved through application of a simulation tool to examine the following factors: (1) gas desorption induced shale deformation; (2) hydraulic fracture density; (3) rock micro-structures; and (4) in-situ stresses.

# Johns, Mike, Professor & May, Eric, Professor

***Carbon Sequestration***

**Suitability: Chemical Engineering, Mechanical Engineering, Mechanical Engineering (Oil and Gas Major)**

Western Australia has several major offshore gas assets containing significant quantities of carbon dioxide. Scenarios for dealing with this CO2 must be developed before these gas fields can be developed. One scenario involves the re-injection of carbon dioxide produced from one reservoir into the extremities of a different natural reservoir for the purpose of both CO2 disposal and enhanced gas recovery. However, such a strategy is only viable if the probability of breakthrough by the re-injected CO2 to the producing wells is small. Simulating reliably this novel reservoir production scenario requires an improvement in our fundamental understanding of the hydrodynamic behaviour of supercritical CO2 in heterogeneous gas and water-saturated rock. Research projects are available measuring this behaviour as well as its inclusion into relevant field simulations.

# Johns, Mike, Professor; Dr Einar Fridjonsson, Dr Brendan Graham, Dr Zach Aman

## Oilfield Water Management

**Disciplines: Chemical Engineering, Mechanical Engineering, Mechanical Engineering (Oil and Gas Major)**

Natural gas (and oil) extraction results in the production of substantial quantities of (formation) water. This water is required to be discharged back to sea following separation from the hydrocarbon fluid. Increasingly this separation is being pursued sub-sea, such that water treatment on the surface is avoided. Such sub-sea technology is particularly relevant to floating LNG production facilities. We are currently developing technology to both monitor the ppm oil contamination of this discharge water such that it is compliant with environmental legislation, as well as the use of novel NMR-based flow metering methods for oil/gas/water production flow quantification. Projects are available in which further validation of these technologies will be conducted as well as their adaptation for sub-sea deployment. We also consider optimum desalination of sea water for the provision of required process water and the effective separation of frequently encountered and troublesome water-in-crude oil emulsions into their constituent parts.

# Joldes, Grand, Senior Research Fellow

**Co-Supervisors: Miller, Karol, Professor and Doyle, Barry, Assoc/Prof**

## Stress modelling in vascular aneurisms

Disciplines: Mechanical

Prerequisite skills: **Finite Element Modelling**

Abdominal aortic aneurysm (AAA) is a symptomless disease and has earned itself the reputation ‘the silent killer’. AAA rupture kills nearly 4 Australians every day and surgical repairs cost the national health system ~$230m/year. Importantly, the majority of these operations may be unnecessary as only 10% of cases ever rupture. If we could reliably predict which cases are at risk of rupture and which are not, we could save many lives and reduce the huge associated medical costs. Patient-specific modelling (PSM) is fast becoming a useful risk assessment tool.

This project involves the modelling of AAA using the finite element method and the computation of stresses in the vascular wall under the effect of blood pressure. You will evaluate and use a set of tools developed at ISML for AAA extraction from medical images, model creation and FEM simulation.

# Karrech, Ali, Associate Professor

***Mechanical Instability of Pipelines under Large Deformation***

**Disciplines: Civil**

**Prerequisite skills: Finite Element Method and Solid Mechanics**

Pipelines are used by the oil and gas industry to transfer fluids under variable loading conditions. They often undergo large and/or permanent deformations, which can affect their performance. The purpose of this project is to use advanced finite element and continuum damage mechanics techniques to describe the bifurcation of these structures.

# Karrech, Ali, Associate Professor

***Pit Optimisation and Slope Stability in Surface Mining***

**Disciplines: Civil, Mining**

**Prerequisite skills: Surface Mining and Rock Mechanics**

This project integrates surface mine design techniques and advanced numerical modelling of rock deformation. Optimisation and Computer Aided Design tools will be used to produce pit outlines which maximise profit under geotechnical constraints. The obtained results will be integrated in a numerical framework, which uses advanced parallel computing techniques to estimate slope stability. The process will be iterative depending on predefined mining schedules.

# Karrech, Ali, Associate Professor

***Blast Induced Vibrations in Fractured Rock Masses***

**Disciplines: Civil, Mining**

**Prerequisite skills: Surface Mining and Rock Mechanics**

Blasting is commonly used in surface and underground mining to fragment rock masses and subsequently facilitate their loading and haulage. The existence of joints, fractures and damage zones and their spatial distributions affect the responses of rock masses. The purpose of this research work is to study the stochastic nature of weaknesses on the overall mechanical performance of materials using numerical methods. In particular, strength, stiffness, and energy attenuation will be investigated under different loading conditions.

# **Keating, Adrian, Professor**

Co-Supervisor: Parish, Gia, Professor

## Micromachining of low modulus, porous films at the microscale

Disciplines: Computer, Electrical & Electronic, Materials, Mechanical, Mechatronic, Software

Prerequisite skills: This is an interdisciplinary project. An understanding of measurement systems (such as obtained through MECH4424) would be valuable. Matlab/Mathematica required

This project investigates how micromachines can be made using highly porous, low modulus films at the microscale. The nano sized pores in the films can be used to tailor the mechanical properties properties, which is useful for next generation, ultrasensitive bio- and chemical-sensors. Techniques will be reviewed and compared, modelling undertaken (ANSYS or COMSOL) and depending on the skills of the applicants, experiments will be designed and developed to undertake measurements of these films.

# **Keating, Adrian, Professor**

## Characterisation of fibre optic endoscopes

Disciplines: Computer, Electrical & Electronic, Materials, Mechanical, Mechatronic, Software

Prerequisite skills: This is an interdisciplinary project. An understanding of measurement systems (such as obtained through MECH4424) would be valuable. Matlab/Mathematica required.

High density endoscopes are becoming available with greater than 10,000 separate fibre cores. These imaging bundles contain separate fibres which guide the light ina flexible bundle from the object to the camera. However, methods to understand the performance these fibres bundles is required. Within this project students will review models for endoscopes, extend optical models, setup a test bed to evaluate optical properties, and evaluate performance metrics of the fibre bundles.

# Leggoe, Jeremy, Professor

## Characterising the surface properties of iron ore fines

**Prerequisite skills: Interest in Programming, Strong Numerical Modelling Skills, Strong Statistics and Mathematical skills, good grasp of Materials Science; some understanding of soil science and/or geomechanics would also be appropriate..**

**Disciplines: Mechanical, Mining**

## The behavior of iron ore in transport processes is strongly influenced by the properties of the particles being transported – particularly the properties of the fines. These properties are poorly understood at present, and this project will seek to characterize the current understanding, and identify (and, as feasible, undertake) experimental techniques to characterize the important surface properties of the particles, with particular emphasis on the effect of moisture content on these properties. Ultimately, the goal is to identify and develop appropriate techniques for modeling the interactions of iron ore fines.

