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# **LIST OF POTENTIAL PhD PROJECTS**

## **UNSW Canberra**

# List of Potential PhD Projects at UNSW Canberra

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## ECONOMICS OF DEVELOPMENT

<b>Project:</b>	<i>Addressing state fragility</i>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	Prof Satish Chand ( <a href="mailto:s.chand@adfa.edu.au">s.chand@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Michael Hess ( <a href="mailto:m.hess@adfa.edu.au">m.hess@adfa.edu.au</a> )
<b>Aim:</b> Investigate the nexus between defence and economic development.	
<b>Objectives:</b> <ul style="list-style-type: none"><li>(i) How does economic development affect security in hostile environment?</li><li>(ii) What are the means to reducing state fragility?</li><li>(iii) What are the mechanisms via which economic development affect peace?</li></ul>	
<b>Description of work:</b> <p>Development is difficult in dangerous places. And achieving security in places lacking development is equally problematic. This research project investigates the nexus between defence and development.</p> <p>There are strong theoretical reasons to believe that the level of security to person and property determine the level of effort and investments in any location. This in turn determines the level of income, employment, and levels of welfare in the general population.</p> <p>The School of Business @ADFA has initiated a large research project aimed at exploring the defence-development nexus. In particular, this research explores the use of development as the means to achieving long-term security in fragile states.</p> <p>The project has secured seed funding from the Asia-Pacific Civil Military Centre of Excellence to study the contributions of host communities to sustaining peace in post-conflict Bougainville. A PhD scholar has been recruited from Papua New Guinea to assist with this research.</p> <p>It is envisaged that the country coverage of this work will, subject to funding and availability of research personnel, be extended to Afghanistan, Fiji, East Timor, Indonesia, Pakistan, Solomon Islands, Sri Lanka, and Vietnam. Doctoral students and post-doctoral fellows will form the core of this project. A student has been recruited to work on this issue in Pakistan.</p> <b>Method:</b> <p>The PhD scholars will first review the rapidly evolving literature on the relationship between defence and development. A mix of qualitative and quantitative data will then be collected to establish the causal links between the level of security and income generation in post-conflict states and the contributions of the above to reducing state fragility. Ideally, we would like the scholar to investigate these linkages at the level of individual households and firms in their home countries.</p> <p>ADFA has large group of alumni who either are or have participated in peacekeeping missions abroad. The project will collect data from these personnel. This will be done via: (i) candidature of former peacekeepers turned scholars; and, (ii) through formal interviews of the others as part of the data gathering exercise.</p> <p>The research methodology to be employed will include the conduct of purpose</p>	

designed surveys, focus group discussions, and use of secondary sources for economy wide information. Much of the methodology for this research is being tested and its refinement will be part of ongoing research.

**Pre-requisites:**

We expect the prospective student(s) to have some familiarity with basic statistics and undergraduate level economics. However, no prior knowledge of econometrics is assumed.

The student will spend one semester doing post-graduate level coursework in quantitative research techniques within the School of Business. During this time, the student will also review the literature and refine his/her research question.

The student will spend a semester collecting data in the field. Analysis of the collected data and thesis writing will extend over the remaining two years.

**Supervisory support:**

Professors Chand and Hess will provide joint supervision.

Research on how best to address fragility is both timely and is of policy relevance. And ADFA provides the platform to conduct this research while the School of Business lends the tools for the conduct of this research.

<b>Project:</b>	<b><i>Economic vs. Social Needs in Supply Chain Networks: The Case of Oncology Drugs</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	Dr Daniel D Prior ( <a href="mailto:d.prior@adfa.edu.au">d.prior@adfa.edu.au</a> )

**Objectives:**

The conflict between economic (the profit motive) and customer needs is a well-documented phenomenon facing firms. However, few studies consider the nature of this trade-off across supply chain networks, particularly in life or death customer circumstances. This study seeks to understand this trade off across three primary dimensions. First, the nature of supply chain networks is such that the responsibility for fulfilling customer needs is distributed amongst supply chain network members. How does this distributed mode of responsibility influence end user outcomes? Second, most supply chain network members divide their focus between working collaboratively with other supply chain network members and on internal issues. To what extent does customer orientation exist in specific actors within the supply chain? How does this affect the economic-social trade-off? Third, what approaches or methods (i.e. resources, systems, capital) have supply chain members used to adapt to these circumstances?

**Description of Work:**

- An initial literature review
- A qualitative phase involving interviews and/ or case studies
- A quantitative phase involving survey development, administration, and analysis of results using structural modelling or regression-based techniques
- Potentially an experimental design

**Desirable Applicants:** To apply for this project, applications should meet the criteria for admission to a PhD at UNSW; have industry experience in supply chain management excellent writing skills, and the ability to work independently. Please address these requirements in your application. Applicants should also be prepared to submit certified transcripts, certified identification, their three best pieces of writing in English, and a dissertation or thesis completed as part of their previous studies.

<b>Project:</b>	<b><i>Land tenure and productivity</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Prof Satish Chand (<a href="mailto:s.chand@adfa.edu.au">s.chand@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> This project assesses the impact of land tenure system on the level of investments and productivity at the level of an enterprise.</p> <p><b>Description of work:</b> There are strong theoretical reasons to believe that security of property rights to land will impact on the level of effort and investments expanded by an entrepreneur. This proposition is expected to hold across market and mixed economies.</p> <p>The School of Business @ADFA has a large research project aimed at exploring the impact of the various land tenure regimes on productivity. The empirical analysis done to date has drawn on data from the smallholder oil palm sector in Papua New Guinea.</p> <p>The project has collected data to test the impact of land reform on investment in housing at the level of the household. Purpose designed surveys have been conducted for this purpose in Port Moresby and Suva.</p> <p>China recently embarked upon an ambitious land tenure reform project. There are compelling reasons to believe that these reforms will impact on domestic investment and thus the rate of economic growth. The Chinese experimentation provides fertile grounds to test the link, if any, between land tenure and productivity. This work can be undertaken both at the level of the individual farms and that at the level of households.</p> <p><b>Method:</b> The PhD scholar will examine the impact of changes to land tenure regime on the levels of investment and productivity within PRC. Ideally, we would like one scholar to investigate the linkage at the level of individual farms while the other student will examine the same issue for settler housing.</p> <p>The research methodology to be employed will include the conduct of a purpose designed surveys to collect the primary data for subsequent analysis. The collected data will be analysed using econometric techniques. Much of the methodology for this research has been tested and is being refined as part of an ongoing research within the School of Business at UNSW Canberra.</p> <p><b>Pre-requisites:</b> We expect the prospective student(s) to have some familiarity with basic statistics and undergraduate level economics. However, no prior knowledge of econometrics is assumed. The student will spend one semester doing post-graduate level coursework in quantitative research techniques within the School of Business. During this time, the student will also review the literature and refine his/her research question. The student will spend a semester collecting data in the field. Analysis of the collected data and thesis writing will extend over the remaining two years.</p> <p><b>Supervisory support:</b> Professor Satish Chand will provide primary supervision. Professor Chand has a large externally funded research project to investigate the impact of land tenure reform on productivity within the Pacific islands, and is in the process of extending this project into Asia. The Peoples' Republic of China is an excellent case study for several reasons including the following three: (i) land reforms are being experimented within several</p>	

parts of the nation; (ii) macroeconomic data is available for this analysis; and (iii) there is a sufficiently large number of households and enterprises affected by ongoing reforms to land tenure. The last allows for serious econometric analysis of the impact of land tenure reforms on productivity.