# Leggoe, Jeremy, Professor

**Co-Supervisor: Aman, Zach, Assoc/Prof**

***CFD modeling of immiscible liquid jet break-up***

**Prerequisite skills: Successful completion of ENSC3003 or CHPR 2433 (Fluid Mechanics); Interest (and/or experience) in Computational Fluid Dynamics.**

**Disciplines: Chemical and Process, Mechanical**

In the event of a well blowout, the breakup of the resulting jet is a significant factor in determining the ultimate dispersion of the released material in the environment. This project will develop and interpret CFD models of jet releases into a quiescent relationship to explore the relation between jet dynamics and the distribution of bubble sizes produced by the process. Particular emphasis will be directed towards identifying the relationship between turbulent processes and the bubble size distribution, including a comprehensive review of the relevant literature and subsequent model development.

Previous completion of ENSC3003 (and ideally strong performance I the unit) would be an advantage for this project.

# **Li, Xiaopeng, Dr**

Co-Supervisor: Sercombe, Tim, Professor

## Metallic Glasses from Elemental Metals: A Three Dimensional Printing Prospect

Disciplines: Chemical and Process, Materials, Mechanical

Bulk metallic glasses (BMGs) are a class of advanced materials with novel mechanical and functional properties. They are usually fabricated through rapid casting where sufficient melting of the elemental metals before the casting step is a prerequisite for the successful fabrication of BMGs. In the past decades, BMGs with five and even more elements including some expensive or toxic elements e.g. Pd and Be have been developed in order to achieve large scale BMGs. This makes the melting of these elemental metals more challenging, which has been considered as a bottleneck for the development of entire BMGs field. In this project, Three Dimensional Printing will be used to fabricate BMGs from elemental metals. Two types of BMGs Zr-Cu and Zr-Cu-Al-Co will be investigated. This will provide an innovative and low cost alternative to the fabrication of large scale BMGs.

# Liu, Yinong, Professor

***Subsea Pipeline Corrosion***

**Prerequisite skills: Knowledge set of materials engineering, corrosion**

**Disciplines: Chemical & Process, Materials, Mechanical, Oil & Gas, Petroleum**

This project is an industry sponsored project involving corrosion testing of large scale pipeline samples and laboratory study using electrochemical and chemical techniques. It is experimental based.

# Liu, Yinong, Professor

**Co-Supervisors: Martynuik, Mariusz, Professor, Silva, Dilusha, Professor**

***Silicon based thin films for microelectromechanical systems***

**Prerequisite skills: knowledge set of mechanical engineering, materials engineering**

**Disciplines: Electrical & Electronic, Materials, Mechanical**

This project aims to study the synthesis and properties of Si-Ge thin films used for fabricating microelectromechanical system devices. The project involves experimental work including thin film synthesis, nanomaterials characterisation and possible mechanical (FE) modelling.

# Ma, Guowei, Professor

***Load carrying capacity of GFRP bar reinforced concrete columns***

**Disciplines: Civil**

**Prerequisite skills: Concrete structure design**

Special consideration is needed when designing reinforced concrete structures in corrosive environments such as near the ocean or in situations where corrosion can be accelerated. Glass fibre reinforced polymers (GFRP) can be used as a substitute to steel reinforcement in these structures as GFRP does not corrode like steel. Full scale experiments will be conducted in this particular research to investigate the compressive strength of GFRP bar reinforced concrete columns. These results will be analysed to determine if the use of GFRP bars is practical, and to give accurate guidelines as to what precautions, if any, should be taken when using GFRP in reinforced concrete structures.

# Ma, Guowei, Professor

***Energy absorption blast resistant wall analysis and design***

**Disciplines: Civil**

**Prerequisite skills: Structural dynamics**

Energy absorption capacity is one of the important factors that must be considered for blast resistant wall analysis and design. This project will proposed an innovative design of blast resistant wall using energy absorption devices at the supports. Blast energy will be dissipated at the supports through plastic deformation and frictional effect. Dynamic analysis will be carried out by considering the mode of failure of the structure. Capacity of the blast resistant wall will be evaluated by numerical analysis and experiments.

# **MacNish, Cara, Professor**

Co-Supervisor: Holden, Eun-Jung, Professor

***Automated Feature Identification in Geophysical Data***

Disciplines: Civil; Environmental; Mechatronic; Mining; Ocean Systems; Petroleum; Software

Prerequisite skills: Matlab programming, mathematical and data conceptualization, ingenuity

Machine learning is an area of AI that can be used to identify features in data. This may include, for example, geological features in aerial photographs, weather system features in satellite images, or astronomical features in telescope images. Deep learning seeks to break down the feature learning task into a hierarchy of structured representations. As an example, convolutional neural networks are inspired by mechanisms thought to occur in the human eye and visual cortex. Rather than process an image directly into recognisable features, different layers 'look for' different kinds of features, such as lines, composite shapes, or more complex objects or structures. The aim of this research topic is to investigate the use of deep learning techniques for identifying key features in geological or environmental data. Applications could include mineral exploration or early warning systems.

# May, Eric, Professor

**Co-Supervisor: Graham, Brendan, Dr**

## Natural Gas Processing

Disciplines: Chemical Engineering, Mechanical Engineering, Mechanical Engineering (Oil and Gas Major)

Prerequisite skills: Solid Mechanics, Numerical Methods in Engineering, Finite Element Methods

1(a): Natural Gas and LNG property prediction

Unplanned shutdowns of LNG plants caused by hydrocarbon solids blocking cryogenic heat exchangers are a major, ongoing problem for the industry. Current methods of avoiding them are costly and energy intensive. In addition, LNG production systems are over-engineered because the predictions of process simulators are unreliable. Furthermore, the natural gas industry needs new thermo-physical property data at high-pressures and low temperatures to develop more efficient processes capable of handling more problematic gas reserves. These projects aim to develop new predictive models to avoid shutdowns and improve plant efficiency, and/or improve the reliability of process simulator predictions by anchoring their underlying thermodynamic models to data characteristic of realistic LNG fluids and conditions. Students working on these projects will help develop or improve models that predict crucial properties such as vapour-liquid and solid-liquid equilibrium, density, heat capacity, viscosity, surface tension or thermal conductivity for binary and multi-component hydrocarbon mixtures. This will be done by combining state-of-the-art measurements of these properties with new property package models in process or multi-phase flow simulation software.

1(b): Advanced Natural Gas Separation Technology

Carbon dioxide capture, whether from natural gas streams or from flue gases, is an important and increasing area of research with significant implications for our economy and environment. N2 capture from natural gas is increasingly important in the development of LNG projects where this component is energetically parasitic. These projects will look at the use of novel materials for improved capture efficiency that are either solid adsorbents, including carbons, zeolites and calixarenes, or liquid solvents, such as transition metal complexes. Students working on these projects will help develop and characterise the separation performance of new materials synthesized in our laboratory over a wide range of temperature, pressure and mixture compositions, and/or use the results of such experiments to develop numerical models of advanced industrial separation processes.