## LEADERSHIP

<b>Project:</b>	<i>Leadership in a complex world</i>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	Dr James Warn ( <a href="mailto:j.warn@adfa.edu.au">j.warn@adfa.edu.au</a> )
<p><b>Objectives:</b> The aim of the research is to investigate the concept of leadership in complex social contexts.</p> <p><b>Description of Work:</b> Contemporary leaders operate in a world of complex challenges and are expected to perform within complex, rapidly changing and uncertain environments. Issues are multifaceted, interactive with other sets of issues, problems are ambiguous, their underlying causes are unclear, and once one problem is addressed it seemingly becomes interconnected with other issues.</p> <p>The research would positioned broadly within the research cluster for the School of Business The key domains of the cluster are rebuilding fragile states (business, social, peacekeeping and peace-building operations), governance and change (exercise of collective power across boundaries) and the management of skills and knowledge in these complex situations.</p> <p>The research could address</p> <ul style="list-style-type: none"> <li>· leadership in situations of complex governance arrangements (e.g. civil-military interaction in humanitarian assistance).</li> <li>· experience of leadership from a cross cultural or cross generational perspective</li> <li>· leadership in crisis contexts</li> </ul> <p>The research could explore issues such as how leadership is construed, defined, emerges and is meaningful in these contexts. The research would need to be able to define leadership using an appropriate framework and categorise instances of leadership in order to achieve focused analysis of specific events or situations. The models would enable the leadership variable being investigated to be linked to outcomes or other consequences. The research might consider implications for conceptualizing leadership and the language in which leadership is explained and constructed.</p> <p>A viable project would need access to organizations or key actors or groups so as to obtain data sets, capacity to collate data sets or access for interviews or means to obtain primary data.</p>	

## LAND BUSINESS INTELLIGENCE GROUP

Logistics Informatics as Industrial Informatics addresses the research area of business automation. As the Internet becomes more wide spread and pervasive, the vision of intelligent and collaborative industrial environments empowered by Cyber-Physical Systems and Internet of Things with all transport providers, logistics consortiums, supply-chain partners, coalition forces, inter-agency operators, sub contactors, and end-users with dynamic, agile and reconfigurable enterprise structures has become a reality. As industrial systems have become more intelligent, automated, dynamic and distributed; the monitoring and control of operations has shifted towards the digital paradigm and is increasingly carried over the Internet as is the case for sales of e-services. Logistics activity represents approximately 9-15% of Australia's GDP [2002-2012] or \$57-\$86 billion and it has been found that the introduction of collaborative logistic systems can achieve a 500% return on investment [Gardner 2002]. Weaknesses in logistic capabilities create a multi-billion dollar cost burden on the Australian economy [The Age Jan 2011]. Logistics and supply-chain are vital to the global economy, especially in developing countries where the 90% of logistics companies are SMEs. They provide the engine for growth of value added products and services in the supply chain marketplace and delivers substantial social and economic benefits for Australia. The Transport and Logistics research at UNSW at Australian Defence Force Academy performs multi-disciplinary research incorporating business, ICT, engineering and industrial informatics. As a result of this research, the following projects are available as research topics for potential PhD students:

<b>Project:</b>	<b><i>Aged Care Mobility and Transportation</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Dr George Leu (SEIT)</i>
<b>Objectives:</b> There are a number of problems associated with logistics and mobility for aged or disabled persons. The contribution of this project lies in the development of smart aged care logistics and mobility through the use of intelligent Cyber Physical Systems and integration of intelligence sensor based medical devices and intelligent transportation technologies	
<b>Description of Work:</b> This project involves design and development of frameworks, algorithms, knowledge, information analysis techniques for better management of aged care mobility.	

<b>Project:</b>	<b><i>Ambient Security in Logistics Network</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Jian Kun, Dr. Xiao Mao (SEIT)</i>
<b>Objectives:</b> This research studies methods and techniques for safeguarding infrastructure, Logistics facilities and frontline operations, International and National Security Measures in Logistics and Supply Chain; Types of attacks, vulnerability and weak points in Logistics Networks; Inter-modal security, monitoring and control of malicious activities, Security techniques, Biometrics, X-Ray, Sniffer, CT-Scan, and Sensors Networks, Electronic dog for Goods tracking, Container tracking, Vehicle tracking and Material tracking.	



<b>Project:</b>	<b>Collaborative Logistics</b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Dr Naeem Janjua (n.janjua@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Elizabeth Chang</i>
<p><b>Objectives:</b>  Logistics activity represents approximately 9-15% of Australia's GDP between 2002-2012. The introduction of collaborative logistic systems can achieve a 500% return on investment [Gardner 2002]. Collaborative supply chains and logistics networks involve vertical industry collaboration and horizontal industry services. Weakness in logistic capabilities creates a multi-billion dollar cost burden on the Australian economy. The contribution of this research will be to provide seamless integration between SME logistics providers and multi-national corporate logistics providers through the use of service-oriented e-Hub and Partner to Partner (P2P) connectors. This project develops methodologies and systems to allow logistics companies to form coalitions with worldwide logistics providers. Using this approach, supply chain services and physical resources are coupled and extended beyond their typical region of operation. It involves the coupling of e-Transportation, e-Warehousing, e-Hub Connector and one-stop-shop, P2P (Partner to Partner) and B2B (Business to Business). This has the potential of allowing medium sized, regionally based, logistics providers to compete on the world stage with giant logistic providers such as UPS and FedEx. The research work will build a virtual collaborative logistics consortium that is especially suited to SME (small medium enterprise) supply chain providers, partners and alliances.</p> <p><b>Description of Work:</b>  The research will propose a cutting edge IT infrastructure which will allow the seamless exchange of information between the international logistics partners wherever they are and whenever it is necessary. This enables global supply chain management for all national / international clients, partners, customers, suppliers, sub-contractors and buyers around the world to track the details and movement of goods anywhere at any time. The system will also support the need for communication and co-ordination between all partner transporters and warehouses around the world.</p>	

<b>Project:</b>	<b><i>Congestion management and prediction</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Greg Martin</i>
<p><b>Objectives:</b>  The research aims to reduce traffic congestion &amp; improve the throughput of key roadways. It aims to use cutting edge crowdsourcing, cloud and cyber-physical systems as well as wireless sensor network technologies &amp; data mining techniques to improve our commute to work time (when the roadways are most stressed). The contribution of this work is to include accurate real-time traffic prediction using a hybrid exponential smoothing and neural-nets-based approaches and traffic flows forecasting using swarm intelligence. Among the work in this area also include Congestion issues, impact and global view, congestion management through collective intelligence and crowd sourcing, Logistics issues in Infrastructure Strategies, Planning and Policy, Intelligent Logistics Infrastructure Design and Development, Intelligent strategy for planning and design (including ports, Air or Sea), Intelligent strategy for planning and design of highway, overpass, road, rail and freight corridors. The research also includes urban and regional development model through data mining for the specific characteristics of road user background and travelling behaviour and enablement of the study on road user demographic background and how this has affected the local industry and urban regional business development, including the prediction of population growth, and its impact on local business and services in 5, 10 or 25 years' time</p>	

**Description of Work:**

This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.