# **McDonald, Chris, Dr**

***Gesture-based Authentication and Authorisation***

Disciplines: Computer; Electrical & Electronic; Mechatronic; Software

Prerequisite skills: Systems programming, networking, some knowledge of cryptographic software

As computing devices become smaller and increasingly ubiquitous, they are used not as traditional computers but as digital conduits to devices with greater computing ability and access to data. While smartphones have computing and storage capacities that mirror those of desktop computers of just a decade ago, their most common role is to present a small form-factor interface to complex programs over network connections. The access to remote programs and data requires authentication; traditional approaches still involve usernames and passphrases, captured via an on-screen keyboard, and securely transmitted to the provider of the data.

However, in some work environments, the use of an on-screen keyboard is often difficult - if the user is wearing gloves, or if the environment is hazardous, dusty, wet, or sterile. Authentication details are often cached by smartphones, but doing so actually authenticates the device, not its current user, and prevents device sharing. Moreover, newer generations of wearable devices, such as wristbands, bracelets, and thimbles, don't have keyboards and, often, only single line displays.

This project seeks to investigate the use of gesture-based authentication, to enable the current holder, or carrier, of a smart-device to authenticate with a remote computing system, and to remain the authenticated user until they proactively leave the system, a period of inactivity elapses, or another new user takes up the device. The gestures should involve three- or higher dimensional data streams capture from the devices' gyroscopes, digital compass, and clocks, in a manner that a remote computer system can request a specific higher-dimensional gesture to be rendered, or performed, or a register user can repeat a stored gesture that applies to their intended role.

# **McDonald, Chris, Dr**

***Visualisation of network firewalls***

Disciplines: Computer; Electrical & Electronic; Mechatronic; Software

Prerequisite skills: Systems programming, networking, some knowledge of cryptographic software

Computer network firewalls monitor and filter network traffic based on a combination of characteristics, such as the physical attributes of the traffic, the protocols being employed, and the traffic's relationship with other traffic observed over a window of time. Contemporary operating-systems and devices implement their firewall software in their kernels, and define and monitor their firewalls' operations through either command-line or graphical interfaces that interact with data-structures and functions provided by the kernel. Some contemporary firewall suites have names netfilter, iptables, NFTables, and PF.

This project seeks to develop software to visually demonstrate the operation of a network firewall, by executing the same code that the kernel, itself, executes and annotating the actions taken. The software will support firewall specification rules written for at least two of the contemporary systems, and receive its network traffic from either real or synthetically generated network packet traces. Several firewall devices will be simulated in a large environment, where each firewall maintains and executes its own ruleset and traffic and application mix.

# McLaughlin, Robert, Associate Professor

***Image processing and Visualisation of Optical Imaging Data***

**Disciplines: Computer; Electrical & Electronic; Software**

**Prerequisite skills: C, C++ or Java**

This project will develop image processing and visualisation algorithms for high resolution imaging data in biomedical applications. The Optical + Biomedical Engineering Lab develops new medical imaging techniques for a range of diseases, including cancer detection and intra-operative guidance. Depending on the student’s aptitude, this topic contains a range of potential software development subprojects, including implementing algorithms for visualisation of very large data sets; automated techniques to quantify medical images; and algorithms for tissue detection.

Students are required to be experienced in one of the following languages: C, C++, Java. It is expected that some algorithm development will be done in Matlab.

Students are encouraged to come and talk to Robert McLaughlin to discuss possible projects prior to submission.

# **Mian, Ajmal, Associate Professor**

***Fusion of RGB and hyperspectral images for increased resolution***

Disciplines: Computer; Electrical & Electronic

Prerequisite skills: Matlab, computer vision or image processing

Hyperspectral cameras have low spatial resolution but high spectral resolution. This project aims to combine the spatial resolution of a conventional RGB camera with the spectral resolution of a hyperspectral camera to simultaneously achieve high spatial and spectral resolution. The student will be given access to our hyperspectral and RGB cameras and existing software developed in our lab [1]. The student will be required to collect data by imaging natural objects using the two cameras and then extend the existing software to perform better image fusion/resolution enhancement. To benchmark the new technique/software, the student will be given existing hyperspectral data used in the following paper [1].

[1] N. Akhtar, F. Shafait. A. Mian, "Sparse Spatio-spectral Representation for Hyperspectral Image Super-Resolution", European Conference on Computer Vision (ECCV), 2014. [pdf] [MATLAB code]

# **Mian, Ajmal, Associate Professor**

***3D object recognition***

Disciplines: Computer; Electrical & Electronic

Prerequisite skills: Computer Vision, Matlab or C++

Kinect-2 can simultaneously capture shape and texture of an object in XYZRGB form i.e. each pixel has Red, Green, Blue colour components and XYZ coordinates. This data allows to perform better object recognition under changing illumination and pose. In this project, the student will be required to collect data using the Kinect-2 sensor and develop algorithms to perform object detection in cluttered scenes. More precisely, the student will train a classifier with multiple XYZRGB images of objects and then detect these objects of interest in a scene containing background clutter.

# Oldham, Carolyn, Professor

***Impact of Dredging on seagrass and reefs near Exmouth***

**Disciplines: Civil, Environmental and Ocean Systems**

**Prerequisite skills: Matlab**

Coastal dredging can cause significant turbidity plumes along the coast impacting reef systems and seagrass meadows. To develop guidelines for dredging operations to protect coastal ecosystems, we require a good understanding of the natural variability in light over seasons and during storm events. You will be analysing extensive light data from Muiron Islands (off Exmouth), and from Exmouth Gulf to establish what background light levels are experienced by healthy ecosystems. This analysis will be used to develop dredging guidelines.

# **Pan, Jie, Professor**

Co-Supervisors: Keating, Adrian, Professor and Hodkiewicz, Melinda, Professor

## Energy harvesting - Inductive charging

Disciplines: Electrical & Electronic, Mechatronic

Prerequisite skills: Some electrical or physics background required. Likely to need a blend of theoretical and practical skills.

This project is about energy harvesting to power micro-sensors like those used in your phone. We need to identify the best approach to charging our sensors from the magnetic and electrical fields found around transformers. This will initially involve a literature review, patent search and search in the commercial space to identify options and then the development of a suitable approach. Depending on progress this project could also result in a functional spec. development and a prototype inductive charging unit being built.

# **Pan, Jie, Professor**

Co-Supervisors: Keating, Adrian, Professor and Hodkiewicz, Melinda, Professor

## Energy harvesting - Transformer magnetic field modelling

Disciplines: Computer, Electrical & Electronic, Mechanical, Mechatronic

Prerequisite skills: Matlab (for modelling) required. Ability (or willingness to learn) to use Arduino's and programs necessary for data collection. Aptitude and interest for experimental work.