<b>Project:</b>	<b><i>Data Risk Management</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Dr Omar Hussain (o.hussain@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Tharam Dillon</i>
<b>Objectives:</b>	
<p>Due to the distributed nature of defence and logistics operations, their operational data is stored in many different information repositories which are spread over various geographical locations. Such data stored in such distributed locations is crucial to generate highly confidential intelligence knowledge and operational plans in Defence. Similar is the case for managing supply chain operations in the logistics domain. Hence, to facilitate such operations, an Enterprise System that identifies the relevant information from different distributed information sources and integrates them to the Enterprise Information Repository on which analytics can be performed is needed. The literature approaches this problem as a data warehousing one, but in reality, it is a much bigger and more complex one that demands to be looked at from the Data Quality perspective. The objective of this project is to design, model, develop and test such a framework for data cleansing and data quality to support the Defence and Logistics Enterprise Systems.</p>	
<b>Description of Work:</b>	
<p>This project involves design and development of algorithms, risk modelling knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Defence Logistics</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Dr. Omar Hussain and Dr. Naeem Janjua</i>
<b>Objectives:</b>	
<p>The research incorporate wide array of issues facing to the Defence Industry nationally and internationally. Key research areas including the development of cutting edge frameworks, methods, technologies and accounting frameworks in the area of automated warehousing, intelligence asset management, integrated Inter-agency and multi-national forces operations, intelligent civilian contact management and vendor logistics performance, contingency planning and support logistics life cycle sustainment, situation awareness in ad-hoc environment, NATO and International standards for Defence Logistics security and safety.</p>	
<b>Description of Work:</b>	
<p>The contribution of the research in above areas including developing innovative solutions, techniques, methods, tools and proof of concepts through prototype systems, scientific or engineering methods or practical system proof.</p>	

<b>Project:</b>	<b>Green Logistics</b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Tharam Dillon;</i>
<p><b>Objectives:</b>  In cooperation with Fleetwood Corporation, who provides transportable mobile homes for resources, oil and gas exploration industries right across Australia, this project aims to reduce energy consumption and related emissions for Fleetwood's BHP, Rio Tinto and Woodside Camps. The contribution of this research is to reduce both energy use and emissions in line with the upcoming carbon-trading schemes. The project requires developing prototype systems and field-testing and possible deployment in real world.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b>Green Logistics</b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Professor Satish Chand, Dr. Naeem Janjua,</i>
<p><b>Objectives:</b>  Global warming is becoming a big problem and carbon emissions from a variety of sources are the cause of it. To control emission, a number of carbon emission reduction policies and schemes such as the Kyoto Protocol &amp; COP15 treaty have been reached and put in place. Many accounting models have already been proposed in the current literature to solve the problem of responsibility ambiguity. However, the current accountability models are proposed for the general industries and not for the aviation industry. We feel that these models cannot be applied directly to the aviation industry since factors of influence are significantly different. In Aviation, it involves a mix of international and national factors such as the accountability and the implications of members and non-members of the climate change treaties in different countries. Hence, taking into account all the determinant factors and different stakeholders involved in the process of the carbon accounting, we are proposing an efficacious and fair accountability model for the aviation industry in our research. This accountability model can be used to assist Australian government in coming up with a fair tax 'relief/subsidy' scheme for the aviation companies for a more sustainable tourism to the country; since inclusion of aviation into the carbon reduction scheme is going to be taxing to the aviation and tourism industry growth. This research is to improve carbon emissions by the replacement of diesel fuelled large trucks and semitrailers by Bio-Fuel or Gas fuelled vehicles through wireless sensor technologies and real time data mining. This project is in collaboration with JR Bulk Liquids Transportation Pty Ltd. The research work includes: the study of social, economic and environmental impact of Carbon emission, the possible enforcement of green logistics as pre-conditions for Defence, National and International trades, monitoring Transportation Net Green House Emission in world comparison view, and Transport emission per capita, IEA Reports, a world view of penalties. An approach to calculate CO<sub>2</sub> cost from Air, Rail, Land, Sea and other transportation mediums, a methodology for Multi-national approach to Green Trade Logistics and alternative fuel and underlying technologies for Green Logistics, measuring, monitoring, controlling and reducing emissions.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Intelligent Asset Management</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (<a href="mailto:e.chang@adfa.edu.au">e.chang@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Naeem Janjua (<a href="mailto:n.janjua@adfa.edu.au">n.janjua@adfa.edu.au</a>), Professor Michael O'Donnell; (<a href="mailto:m.odonnell@adfa.edu.au">m.odonnell@adfa.edu.au</a>), Mr Michael Forsyth</i>
<p><b>Objectives:</b>  The project manages the inspection and maintenance of enterprise asset, Defence Asset, mining industry asset, Agriculture, earth moving and construction heavy lifting equipment asset, and Logistics asset including trains assets such as to prevent train derailments and/or complete shutdowns of the south, west, east and north-bound train network, for the logistics industry, including supply chain, agriculture, resources and Defence industry. This research project sponsored by Fastrack Australia, aims to develop a Cloud based solution coupled with RFID solutions to manage big data on behalf of government and industry and individual users, to provide reliable identification information for heavy industry equipment, vehicles, robots and lifting gear equipment such as chains, shackles, slings, hooks used in the industry. Equipment have to be certified according to Australian Safety Standards. However, the problem that the certifying authorities face is to uniquely identify these items because it is quite easy to move items across and lose the identification information. Currently, metal tags are used to provide identification, but the problem with this approach is that data entry needs to be performed manually, which can result in data entry errors and tags can be easily switched from one certified item to another uncertified item.</p> <p><b>Description of Work:</b>  This project implements High Frequency (HF) RFID tags to tag all lifting gear equipment. The key advantage of using RFID to track lifting equipment is that once RFID tags have been embedded in the equipment, they are difficult to remove and replace. It aims to develop a new inspection &amp; maintenance system that incorporates condition monitoring, RFID, barcode and mobile devices.</p>	

<b>Project:</b>	<b><i>Intelligent Transportation</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (<a href="mailto:e.chang@adfa.edu.au">e.chang@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr. George Leu (SEIT)</i>
<p><b>Objectives:</b>  Road Users are central to safe and effective management of road traffic. Connections between smarter vehicles and smarter infrastructure offer new possibilities and new challenges. The contributions of the project is to develop a set of measurement for evaluation of the intelligent vehicles with human to system, human to environment, human to infrastructure interaction. Among the research work also include Vehicle-to-Vehicle and Vehicle-to-Infrastructure communications, Infrastructure to Driver and Vehicle-to-Driver communications, Collision avoidance and automatic road enforcement systems, Spatial Information aided travel, transit, and routing, Intelligent fleet, heavy vehicles and road transportation, Intelligent Aircraft loading and balancing systems, Traffic monitoring, prediction, and optimization</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, CPS frameworks, information analysis techniques and good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Linked Data Analytics in Logistics Operations</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Dr Omar Hussain (o.hussain@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Dr Naeem Janjua (n.janjua@adfa.edu.au)</i>
<p><b>Objectives:</b>  Big Data provides a wealth of data from which to process knowledge. But to achieve this, the first crucial step is to transform data to the relevant meaning in the domain in which knowledge has to be synthesized. For example, to synthesize knowledge from supplier management to operational strategy in the context of a Logistics ecosystem, it is first important to transform the relevant data related from supplier management to a state which has some meaning in operation strategy. Once this is done, the resulting new information from supplier management can be used to carry out meaningful analytics and learning in the area of operational strategy of the supply chain. This approach is known as Learning by Transfer. The objective of this project is to apply this principle for learning by transfer in Defence and Logistics operations.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Logistics Big Data Analytics</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (e.chang@adfa.edu.au)</i>
<b>Co-Supervisor</b>	<i>Dr. Naeem Janjua and Professor Tharam Dillon</i>
<p><b>Objectives:</b>  The research will carry out data analytics, finding correlations and pattern recognitions through intelligent computational technologies, various statistical analytic methods and software that turn the large complex data set into meaningful information and knowledge. In here, we study and conduct research into the following topics: Complex data structures including trees, graphs, text and spatial-temporal data; Mixed information types including image, video, web and text; Data that is distributed across multiple data sources; Joint mining of structured, semi-structured and unstructured information; Rare events whose significance could be masked by more frequently occurring events; Data, text and content mining; Web mining and document management; Knowledge discovery, representation and knowledge mining; Integrating a knowledge base from a <i>data mining</i> system and applying this knowledge during the data mining; Integrating a wide range of data mining techniques and methods and deriving incremental new knowledge from large data sets and prior knowledge. The types of knowledge extracted from information mining activities include: Embedded structures and relationships leading to associations between these embedded structures and embedded trees rather than just between simple variables; and also Knowledge that conforms to a certain model structure to enhance the model. The sources of information addressed in such mining activities include: Information gathered by a corporation or enterprise about its clients; Information provided by customers or viewers as a result of their own choice such as product reviews and trustworthiness information. Such information is of considerable importance in trust, reputation and risk assessment systems; and Information on social networking sites, to permit opinion mining.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, information analysis techniques, good mathematical knowledge as well as numerical modelling.</p>	