This project is about energy harvesting to power micro-sensors like those used in your phone. We want to scavenge energy from the magnetic field around a transformer. The project will include experimental and modeling work to identify the concentration of the magnetic field and hence where to best place the sensors. The work will involve live transformers so you will develop and need to demonstrate industry-relevant safety management skills.

# Pan, Jie, Professor

**Co-Supervisors: Mathhews, Dave, Dr; Sun, Hongmei, Ms**

***Sensing, actuation and analysis of structural vibration***

**Prerequisite skills: Interests in undertaking experimental work on vibration and sound and prepared to spend at least 3 hours/week in the laboratory**

**Disciplines: Electrical & electronic, Mechanical, Mechatronic**

This group project is to develop advanced methods for investigating the characteristics of structural vibration and for condition monitoring of engineering structures. It includes (1) construction and characterisation of a non-contact electromagnetic shaker for measuring the frequency response function of small structures; (2) the use of PVDF in understanding the sound transmission in a violin bridge; (3) ball joint condition monitoring using PVDF sensors; and (4) the use of Cellular Automata in generating Chlandi patterns.

# **Pan, Jie, Professor**

Co-Supervisors: Sun, Hongmei, Ms.; Wilkins, Roberts

***Study and control of interaction between fluid, sound and vibration***

**Prerequisite skills: some background in vibration and control, and prepared to work in the acoustical lab for at least 3 hours/week.**

**Disciplines: Electrical & electronic, Mechanical, Mechatronic**

This group project is about an experimental and numerical study and control of the interaction between fluid, sound and vibration. It includes (1) measurement and prediction of transformer noise; (2) measurement, analysis and control of TBL induced structural noise; and (3) measurement and analysis of torsional vibration characteristics of violin strings.

# Pasternak, Elena, Professor

## Modelling of Fragmented Structures

**Prerequisite skills: Finite element analysis, matlab**

**Disciplines: Electrical & Electronic, Materials, Mechanical, Mechatronic, Oil & Gas**

Fragmented solids and structures are discontinuous or heavily fractured materials, whose fragments are not bound together. That is why prediction of structural response of fragmented bodies and evaluation of their mechanical properties is a challenging and exciting task. The project involves modelling of fragmented solids using the finite element method.

# Pattiaratchi, Chari, Professor

**Co-Supervisor: Wijeratne, Sarath, Dr**

***Connectivity around Australia through particle tracking***

**Disciplines: Civil, Environmental, Ocean Systems**

**Prerequisite skills: Fluid mechanics, computer literate**

We have developed a hydrodynamic model called ozROMS which covers the whole of Australia providing current patterns over a 3 year period. This project will use the output of this model together with a particle tracking model to examine the connectivity around Australia. The particles could be used as a proxy for oil spills, tracks of turtles, migration of eggs and larvae, marine debris etc.

Students will be able to choose any number of locations and these proxies to examine and analyse particle tracks for a particular application.

# Pattiaratchi, Chari, Professor

**Co-Supervisor: Wijeratne, Sarath, Dr**

***Climatology of infra-gravity waves in south-west Australia***

**Disciplines: Civil and Environmental, Ocean Systems, Oil & Gas, Software**

Infra-gravity waves are those with periods 30-300s range and occur frequently along the south-west Australian coastline. These waves are formed when through the propagation of longer-period swell from distant storms. They have major impacts on port operations as they set up oscillations in these ports which interferes with the ship loading/unloading operations. For example the port of Geraldton has estimated losses of up to $ 8 million per annum due to closing of the port due to oscillations generated by these infra-gravity waves. This project will analyse data collected from different locations along the WA coast (Geographe Bay, Mandurah, Perth Metro, Jurien and Geraldton) to develop a climatology to answer the questions how, when and under what combination of wave conditions does these waves occur?

# Sercombe, Tim, Professor

## Design of a powder heating unit

Disciplines: Materials, Mechanical

The aim of this project is to continue the design a new powder heating system for our SLM equipment that is capable of heating powder to ~600deg C. A group of FYP students have designed a heating system, but have failed to achieve the desired temperatures. In this project, you will build on their work and overcome the limitations of their design. Once the appropriate temperatures can be obtained, testing and evaluation of the effect of heating will be undertaken.

# **Smith, David, Winthrop Professor**

Co-Supervisor: Gardiner, Bruce, Adjunct Professor

***Mechanics and repair of cartilage, bone and tendon***

Disciplines: Chemical & Process; Civil; Electrical & Electronic; Environmental; Materials; Mechanical; Mechatronic; Software

Prerequisite skills: some knowledge of computational modeling

We have a number of projects in the general area of modelling musculoskeletal tissues. The projects can be catered to suit a number of backgrounds, but generally we are interested in how cells sense and then respond to their mechanical and biochemical environment. Often this response is to synthesis new tissue components, so as to repair mechanical induced damage incurred during daily activity. Projects can be entirely mechanical, entirely transport related (e.g. diffusion) or entirely about control systems. Ideally each project will contain a little of each. Methods could be anything from FEM of PDEs to discrete or agent-based models.

# **Sreeram, Victor, Professor**

Co-Supervisor: Abood, Hatim, Mr

***Reconfiguration of Distribution Systems Industry Partner Details: Western Power***

Disciplines: Electrical & Electronic

Prerequisite skills: Programming using MATLAB

It is well known that the distribution grids have a considerable level of power losses when compared to that of a transmission system. The power lines (feeders) in the distribution grids, usually, are distributed radially for long distances which create voltages drop in the feeders and power loss. Moreover, the existence of the Distributed Generation (DG) in the distribution grid adds to the complication in terms of calculation of power flow.

Most of the available studies suggest to reconfigure the distribution grid in such a way to reduce losses in the power feeder. In this project, it is proposed to investigate with the aid of numerical simulations to find the near-optimal configuration of distribution system when DGs are included. The project will involve applying Artificial Intelligent (AI) techniques to find the optimal solution. This study will be implemented using Matlab and DIgSILENT software.

The students first collect data from the electrical companies in WA and develop the algorithms for the proposed solution using different mathematical techniques.

# **Sreeram, Victor, Professor**

Co-Supervisor: Azhar, Uzma, Ms

***Study of Distribution system with high penetration of PV system***

***Industry Partner Details: Western Power***

Disciplines: Electrical & Electronic

Prerequisite skills: Programming using MATLAB

High penetration of PV systems in distribution grids have resulted in new challenges such as over voltages and reverse power flow. The power-voltage characteristics of such distribution system are relatively different from the conventional distribution system and hence required to be analyzed in detail.

Existing studies have focused on static equivalent model of grids with high PV penetration. In this project,reactive power regulation schemes in different PV systems will be analyzed along with further investigations on the load and PV dynamics in order to make an equivalent dynamic model of distribution grid with high PV penetration.

The student will collect requisite data from Western Power and utilize the same in the system studies.

# **Sreeram, Victor, Professor**

Co-Supervisor: Jazlan, Ahmed, Mr

***Model Order Reduction of Dynamic Systems***

Disciplines: Electrical & Electronic

Prerequisite skills: Signals and Systems, Digital Signal Processing, Matlab Programming, Linear Algebra

The objective of model reduction problem is to find a low-order model for a given high-order system such that the low order model retains or closely approximates the input-output behaviour of the original high-order system. Model reduction has a number of applications. In this project we focus on the following two applications:

Application #1: Seismic Migration is the process by which seismic events are geometrically re-located in either space or time to the location the event occurred in the subsurface rather than the location that it was recorded at the surface, thereby creating a more accurate image of the subsurface. Obtaining an accurate image of the subsurface enables a skilled geologist to make the correct decisions for determining regions which are suitable for oil & gas/mineral exploration. Efficient1D and 2D filter designs are essential for seismic migration. This topic involves the design of 1D and 2D FIR seismic migration filters using modified projection on convex sets (MPOCS) or other suitable techniques. The filter design process often yields filters with high order which becomes cumbersome for practical implementations. In this project 1D and 2D model reduction algorithms will be applied to these 1D and 2D FIR filters to yield 1D and 2D IIR seismic migration filters with lower order but preserve as much as possible the original characteristics of the original 1D and 2D FIR filters. Such lower order filters are desirable to avoid the difficulties associated with high order filters.

Application #2: The building block components of a machine can be represented by finite element (FE) models obtained using commercial software such as ANSYS. The use of a complete FE-model with finer mesh which incorporates intricate design details is not yet feasible to be used as a subcomponent of a larger automated process/control system due to computational constraints. Therefore developing reduced order models which preserve the time and frequency domain characteristics of the original system is highly desirable. In this project FE models will be obtained from a selected machine tool/mechanical system and model reduction techniques will be applied to obtain reduced order models. The practicality of the reduced order models will be justified through simulations of a complete control system/automated process using Simulink or other software.

# **Sreeram, Victor, Professor**

Co-Supervisor: Lamsal, Dipesh, Mr

***Control and Operational Strategies for Wind-PV System with Energy Storage System***

Disciplines: Electrical & Electronic

Prerequisite skills: Matlab Simulation, Power System, Renewable Energy

It is established that wind and PV systems have fluctuated power output. In addition, the load pattern of the consumer also varies. With the increasing penetration of wind and PV power, there is a rising need to manage both the generated power fluctuation as well as sharing of load when there is sudden change in load pattern. Neglecting these two factors will jeopardize the power quality of the system.

Existing studies have demonstrated control and operational strategies of wind or PV system with different energy storage devices, however simultaneous smoothing of the fluctuating power output of the wind or PV together with the sharing of the change in load along with the appropriate capacity of storage device needs to be investigated.

This essence of this project is the development of control and operational strategies for both smoothening the fluctuating power output of the wind or PV and sharing of the change in load along with the appropriate capacity of the storage device such as battery, ultra capacitor and fuel cell/electrolyzer. Battery and Ultra capacitors are used to smooth power fluctuation of Wind /PV whereas fuel cell/electrolyzer is used to manage the load sharing. As part of the development of control and operational strategies, this project will require data collection and comprehensive Matlab simulations.

# **Stanwix, Paul, Professor**

# **Co-supervisor: May, Eric, Professor**

***Investigating condensation phenomena near fluid mixture dew points using microwave cavity technology***

Disciplines: Chemical & Process, Electrical & Electronic, Oil & Gas

Prerequisite skills: Proficient in Mathematica, or demonstrated programming ability. Experience working with measurement and diagnostic equipment.

The aim of this project is to study surface phenomena associated with condensation near fluid mixture dew points using novel microwave re-entrant cavity technology. These condensation phenomena are not well understood, however recent work has indicated that they significantly impact the precision of fluid mixture property measurements near the dew point curve, when precursor condensation occurs on the surfaces of the measurement apparatus. Understanding and quantifying these condensation phenomena would represent a significant contribution to fundamental science and the development of reference quality equations of state.

# **Tavner, Angus, Professor**

## Experimental testing of adhesives for bonding wood

Disciplines Chemical & Process, Civil, Materials, Mechanical, Oil & Gas

Prerequisite skills Practical experience with adhesives and/or woodworking would be an advantage

Instructions for the use of glues and resins for bonding usually suggest that the surfaces should be clean, dry, free of grease and dust etc. This project aims to answer the question "What if they're not that clean?" This work continues some work looking at bonding of steel surfaces in similar circumstances.

# Tavner, Angus, Professor

## Motorsport Projects

**Prerequisite Skills: Electrical & Electronic, Materials, Mechanical, Mechatronic, Oil & Gas**

Each year the UWA Motorsport team builds a single-seat open-wheel racing car to compete in the Formula SAE competition. These projects will allow students to design, build, test and analyse parts or systems for the 2015 car. Project topics are decided in collaboration with the Technical Director of the UWAM team, based on the requirements of the team and the background, experience and interests of the students. Interested students should make contact with the team to discuss the opportunities available this year. (Up to five students)

# **Togneri, Robert, Professor**

***Speech and Signal Processing and Recognition***

Disciplines: Computer; Electrical & Electronic

Prerequisite skills: MATLAB, signal processing

This topic covers speech, speaker and music recognition, speech enhancement and source separation, and microphone array processing using adaptive and statistical filters and classifiers, and is recommended for students with an interest in audio, speech, image and music processing, biometric identification, and signal detection, localisation and enhancement. With this project you will develop the necessary basic research skills for hearing and speech assistive technologies, human-computer interaction systems, and signal enhancement for communications and audio systems. Students should have a good understanding of signal and systems and signal processing and be keen to carry out experiments or build working systems based on real and simulated data in the MATLAB or the programming environment required.

Suggested specific projects are listed below (for details see: http://staffhome.ecm.uwa.edu.au/~00014742/research/SIPProjects.html) and students are welcome to consider and propose alternatives in the first semester:

Speech Enhancement and Intelligibility; Microphone Arrays for Source Localisation and Separation; Build Your own Speech Recognition System; Building an Industry Standard Speaker Verification System.

# Tong, Feifei, Dr

**Co-Supervisors: Cheng, Liang, Professor; Draper, Scott, Dr**

***Flow around structures at extremely low Reynolds number***

**Disciplines: Civil, Ocean Systems, Oil & Gas**

**Prerequisite skills: hydrodynamics, fluid mechanics, interest in numerical modeling.**

Viscous flow around cylindrical structures has been attracting sustained research activities in fluid mechanics; and in recent decades, the study has been further driven by developments in coastal civil engineering, offshore oil and gas industry and ocean wave energy. Enormous effort has been expended on understanding the force behaviour exerted by the flow on bluff bodies, the boundary layer development and separation, and the vortex dynamics in the wake, due to its significance in both academics and engineering applications. For instance, the Kármán vortex can contribute to vortex-induced vibration and noise.