<b>Project:</b>	<b><i>Performance Analytics for Logistics Intelligence</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Dr Naeem Janjua (<a href="mailto:n.janjua@adfa.edu.au">n.janjua@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Professor Satish Chand, Professor Elizabeth Chang</i>
<p><b>Objectives:</b>  This project is sponsored by Blue Logistics, Queensland. In this project, through real time GPS data, we track all targeted vehicles in terms their route, time, travel patterns, speed, fleet movement over the cities, town, and country and fuel performance, etc. By mapping them on the Google map we carry out targeted real-time data analytics and discover travel patterns, productivities and in conjunction with road elevation and Google earth data, we work out the energy consumption, carbon emission, fuel (LNG, Diesel, Bio) performance, vehicle performance, logistics operators/driver performance, bottleneck routs, and with time stamps from the black boxes embedded in the heavy vehicles.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as numerical modelling.</p>	

<b>Project:</b>	<b><i>Provenance of Goods and Asset, Track n Trace technology</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Professor Elizabeth Chang (<a href="mailto:e.chang@adfa.edu.au">e.chang@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Professor Michael ODonnell, Prof Ruhul Sarker (SEIT)</i>
<p><b>Objectives:</b>  We track and trace everything, like for example quality of service against SLA agreement, reputation of the service provider through crowd sourcing and text mining, e-Warehousing orders, distribution and dispatchers etc. These factors are traced because they are important for the day-today running of the operations. The contributions in this project include developing techniques that will assist in the provenance of goods and asset. It aims to use low cost approximated GPS systems, Cyber-Physical Systems and Internet of things, coupled with RFID systems to track Goods, Containers, Vehicles and Assets movement; Real time optimization of human, material and infrastructure resources to all transport logistics operators, service providers, manufacturers, mining industries, and joint Defence operations.</p> <p><b>Description of Work:</b>  This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Relational Inertia: Explaining Habitual Group Purchase Decisions in Business Markets</i></b>
<b>Program Code:</b>	<i>1541</i>
<b>Supervisor:</b>	<i>Dr Daniel D Prior (<a href="mailto:d.prior@adfa.edu.au">d.prior@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Omar K Hussain, Prof Elizabeth Chang</i>
<p><b>Objectives:</b>  Current research into purchase decisions in business markets suggest that commitment and switching costs are the primary reasons for customer loyalty. This study suggests that a third category also exists. "Relational inertia" occurs when repeat purchases from one supplier are due to habit or conservatism. This study considers two perspectives. At the individual level, purchase decisions are one of many demands that individuals face. Drawing on bounded rationality theory and job demands theory, it is likely that individuals consent to repeat purchases due to excess cognitive load. At the firm level, relational inertia may result from cultural conservatism, decision avoidance from senior managers and the presence of specific firm processes that align to the supplier. The overall objective of this study is to</p>	

uncover the degree to which i) relational inertia is present in different purchase contexts (e.g. industry, product type, firm size, location) and, ii) to determine its relative effects on firm purchase decisions.

**Description of Work:**

- An initial literature review
- A qualitative phase involving interviews and/ or case studies
- A quantitative phase involving survey development, administration, and analysis of results using structural modelling or regression-based techniques
- Potentially an experimental design

**Desirable Applicants:** To apply for this project, applications should meet the criteria for admission to a PhD at UNSW; have industry experience in business-to-business interactions and excellent writing skills.

<b>Project:</b>	<b><i>Risk Optimization-based Logistics management</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Dr Omar Hussain (o.hussain@adfa.edu.au)</i>
<b>Co-Supervisor</b>	TBA

**Objectives:**

Various approaches in the existing literature optimize operations in different logistics areas, such as procurement, production and distribution. However, all of them synthesize knowledge in an area only from the past observations which are related to it. This process of knowledge synthesis is classified as historic-based process of logistics operations optimization. However, in today's information centred age, Big Data provides a wealth of information from different relevant areas to analyse it in real time and synthesize knowledge for another area. For example, analytic techniques can be applied on the real-time Big Data information coming from production planning and control (production logistics area) to synthesize knowledge and make decisions relevant to supplier management, ordering and order control (procurement logistics area). Furthermore, it is not necessary for the information coming from different areas to be relevant to the same supply chain; it can also be from other similar production units or supply chains. This process of knowledge synthesis is termed as the current-trend based process of supply chain operation optimization, where real-time information from other parts of the supply chain are utilized to make optimization decisions, improve efficiency, reduce wastage and losses. The objective of this project is to design, model, apply and test such a framework for managing operations in the logistics ecosystem by using knowledge across different areas.

**Description of Work:**

This project involves design and development of algorithms, risk modelling knowledge, information analysis techniques, good mathematical knowledge as well as possible numerical modelling.

<b>Project:</b>	<b><i>Satisfying Users with Buying Centre Decisions for Complex Products and Services</i></b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	<i>Dr Daniel D Prior (<a href="mailto:d.prior@adfa.edu.au">d.prior@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	

**Objectives:**

Most firms use 'buying centres' – groups of representative individuals – to make purchase decisions on behalf of the firm. These individuals exercise purchase authority on behalf of the firm as a whole and so this raises an important agency problem: do they serve all stakeholders' interests equally well? This study seeks to investigate the degree of stakeholder perceived justice present in buying centre

decisions. Three perspectives are of interest in this study. First, the formation of the buying centre shapes decisions, particularly in terms of membership stability, the definition of responsibility scope, and the parameters of the decision-making process. Second, the nature of the product/ service may influence the buying centre decision process; more complex products are likely to require greater expertise; services are likely to be more subjective. Third, user evaluations are likely to focus on engagement with products and services over time. These usage experiences are separate from the purchase process.

**Description of Work:**

- An initial literature review
- A qualitative phase involving interviews and/ or case studies
- A quantitative phase involving survey development, administration, and analysis of results using structural modelling or regression-based techniques
- Potentially an experimental design

**Desirable Applicants:** To apply for this project, applications should meet the criteria for admission to a PhD at UNSW; have industry experience in business-to-business interactions and excellent writing skills.