This project aims to provide a quantitative numerical analysis of flow past two cylinders at extremely low Reynolds number (typically smaller than 50), where depending on the cylinders' arrangement, the flow interference may completely alter the flow feature compared to that around a single structure, and thus brings new understanding to this less well studied subject. Students involved in this project will have the opportunity to access the largest supercomputer in southern hemisphere. The project is suitable for students who aim to work in ocean engineering or pursue a higher degree in fluid mechanics after their undergraduate study.

# Trevelyan, James, Professor

***Studying Engineering Practice and Engineering Education***

**Disciplines: Chemical & Process, Civil, Computer, Electrical & Electronic, Environmental, Materials, Mechanical, Mechatronics, Mining, Ocean Systems, Oil & Gas, Petroleum, Software**

What do engineers really do? What does engineering work actually involve? How does it happen? How do engineers learn to do it?

What can you expect to be doing as a novice engineer? How do novice engineers adjust to the difference between expectations and reality?

Surprisingly these issues have not been carefully researched until recently. We have started to do this over the last 10 years with some surprising results. This work seems to be unique: you will have the opportunity to help shape a new research field and learn some challenging research techniques.

This work started because we noticed that the cost of engineering and most engineered services in industrialised countries seems to be less than developing countries, contrary to what might be expected. This includes the basic elements of any society: water supply, electricity, transport, communications. In Pakistan, for example, water can cost 20 - 40 times as much as in Perth, and millions of poor people cannot afford water to wash their hands.

This research will help you learn more about the vital roles that engineers and engineering play in any economy. You will be able to work on some challenging issues that go to the roots of our industrialised societies.

Look here for more information about this research before you decide to apply! This is a team project and you will enjoy support from several highly experienced engineers.

Students will also gain a unique insight into the work of engineers by taking part in research interviews. One of the first objectives of this project is to carry out systematic research to understand how today's engineers perform their day-to-day work, take decisions, find information, and develop their career skills. This seemingly obvious research seems to have been overlooked, and previous surveys have confirmed that both students and academics have little idea about what is important for engineers in industry.

# **Wang, Jin, Dr**

Co-Supervisor: Cardell-Oliver, Rachel, Associate Professor

***Customer Segmentation from Smart Meter Data for Water Efficiency***

Disciplines: Civil; Computer; Environmental; Software

Prerequisite skills: Statistical Tool Skills (such as MATLAB, R); Basic Math skills

This project is with the CRC for Water Sensitive Cities and and the Water Corporation of Western Australia. Smart water meters are being deployed by water utility companies to monitor water use in real-time. Real-time water consumption data is useful for better understanding water use behaviours. The aim of this project is to develop data mining methods to automatically identify target customers for water efficiency program. Existing customer segmentation methods from energy data will be extended to analyze water use data. Case studies will be conducted on real water use datasets collected from the areas of Karratha and Kalgoorlie-Boulder, Western Australia.

# Wittek, Adam, Professor

## Brain Skull-Interface in Biomechanical Models of the Brain: 1 Millimetre of Soft Tissues that Can Determine Whether You Survive Brain Surgery or Car Crash

Disciplines: Mechanical

Prerequisite skills: Solid Mechanics, Numerical Methods in Engineering, Finite Element Methods

The importance of computational biomechanics of the brain has grown in recent years due to its successful application in modelling neurosurgery and brain trauma prevention. Limited knowledge of the brain–skull interface properties that determine the boundary conditions for brain models is a major barrier in improving fidelity and reliability of computer simulations of the brain mechanical behaviour.

The brain–skull interface is formed by several layers of tissues with a total thickness of around 1 millimetre. Experimental investigation of the mechanical properties of these tissues and their interactions is challenging. This project will evaluate the effects of assumptions regarding such properties and methods/approach for representation of the brain-skull interface on responses of biomechanical models of the brain for surgery simulation and analysis and prevention of brain injury.

The project will involve:

1. Creation, modification and application of biomechanical models of the brain using finite element and/or meshless methods;
2. Incorporation of the data available in the literature and recent experimental results on mechanical properties of the brain–skull interface into biomechanical models of the brain. This may involve creation of new numerical algorithms for brain–skull interface modelling;
3. Verification, validation and evaluation of performance of the created algorithms and models.

# Wittek, Adam, Professor

**Co-Supervisor: Singh, Surya, Dr. (University of Queensland)**

## Biomechanical Simulation for Remote (Robotics) Surgery

Disciplines: Electrical & Electronic, Mechanical, Mechatronic

Prerequisite skills: Solid Mechanics, Numerical Methods in Engineering, Finite Element Methods

Integration of computing and robotics has been recognised as one of the key elements of “the wave of third industrial revolution” (a term used in the article in “The Economist” from October 4th, 2014) that affects not only traditional engineering applications but also health care delivery (e.g. surgery).

So far application of surgical robots has been limited. Surgical tool placement/insertion in the body organs (such as e.g. needle insertion when conducting biopsy) is a challenging task that requires to account for changes in the target position caused by organ deformation due to interactions between a surgical tool and the tissue. One may attempt to track a surgical target (e.g. tumour) and tool using medical imaging. However, intraoperative 3D imaging (magnetic resonance imaging MRI, computed tomography, ultrasound US) for surgical tracking is limited using the equipment in standard operating theatres. Predicting the intraoperative organ/tissue deformations using biomechanical can augment the currently used imaging techniques for surgical tracking.

This project focuses on:

* Fast (“real-time”) biomechanical algorithms and models for predicting intraoperative organ/tissue deformations due to interactions with a surgical tool;
* Integration of biomechanical models with medical image processing software;
* Integration of biomechanical models with robotic systems;
* Evaluation of the proposed modelling and hardware solutions using experiments on mechanical phantoms of body tissues/organs.

The project will be conducted as a part of collaboration between the Intelligent Systems for Medicine Laboratory at the University of Western Australia and Robotics Design Laboratory at the University of Queensland.

# Yang, Hong, Professor

***Electrochemical Study of Corrosion of Pipeline Materials in Seawater***

**Disciplines: Materials, Mechanical and Chemical Engineering**

This project is designed to study the pitting behaviour of a range of steel alloys commonly used in subsea pipelines including carbon steels, stainless steels and other corrosion resistant alloys in fresh and treated natural seawaters. The main aim of the project is to investigate the effectiveness of a proprietary chemical package in corrosion control of subsea pipeline materials.

# Zhang, Dongke, Professor

## Co-supervisors: Dr Yang Zhang and Mr Zhezi Zhang

***Catalytic cracking of tar over a bed of biochar using toluene as tar model compound***

**Disciplines: Mechanical and Chemical Engineering**

Tar is generated in biomass pyrolysis and gasification processes and is finally present in the pyrolysis gas, resulting in the blocking and corrosion problems in the downstream processes. It is of significance to develop an economic and sustainable method to crack the tar to improve the quality and quantity of pyrolysis gaseous products. As biochar is a low-cost by-product from pyrolysis with high catalytic activity, this project will focus on the catalytic cracking of tar over a bed of biochar using toluene as tar model compound.