<b>Project:</b>	<b>Smart Port</b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	Professor Elizabeth Chang ( <a href="mailto:e.chang@adfa.edu.au">e.chang@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Professor Greg Martin
<p><b>Objectives:</b>            ALC 2012 estimates that every 1% increase in efficiency will save Australia around \$1.5 billion. The problems are very complex, as asserted by Michael Pal, Fremantle Port Authority in 2011. The key issue has been the monopoly-based control of container movement and all port and road operators' activities, which affect SMEs' productivity and resulting financial loss in Australia Ports. The project seeks to support national strategy on Port Management, addressing fundamental issues of port infrastructure development, freight networks, logistics networks and its impact on urban planning</p> <p><b>Description of Work:</b>            This project involves design and development of optimization and simulation algorithms, knowledge analysis techniques and good mathematical knowledge.</p>	

<b>Project:</b>	<b>Trust in Logistics Services</b>
<b>Program Code:</b>	1541
<b>Supervisor:</b>	Professor Elizabeth Chang ( <a href="mailto:e.chang@adfa.edu.au">e.chang@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Farookh Hussain; Dr. Nelia Hyndman-Rizk
<p><b>Objectives:</b>            Trust and Reputation is vital to Transport Logistics Industry, Government, Consumers, Business etc, especially if we look at long-term strategies. Recommendation systems through collective intelligence and crowdsourcing techniques to determine the trust and reputation of service providers and making recommendations to the customers; The contribution of this research is to build a set of methodologies for evaluating the trust, security and accountability mechanisms, analysing cascading failures and calculate the value at Risk Models, and their application to government, extended enterprises and the consortium industry. Another aspect of the research work include defining a new conceptual framework for an enhanced Service-Oriented Architecture (SOA) infrastructure – Service Space – with regard to service distribution and service discovery. We will explore the junction of the frontiers of several ICT disciplines: software architecture, information retrieval, distributed systems, business intelligence and SOA. The</p>	



framework will integrate web services, social networking and the Web 2.0 technology by conceptualising and realising a number of original web-compliant SOA architectural styles for service-oriented computing. The research will integrate Web 2.0 practices into the area of web services / SOA. In particular, the concept of being able to search for an entity in order to form a coalition with it is central to the idea of the formation of Digital Ecosystems. Traditional service discovery mechanisms, which are typically non-semantic in nature, suffer from many issues, most notable of which is the imprecision of search results. Moreover, there is no method by which the quality of a service provider that has been nominated as a result of the search process can be ensured. The recommendation systems will provide methods that filter and rank the result of search processes based on the quality of the service providers retrieved as a result of the search process. The proposed system keeps track of the quality of all the service providers and displays them for the end-user the recommendation dashboard during the search-retrieval process.

**Description of Work:**

This project involves design and development of algorithms, knowledge, information analysis techniques, good mathematical knowledge as well as numerical modelling.

# SCHOOL OF ENGINEERING AND INFORMATION TECHNOLOGY

<http://seit.unsw.adfa.edu.au/>

## Aerospace, Civil and Mechanical Engineering

### ACOUSTICS & VIBRATION

<b>Project:</b>	<i>Adaptive modal superposition mirror</i>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Andrew Lambert ( <a href="mailto:a.lambert@adfa.edu.au">a.lambert@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )
<b>Objectives:</b> Traditional adaptive optics (AO) deformable mirrors use segmented actuator patterns requiring elaborate manufacturing techniques. The range of surface curvatures used for corrective action can be described by Zernike polynomials, which are a sequence of orthogonal polynomials on the unit circle. The vibration modes of a circular membrane exhibit striking similarities to Zernike polynomials; in fact, they can be all expressed as functions of Bessel functions. This leads to the possibility of using a vibrating membrane mirror in adaptive optics. The objective of this project is to design, manufacture and test a modeshape mirror capable of reproducing the essential Zernike polynomials to be used in adaptive optics.	
<b>Description of Work:</b> This project involves design and conduct of laser experiments, high levels of signal processing and analysis techniques as well as possible numerical modelling.	

### CIVIL ENGINEERING

<b>Project:</b>	<i>Adaptive modal superposition mirror</i>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Andrew Lambert ( <a href="mailto:a.lambert@adfa.edu.au">a.lambert@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )
<b>Objectives:</b> Traditional adaptive optics (AO) deformable mirrors use segmented actuator patterns requiring elaborate manufacturing techniques. The range of surface curvatures used for corrective action can be described by Zernike polynomials, which are a sequence of orthogonal polynomials on the unit circle. The vibration modes of a circular membrane exhibit striking similarities to Zernike polynomials; in fact, they can be all expressed as functions of Bessel functions. This leads to the possibility of using a vibrating membrane mirror in adaptive optics. The objective of this project is to design, manufacture and test a modeshape mirror capable of reproducing the essential Zernike polynomials to be used in adaptive optics.	
<b>Description of Work:</b> This project involves design and conduct of laser experiments, high levels of signal processing and analysis techniques as well as possible numerical modelling.	

<b>Project:</b>	<b><i>Characterisation of Self Compacting High Performance Concrete</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> ) Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<p><b>Objectives:</b> Self Compacting Concrete (SCC) is the way for the future of concrete technology. The necessity of using highly efficient superplasticisers and viscosity modifying agents means that it is highly probable that such sophisticated polymers may affect the processes of hydration, setting, and almost all of the mechanical and durability characteristics of the hardened concrete. The objective of this project is to conduct micro and nano-analysis on SCC and analyse the effects of the characteristics that SCC possesses on its long term mechanical and durability properties</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Production of SCC using the state of the art methods.</li> <li>• Conducting a micro/nano study using SEM, XRD and Spectrotomography.</li> <li>• Analysis of microstructural results and relating them to macrostructural mechanical and durability characteristics.</li> </ul>	

<b>Project:</b>	<b><i>Creep and Shrinkage of Lightweight High Performance Concrete</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> ) Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<p><b>Objectives:</b> High performance lightweight concrete has been produced in Australia and China based on an invention by Dr Kayali, the Supervisor of this research. The new concrete is an environmentally sustainable material due to many benefits that range from using waste products, to reducing cement use and increasing the durability of structures. The concrete science and industry must be supplied with evidence of systematic scientific study that shows and analyse the characteristics of this concrete on long term structural performance. High on the list of main structural performance properties are shrinkage and creep. These two characteristics make essential differences when designing prestressed, post-tensioned and high strength concrete structures.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Produce lightweight high performance concrete.</li> <li>• Study the creep characteristics</li> <li>• Study the shrinkage characteristics.</li> <li>• Analyse the properties on both the microstructural and the macrostructural scales</li> </ul>	

<b>Project:</b>	<b><i>Optimization of Self Compacting High Performance Concrete</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> ) Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<p><b>Objectives:</b> With Self Compacting Concrete (SCC) becoming the dominant method of concrete production, it is necessary to be able to obtain optimum mix designs. The optimisation will take into consideration the environmental necessity to reduce cement use, using waste materials, reducing energy consumption, reducing overall cost, increasing ease of production and placing, reducing short term shrinkage and cracking problems and designing for long term durability and sustainability.</p>	

**Description of Work:**

- Study and analyse the rationale that underlies the different design procedures used in SCC.
- Theorise models that will take into consideration the objectives of the research.
- Design a large number of different mixes based on the models in step 2 above.
- Test and analyse the results.

**COMPOSITE MATERIALS & STRUCTURES**

<b>Project:</b>	<b><i>Blast responses of panels made of a hybrid-fiber engineered cementitious composites.</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> ) Prof. Paul Hazell ( <a href="mailto:p.hazell@adfa.edu.au">p.hazell@adfa.edu.au</a> ) (joint supervisor)
<b>Objectives:</b>	<p>Explosive loading is one of the typical loadings encountered for defence and protective structures in military fields. Some strategic important civilian infrastructures such as government buildings, embassy buildings, bridges, nuclear plants might be the targets for a terrorist bomb attack. The application of construction materials with outstanding blast resistance capability is essential for defence or protective structures. Thus development of blast resistant construction and building material and understanding structural responses to blast loading are very important.</p> <p>In recent years, Zhang and her associates developed new hybrid-fiber ECCs reinforced with PVA fiber and steel fiber and studied the mechanical behaviour and impact resistance of ECC panels. It is found the material exhibits improved strength and very good strain capacity and good capability to resist impact via extensive experimental and numerical studies and numerical. But the blast resistance of the ECCs are not know yet and hitherto no research on the blast response of ECC material or ECC panels have been reported.</p> <p>In this research the structural behaviour of ECC panels under blast loading is investigated. 3-D numerical modelling using LS-DYNA, which is an explicitly dynamic finite element software package will be employed to investigate the structural behaviour of the ECC panels under blast loading. To compare the blast resistance, the structural behaviour of a conventional steel rebar reinforced concrete panel is also studied. The success in the simulation of the structural responses of concrete structures using commercial FE tool is highly dependent on the constitutive models of the material and the equation of state. Thus the research will focus on the development of dynamic material models for the ECC under tension and compression with strain rate effect considered. Experimental studies will also be conducted to obtain the physical structural responses of the panels under blast loading.</p> <p>Through this research it is expected that efficient constitutive model under blast loading with strain rate effect for ECCs and modelling and analysis techniques for predicting the blast responses of ECC panels will be developed. The outcome of this project will largely promote and enhance the applications of the new ECC composites in defensive and safety-sensitive structures and will improve structural safety of these kinds of structures.</p>

<b>Project:</b>	<b><i>Characterisation of Mechanical behaviour of metal foams under static and dynamic loadings</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> )
<b>Co Supervisor:</b>	Prof. Paul Hazell ( <a href="mailto:p.hazell@adfa.edu.au">p.hazell@adfa.edu.au</a> )
<p><b>Objectives:</b>  Metal foams such as aluminium foam has been used increasing in many industries such as mechanical engineering, aeronautical and aerospace engineering due to their unique mechanical capability for energy absorption and impact resistance. In this research, the mechanical behaviour of aluminium foams under static and dynamic loading with varying strain rates will be investigated through extensive experimental, analytical and numerical studies for an insightful investigation.</p> <p>For experimental studies, the mechanical behaviour of the foam under varying strain rate will be bested to investigate the mechanical behaviour of the foam under different loading conditions including static loading, impact and blast loadings. For analytical studies, micromechanics theory will be applied to study the mechanical properties of the materials. For numerical studies, multiscale finite element analysis method and procedures will be developed so as to study the mechanical behaviour of the foam under different strain rate insightfully. The results from the three different methods will be used to validate against each other.</p> <p>The candidate needs to have good academic backgrounds on Engineering Mechanics and numerical analysis.</p>	

<b>Project:</b>	<b><i>Characterisation of Mechanical behaviour of Nanophotonic composites.</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> )
<b>Co Supervisor:</b>	Dr. Zhen Luo School of Electrical, Mechanical and Mechatronic Systems The University of Technology
<p><b>Objectives:</b>  A mutiscale numerical modelling technique and model and micromechanic analytical method will be developed in this research to model the effective macroscopic properties of Nanophotonic composites in this research. Based on the model, parametric studied will be conducted to study the effect of a series of geometry of the cells such as the shape and topology of the unit cell to achieve the most optical structural design for the metalmaterial with the most desired properties. The candidate needs to have good academic backgrounds on Engineering Mechanics and numerical methods.</p>	

<b>Project:</b>	<b><i>Design Optimisation of Composite Structures</i></b>
<b>Program Code:</b>	1661/1663
<b>Supervisor:</b>	Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<p><b>Objectives:</b>  The project is concerned with the development of design optimisation procedures formulated for composite materials, thin-walled and sandwich structures, hybrid metal-composite structural components with applications in aerospace, marine, offshore, shipbuilding and other industries. The relevant modelling approaches and optimisation techniques are to be developed and implemented.</p>	

**Description of Work:**

- Development of mechanical and numerical models
- Model implementation into the FE code
- Structural design and analysis
- Development of the theoretical and specialised numerical optimisation techniques
- Sensitivity analysis of the composite components-demonstrators
- Material characterisation and prototype testing

<b>Project:</b>	<b>Dynamic collapse of metallic lattice structures</b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Prof Paul Hazell ( <a href="mailto:p.hazell@adfa.edu.au">p.hazell@adfa.edu.au</a> ) Dr Mahmud Ashraf ( <a href="mailto:m.ashraf@adfa.edu.au">m.ashraf@adfa.edu.au</a> ) (Joint Supervisor)
<b>Joint-Supervisor:</b>	Dr Yixia (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> )

**Objectives:**

Metallic lattice materials have shown promise for lightweight sandwich panels that provide protection against blast and shock propagation. However, little is known of their dynamic spall characteristics (when compressed) and their collapse under dynamic loading. Using a plate-impact technique, where a shock is imparted to the face-plate of a sandwich structure, the collapse of a cellular structure can be interrogated with the response of the structure being monitored in real-time using piezo-resistive gauges and Heterodyne velocimeter (Het-v) techniques (a laser-based Doppler-shift technique used to track velocities of surfaces or interfaces). A typical experimental approach is provided below in Fig. 1.

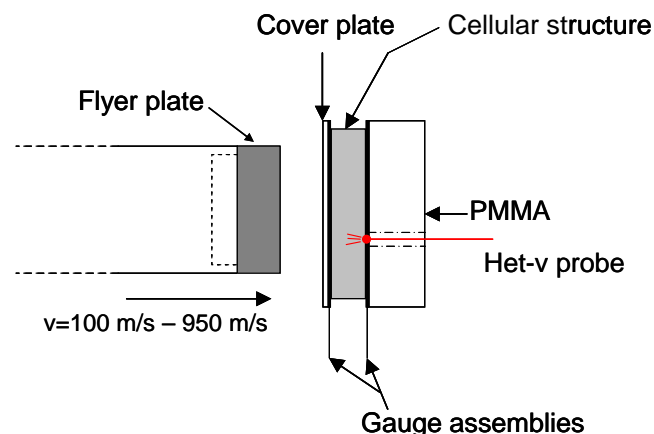


Fig. 1: A typical experimental set-up that will provide the core approach to this study.  
Note: this facility is not currently available at UNSW Canberra.

In addition to the experimental approach summarised above, it is expected that a modelling approach will be adopted using LS DYNA to enhance our understanding of the physics of collapse with special attention given to micro-lattices.

The novelty of this PhD research package will be to (a) optimise designs of cellular structures to maximise the energy absorption and shock mitigation; (b) enhance our understanding of the physics of lattice collapse; and (c) examine their failure characteristics when a tensile pulse is subsequently applied.

It is intended that new designs of blast mitigating structures will result..