## Sub-project 1: Effect of cracking temperature on the tar conversion rate, gas product yield and gas product composition

The objective of this sub-project is to experimentally study the effect of cracking temperature on the tar conversion rate, gas product yield and gas product composition. Tar cracking experiments will be conducted in a fixed-bed reactor at different cracking temperatures. The tar conversion rate, gas product yield and gas product composition will be measured using GC-MS and GC-TCD/FID located at Centre for Energy of UWA. This sub-project is expected to provide an insightful understanding of the effect of cracking temperature on the tar cracking process.

## Sub-project 2: Effect of residence time on the tar conversion rate, gas product yield and gas product composition

The objective of this sub-project is to experimentally study the effect of residence time on the tar conversion rate, gas product yield and gas product composition. Tar cracking experiments will be conducted in a fixed-bed reactor at different residence times. The tar conversion rate, gas product yield and gas product composition will be measured using GC-MS and GC-TCD/FID located at Centre for Energy of UWA. This sub-project is expected to provide an insightful understanding of the effect of residence time on the tar cracking process.

## Sub-project 3: Effect of steam and oxygen additions on the tar conversion rate, gas product yield and gas product composition

The objective of this sub-project is to experimentally study the effect of steam and oxygen addition on the tar conversion rate, gas product yield and gas product composition. Tar cracking experiments will be conducted in a fixed-bed reactor with steam and oxygen additions. The tar conversion rate, gas product yield and gas product composition will be measured using GC-MS and GC-TCD/FID located at Centre for Energy of UWA. This sub-project is expected to provide an insightful understanding of the effect of steam and oxygen additions on the tar cracking process.

## Sub-project 4: Effect of biochar particle size on the tar conversion rate, gas product yield and gas product composition

The objective of this sub-project is to experimentally study the effect of biochar particle size on the tar conversion rate, gas product yield and gas product composition. Tar cracking experiments will be conducted in a fixed-bed reactor while biochar with different particle sizes will used as catalysts. The tar conversion rate, gas product yield and gas product composition will be measured using GC-MS and GC-TCD/FID located at Centre for Energy of UWA. This sub-project is expected to provide an insightful understanding of the effect of biochar particle size on the tar cracking process.

# Zhang, Dongke, Professor

## Co-supervisor: Mr Zhezi Zhang and Dr Mingming Zhu

***Ignition and combustion characteristics of Zhundong lignite***

**Disciplines: Mechanical and Chemical Engineering**

Zhundong lignite, with an estimated reserve of up to 3.9 Gt, is a super-large coal resource in northwest China and is predicted by some to provide China with a secure energy supply for many decades to come. However, as lignite, it suffers from the typical shortcomings of the low rank coal in every aspect, such as high moisture content and high surface reactivity (high spontaneous combustion tendency). Moreover, its high alkali and alkali earth metal (AAEM) content, especially the high sodium content, made the utilisation of the resources very challenging. Washing treatment is an effective technique that can be deployed to reduce the sodium content prior to the downstream utilisation of Zhundong lignite. This project will focus on the fundamental understanding of the ignition and combustion characteristics of the Zhundong lignite before and after the washing treatment.

## Sub-project 1: An experimental study of ignition and combustion characteristics of raw, water-washed, ion-exchanged and acid-washed Zhundong lignite in a thermogravimetric analyser

The objective of this sub-project is to experimentally study the variations of the basic ignition and combustion characteristics of Zhundong lignite with different washing treatments using the state-of-art thermogravimetric analyser. The ignition temperature will be determined by using the TG ignition technique, together with other important parameters such as peak temperature, burnout temperature, burning rate etc.

## Sub-project 2: Effect of NaCl addition to the acid-washed Zhundong lignite on its ignition and combustion characteristics in a thermogravimetric analyser

The objective of this sub-project is to experimentally study the effect of NaCl (the major sodium contributor in Zhundong lignite) addition to the acid-washed Zhundong lignite on its basic ignition and combustion characteristics using the state-of-art thermogravimetric analyser. Different NaCl loading will be applied to the acid-washed lignite using the impregnation technique. The ignition temperature will be determined by using the TG ignition technique, together with other important parameters such as peak temperature, burnout temperature, burning rate etc.

## Sub-project 3: An experimental study of ignition and combustion characteristics of raw, water-washed, ion-exchanged and acid-washed Zhundong lignite in a single particle ignition apparatus

The objective of this sub-project is to experimentally study the variations of the basic ignition and combustion characteristics of Zhundong lignite with different washing treatments using the single particle ignition technique. The ignition temperature will be determined by using the direct thermocouple measurement technique. The ignition and combustion process will be recorded using the high speed CCD camera. By analysing the recorded images, other important parameters such as ignition delay time, volatile flame duration, burnout time, burning rate, can also be determined.

## Sub-project 4: Effect of NaCl addition to the acid-washed Zhundong lignite on its ignition and combustion characteristics in a single particle ignition apparatus

The objective of this sub-project is to experimentally study the effect of NaCl (the major sodium contributor in Zhundong lignite) addition to the acid-washed Zhundong lignite on its basic ignition and combustion characteristics using the single particle ignition technique. Different NaCl loading will be applied to the acid-washed lignite using the impregnation technique. The ignition temperature will be determined by using the direct thermocouple measurement technique. The ignition and combustion process will be recorded using the high speed CCD camera. By analysing the recorded images, other important parameters such as ignition delay time, volatile flame duration, burnout time, burning rate, can also be determined.

# Zhang, Dongke, Professor

**Co-supervisor: Dr Mingming Zhu and Dr Yu Ma**

***Fuel Efficiency and Emissions in Compression Ignition Engines***

**Disciplines: Mechanical and Chemical Engineering**

This project aims to evaluate and compare the fuel efficiency and exhaust emissions from the combustion of diesel and biofuels in compression ignition engines (known as diesel engines).

## Sub-topic 1: Study on the combustion characteristics of diesel/methyl stearate in a diesel engine

The effect of diesel/ methyl stearate blending ratio and the combustion catalyst on the fuel efficiency, ignition delay and heat release rates will be investigated under different engine speed and load conditions.

## Sub-topic 2: Study on the gaseous emissions and characteristics of soot particles from the combustion of diesel/ methyl stearate in a diesel engine

The effect of diesel/ methyl stearate blending ratio and the combustion catalyst on the emissions of smoke, NOx, CO and unburned hydrocarbons, as well as on the physical and chemical characteristics of soot particles will be investigated under different engine speed and load conditions.