<b>Project:</b>	<b><i>Green bricks – building a better way</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> ) Dr Andrew Neely ( <a href="mailto:a.neely@adfa.edu.au">a.neely@adfa.edu.au</a> )
<p><b>Objectives:</b> A novel building material which uses the waste fly-ash from coal-fired power stations to make bricks has been developed and is currently undergoing production start-up in a dedicated factory in China. This project will firstly establish the cradle to grave energy requirements for the manufacture of these bricks using established analytical techniques. This work is required to help establish the “green” credentials of these novel building products. This project will also establish an experimental method to measure the thermal properties of the range of bricks produced using fly-ash. It is anticipated that numerical modelling of the thermal behaviour of the bricks could also be performed using FEM. This work will lead to recommended recipes to optimise the thermal properties of the bricks both via composition and via geometry.</p> <p><b>Description of Work:</b> Identify the main components of the manufacturing process and use the literature to establish approximate energy budgets for each process.</p> <ul style="list-style-type: none"> <li>• Set up a computational model to calculate the overall energy budget for a range of parameters.</li> <li>• Design and perform experiments to measure the thermal conductivity and heat capacitance of the bricks at a range of humidity levels.</li> <li>• Determine the dependence of these thermal properties on the brick constituents.</li> <li>• Vary the geometry of the bricks to optimise the thermal performance .</li> </ul>	

<b>Project:</b>	<b><i>Impact and penetration of comminuted ceramic materials</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Prof Paul J Hazell ( <a href="mailto:p.hazell@adfa.edu.au">p.hazell@adfa.edu.au</a> )
<b>Joint-Supervisor:</b>	Dr Yixia (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> )
<p><b>Background:</b> The penetration of comminuted (i.e., highly fracture and fragmented) materials is of interest for several reasons. These include the possibility of being able to predict the penetration into pre-fractured concrete, ceramic and glass materials. Of particular interest is the possibility of predicting the resistance of such materials to penetration by projectiles and the strength that they offer during the penetration (and compaction) process. Such materials are known to be pressure-dependent in their behaviour and therefore it is thought that a Drucker-Prager relationship is appropriate. Also, the inter-particle friction of the individual particles is thought to play a large part in the resistance to penetration – particularly when these materials are compacted.</p> <p><b>Objectives:</b> The goal here is to provide insight into the behaviour of highly compacted, highly fractured material so that it is possible to establish a family of constitutive relationships that define the break-down from intact to fractured to highly comminuted material. This is particularly important for modelling the dynamic behaviour of ceramic materials. The challenge will be implementing these models into a continuum explicit code..</p> <p><b>Description of work:</b> This project will be experimental and computational in nature. The student will be required to independently carry out experimental characterisation tests using universal testing machines as well as manufacture powder compacts for ballistic testing. Computational studies may involve minor code development including the</p>	



possibility of modifying existing constitutive models in commercial Hydrocodes to successfully simulate the dynamic behaviour of a powder compact. Technical and full supervisory support will be available.

<b>Project:</b>	<b><i>Integrated metal-composite joint design for the filament wound transmission shafts</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> ) Mr Alan Fien ( <a href="mailto:a.fien@adfa.edu.au">a.fien@adfa.edu.au</a> )
<p><b>Objectives:</b> Adhesive bonding of high-loaded composite transmission shafts does not provide sufficient strength and stiffness. In order to create a highly rigid and efficient joint, it is necessary to search for fundamentally novel design and engineering solutions. The fastening should be designed in the way that the torque is transmitted from the metal fitting to the filament wound shaft through the reinforcing material, rather than a layer of the binder. This could be achieved by integrating the metal fitting into the composite material during the formation of the joint.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Develop novel design solution for metal-composite joint with integrated metal fitting, using CAD technology</li> <li>• Perform finite-element parametric analysis and design optimisation</li> <li>• Prototype design and manufacture</li> <li>• Prototype testing</li> </ul>	

<b>Project:</b>	<b><i>Long term durability of hybrid FRP-Concrete beams</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Amar Khennane ( <a href="mailto:a.khennane@adfa.edu.au">a.khennane@adfa.edu.au</a> )
<p><b>Objectives:</b> Composite materials, particularly fibre-reinforced polymers (FRP) are increasingly being used in infrastructure applications. However, there remain concerns regarding their long-term performance under load for civil engineering applications. Understanding the mechanisms of composite failure under load is an important issue for structural design. In particular, it is useful to have a theory capable of assessing how the environment and details of the constituents and microstructure affect the resulting composite material behaviour. The objective of this work is to assess the long term behaviour a hybrid beam (FRP-Concrete) for infrastructure and to develop through life estimation methods</p>	

<b>Project:</b>	<b><i>Mechanical and structural behaviour of a new fire resistance construction material</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> ) Co-supervisor: An appropriate co-supervisor will be appointed.
<p><b>Objectives:</b> Fire resistance capability of the construction materials play a significant role for the safety of the structures and personnel in case of fire. Material properties of conventional concrete or steel/FRP reinforced concrete material deteriorate severely in fire conditions causing imminent structural failure which expose life and facilities at great risk especially in some structures, such as tunnels or underground structures which usually need longer evacuation time. In this research, a hybrid fiber reinforced high performance concrete material with excellent fire resistance capability will be developed. The material properties of the new materials varying with temperatures up to 1500 degrees will be tested in fire furnace to investigate the degradation of the material properties under fire loading. A curved shell structural component</p>	



representing the lining of the tunnel made of this material will be built and the whole structure will be tested in fire furnace to investigate the fire resistance of the structures. The structural behaviour of the structure under fire loading will also be investigated numerically using computer simulation. The material models tested and the finite element model will be further validated by the numerical modelling. Once validated, parametric studies will be carried out to investigate the effect of a series of parameters, such as the thickness of the wall, the shape of the shell, etc.

It is expected a new construction material with excellent fire resistance capability will be developed and the material properties under temperate effect will be investigated. Fire resistance performance of a tunnel-like curved shell structure will also be investigated experimentally and numerically. The material will have very promising prospect of applications in engineering structures. The research outcome will provide importance reference to structural design and lay sound foundation for the application of this material.

<b>Project:</b>	<b><i>Modelling and characterisation of the fibre reinforced reactive powder concrete</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> ) Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> )
<b>Objectives:</b> The project is concerned with the experimental material characterisation and micro-mechanical modelling of the reactive powder concrete reinforced with randomly oriented short fibres. The modelling will involve identification of the input parameters and development of the relevant testing procedures of the material characterisation. The model validation will be performed by comparison of the theoretical/numerical predictions and experimental results obtained for the structural components – demonstrators	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Development of micro-mechanical (FE) model for the reactive powder concrete reinforced with randomly oriented short fibres</li> <li>• Specimens design, manufacture and testing</li> <li>• FE analysis of the structural components - demonstrators (beams)</li> <li>• Demonstrator manufacture and testing</li> <li>• Model validation</li> </ul>	

<b>Project:</b>	<b><i>Production of High Performance Fibre Reinforced Geopolymer Lightweight Aggregate Concrete</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr Obada Kayali ( <a href="mailto:o.kayali@adfa.edu.au">o.kayali@adfa.edu.au</a> ) Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<b>Objectives:</b> With the emphasis on sustainability of building activities, the geopolymers have regained interest from the industry. Dr Kayali, the supervisor of this research, has patented a new unique lightweight aggregate that posses superior qualities and is made from fly ash. The combination of geopolymers and the new lightweight aggregates to produce high quality structural concrete is technically a very promising objective. More importantly this combination is an environmentally important and responsible objective as it lies at the core of sustainability of concrete materials and production.	
<b>Description of Work:</b> Fully understand the geopolymers and the method of their manufacture within ease and cost efficiency.	