## Sub-topic 3: Study on the combustion characteristics of diesel/methyl laurate in a diesel engine

The effect of diesel/methyl laurate blending ratio and the effect of combustion catalyst on the fuel efficiency, ignition delay and heat release rates will be systematically investigated under different engine speed and load conditions.

## Sub-topic 4: Study on the gaseous emissions and characteristics of soot particles from the combustion of diesel/methyl laurate in a diesel engine

The effect of diesel/methyl laurate blending ratio and the effect of combustion catalyst on the emissions of smoke, NOx, CO and unburned hydrocarbons, as well as on the physical and chemical characteristics of soot particles will be systematically investigated under different engine speed and load conditions.

# Zhang, Yang, Dr.

## Co-supervisor: Professor Dongke Zhang and Mr Zhezi Zhang

***Combustion characteristics of biomass pyrolysis gas***

**Disciplines: Mechanical and Chemical Engineering**

Topic brief description:

Biomass pyrolysis gas is regarded as a clean fuel in gas engines and other combustion devices. Understanding the combustion characteristics of biomass pyrolysis gas is of great importance for the design and safe operation of the pyrolysis gas-fuelled combustion devices. This project will study the fundamental combustion characteristics of biomass pyrolysis gas/air flames in terms of their propagation and extinction. Specifically, the effects of temperature and inert dilution will be investigated. The expected outcomes of this project are a set of systematic experimental data on the laminar flame speed and extinction limit at various conditions, and a profound understanding of the effects of temperature and inert dilution on the propagation and extinction of biomass pyrolysis gas.

## Sub-project 1: The effect of unburned gas temperature on the laminar flame speed of biomass pyrolysis gas/air flames

The objective of this sub-project is to experimentally study the effect of unburned gas temperature on the laminar flame speed of premixed biomass pyrolysis gas/air flames. The laminar flame speed will be measured at different unburned gas temperature (300 – 700 K) over a large range of fuel compositions using flat flame and Bunsen flame configurations which have been established at Centre for Energy of UWA. This sub-project is expected to deliver a set of systematic experimental data that can be used to validate chemical kinetic model at elevated temperature condition, and an insightful understanding of unburned gas temperature effect on the propagation of premixed biomass pyrolysis gas/air flames.

## Sub-project 2: The effect of inert dilution on the laminar flame speed of biomass pyrolysis gas/air flames

The objective of this sub-project is to experimentally study the effect of unburned gas temperature on the laminar flame speed of premixed biomass pyrolysis gas/air flames. Similar to Sub-topic 1, the laminar flame speed will be measured with the existence of different dilutions (e.g., CO2, N2 and H2O) over a large range of fuel compositions using flat flame and Bunsen flame configurations which have been established at Centre for Energy of UWA. This sub-project is expected to deliver a set of systematic experimental data that can be used to validate chemical kinetic model at highly-diluted condition, and an insightful understanding of the dilution effect on the propagation of premixed biomass pyrolysis gas/air flames.

## Sub-project 3: The effect of inert dilution on the extinction of premixed biomass pyrolysis gas/air flames

The objective of this sub-project is to experimentally study the effect of inert dilution on the extinction of premixed biomass pyrolysis gas/air flames. The extinction limit will be measured over a large range of fuel composition with different dilutions (e.g., CO2, N2 and H2O) using jet flame, flat flame and opposed-flow flame configurations which have been established at Centre for Energy of UWA. This sub-project is expected to deliver a set of extinction experimental data at various conditions, and an insightful understanding of the dilution effect on the extinction of premixed biomass pyrolysis gas/air flames.

## Sub-topic 4: The effect of inert dilution on the extinction of non-premixed biomass pyrolysis gas/air flames

The objective of this sub-project is to experimentally study the effect of inert dilution on the extinction of non-premixed biomass pyrolysis gas/air flames. The extinction limit will be measured over a large range of fuel composition with different dilutions (e.g., CO2, N2 and H2O) using jet flame and opposed-flow flame configurations which have been established at Centre for Energy of UWA. This sub-project is expected to deliver a set of extinction experimental data at various conditions, and an insightful understanding of the dilution effect on the extinction of non-premixed biomass pyrolysis gas/air flames.

# Zhou, Tongming, Professor

***Force and Vortex shedding from various kinds of bluff structures***

**Disciplines: Civil, Mechanical**

Vortex shedding is a phenomenon that occurs when a flow passes a bluff body (e.g. a single or a group of tall chimneys, which are attached outside the cylinder with various gaps). The objective of the project is to examine the force and vortex shedding characteristics from various kinds of bluff bodies by measuring the flow velocity and forces in the wake. It is suitable for a group of four students.

# Zhu, Mingming, Dr

## Co-supervisor: Dr Yang Zhang and Professor Dongke Zhang

***Rheological properties and combustion characteristics of biochar based slurry fuels***

**Disciplines: Mechanical and Chemical Engineering**

Biochar is a carbon-rich by-product of biomass pyrolysis. One of the feasible ways to utilise biochar is to burn it in diesel engine or other combustors, for example, in the form of biochar-water slurry fuels. However, because of the low volatile content, the ignition of biochar-water slurry fuels tends to be difficult thus needs to be improved. Adding algae or glycerol into biochar-water slurry fuels will bring extra volatiles so will help to improve its ignition behaviour. Meanwhile, the rheological properties of biochar-water slurry fuels may also be change due to the addition of algae or glycerol. Therefore, this project will investigate the rheological properties and combustion characteristics of biochar based slurry fuels.

## Sub-topic 1: Preparation and rheological properties of biochar-algae-water slurry fuels – Algae as an additive

This topic will focus on preparing the biochar-water slurry fuels with the addition of algae, and investigating their rheological properties. The biochar-water slurry fuels will be firstly prepared and the algae will be added into the slurry fuels as additives. The effect of algae loading on the rheological properties of biochar-water slurry fuels will be investigated.

## Sub-topic 2: Preparation and rheological properties of biochar-algae-water slurry fuels – Algae cultivated in the presence of biochar

This sub-topic is similar to Sub-topic 1 but the preparation method of biochar-algae-water slurry fuels is different. The algae will be first cultivated on the surface of biochar and then the mixture of biochar, algae and water will be used to prepare the biochar-algae-water slurry fuels. Similarly, the effect of algae loading on the rheological properties of formed biochar-algae-water slurry fuels will be investigated.

## Sub-topic 3: Ignition and combustion characteristics of biochar-algae-water slurry fuels

The ignition and combustion characteristics of biochar-algae-water slurry fuels will be studied in a single-droplet combustion apparatus. The effect of algae loading on the ignition and combustion characteristics of biochar-algae-water slurry fuels will be investigated.

## Sub-topic 4: Ignition and combustion characteristics of biochar-glycerol-water slurry fuels

The ignition and combustion characteristics of biochar-glycerol-water slurry fuels will be studied in a single-droplet combustion apparatus. The effect of glycerol loading on the ignition and combustion characteristics of biochar-glycerol-water slurry fuels will be investigated.