Arrive at an easy to produce mix design using geopolymers instead of cement, together with fibre reinforcement and the newly produced lightweight aggregates. Test and analyse the results in view of the microstructural and mechanical properties whether characteristic or required of such material

<b>Project:</b>	<b><i>Progressive damage modelling and crash simulation for laminated composite structures</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Prof Evgeny Morozov ( <a href="mailto:e.morozov@adfa.edu.au">e.morozov@adfa.edu.au</a> )
<p><b>Objectives:</b>  The project is concerned with the development of a modelling approach to the simulation of the dynamic response of thin-walled composite structural components subjected to crushing loads. The progressive damage model should be developed and implemented into a FE code using a material characterisation process that is based on the material's experimentally recorded behaviour. The material characterisation involves impact testing of the composite specimens. The performance of the implemented models will be evaluated by comparison of the results of numerical modelling and experimental data obtained from the dynamic testing of composite laminated structural components.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Development of numerical progressive damage model</li> <li>• Model implementation into the FE code</li> <li>• Specimens design, manufacture and impact testing</li> <li>• FE analysis of the laminated components-demonstrators</li> <li>• Demonstrator manufacture and testing</li> <li>• Model validation</li> </ul>	

<b>Project:</b>	<b><i>Radio Frequency Health Monitoring of Composite Structures</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )
<p><b>Objectives:</b>  The objective of this thesis is to investigate and develop a Radio Frequency (RF) method to monitor internal stresses in composite structures. The premise behind the method is that a conductive fibre will reflect an incident RF wave and that the frequency of the reflected wave will be modulated as a function of the strain induced in the conductive fibre due to the stress in the surrounding composite matrix.</p>	

<b>Project:</b>	<b><i>Response mechanics of a hybrid-fibre engineered cementitious composites under impact</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> ) - Chief Prof Paul Hazell ( <a href="mailto:p.hazell@adfa.edu.au">p.hazell@adfa.edu.au</a> ) – Joint supervisor
<p><b>Objectives:</b>  Hybrid fibre reinforced engineering cementitious composite (ECC) is a high-performance fibre-reinforced cement composite and it is a promising engineering material for protective structures due to its excellent mechanical properties, such as high tensile strength, large pseudo strain-hardening, capacity to resist micro-cracking, and high energy absorption.</p> <p>A great deal of research has been conducted to develop the ECC material and to understand the mechanical behaviour of the materials and structural members under various loadings including high-velocity impact loading. Hitherto nearly all the research on the mechanical behaviour of the material has focused on the experimental investigations and nearly no micromechanics theory and method has</p>	

been developed although ECC is actually a micromechanically designed material. Although micromechanical theory could be a very effective method to study the material and mechanical mechanism accurately, there is a significant gap in the research and development of such kinds of theories and methods.

In recent years, Zhang and her associates developed new impact resistant hybrid-fibre ECCs reinforced with PVA fibre and steel fibre and the new ECC has been found to have enhanced capability for impact resistance and energy absorption via extensive experimental and numerical studies.

The proposed research aims to understand the response mechanisms of the new ECC under impact loading and to develop deep understanding of the response and damage mechanism of the material and structures under impact, and to provide a framework for design and development of blast-resistance materials via theoretical and numerical studies. The specific objectives are

- to establish in-depth understanding of the damage and failure mechanism of the material under blast loading;
- to develop and advance theory and knowledge in micromechanics on hybrid-fibre ECC;
- to investigate the mechanical behaviour of the ECC material, and develop suitable constitutive models for the ECC material under tension and compression with strain rate effect.
- to develop effective numerical methods and modelling technique for accurate modelling of the structural performance of ECC panels under blast loading

The candidate needs to have strong backgrounds and knowledge on Mechanics. Experience and knowledge on Finite Element Method and modelling is desired.

<b>Project:</b>	<b><i>Structural performance of an innovative bridge decks system</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	Dr. Y.X. (Sarah) Zhang ( <a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a> ) Co-supervisor: An appropriate co-supervisor will be appointed.
<b>Objectives:</b>	The structural behaviour of a new bridge deck psystem with a high performance hybrid-fiber reinforced concrete material will be investigated in this research. The high-performance hybrid-fiber reinforced concrete material which has superior material properties such as high tensile strength, high strain capability and excellent resistance to dynamic loading will be used to replace the traditional concrete materials. Ongoing research on the material properties and structural behaviour including impact and cyclic dynamic loading has been carried out in Dr. Zhang's research group and a new hybrid-fiber reinforced concrete material has been developed and demonstrated to have excellent impact resistance capability. In this research the structural behaviour of the new bridge deck system using the material will be investigated numerically using finite element analysis and modelling technique. Material model of the material under dynamic loading will be developed. The structural behavior of the new system under both static loading and dynamic loading under the traffic loading will be investigated.

<b>Project:</b>	<b><i>Structural performance of FRP strengthened concrete beam under cyclic loading.</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	<i>Dr. Y.X. (Sarah) Zhang (<a href="mailto:y.zhang@adfa.edu.au">y.zhang@adfa.edu.au</a>)</i> <i>Co-supervisor: An appropriate co-supervisor will be appointed.</i>
<b>Objectives:</b>	
<p>Fibre reinforced polymers (FRPs) have been used to reinforce and strengthen the concrete structures and lot of research has been done in this area. But the structural behaviour of FRP strengthened concrete structures under cyclic loading has not been investigated widely. Thus it is important to study the structural performance especially the interfacial failure between the FRP and concrete under cyclic loading. Dr. Zhang and her student have developed effective numerical models and finite element analysis software for the structural behaviour of FRP strengthened concrete slabs under cyclic loading. This research will study of the structural behaviour of FRP strengthened concrete beams under fixed point cyclic loading experimentally and numerically. A new finite element model will be developed to model the debonding between the FRP and concrete. Effective material models and bond slips models will be developed and validated.</p> <p>The candidate needs to have background and knowledge on Finite Element Analysis and Method and experience and interest on programming using Fortran is desired.</p>	

## COMPUTATIONAL FLUID MECHANICS

<b>Project:</b>	<b><i>Aeromechanical modelling of hot jet engine components</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Andrew Neely (<a href="mailto:a.neely@adfa.edu.au">a.neely@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr John Young (<a href="mailto:j.young@adfa.edu.au">j.young@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>Gas turbine engine components are subject to both low and high cycle fatigue loads during operation. To improve engine reliability, durability, and maintainability through improved engine structural integrity it is necessary to understand the interaction of high-cycle and low cycle fatigue in these components. Existing research is already underway at UNSW Canberra to investigate fatigue interaction in the fan section of aero engines.</p> <p>This project will extend the work into the turbine section of the engine where the addition of thermal loading becomes the major contributor to the fatigue life of the rotating components. The work will be numerically based through a combination of computational fluid dynamics (CFD) and finite element modelling (FEM) analysis to investigate the fluid structure interaction in the turbine section.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Develop CFD and FEM models of the rotating turbine blades.</li> <li>• Apply high-cycle (aerodynamic, vibration) and low-cycle (rotational and thermal stresses) fatigue loads on the component.</li> <li>• Incorporate fluid-structure interaction into the numerical modelling.</li> <li>• Predict stress and strain histories during engine operation.</li> <li>• Investigate the interaction of these loads with internal and external cooling geometries in the turbine blades.</li> </ul>	

<b>Project:</b>	<b><i>Numerical modelling of Brain Cooling</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Andrew Neely, SEIT UNSW Canberra, Assoc Prof Christian Lueck, Canberra Hospital</i> Email: <a href="mailto:a.neely@adfa.edu.au">a.neely@adfa.edu.au</a>
<b>Co-Supervisor</b>	SCUT
<p><b>Objectives:</b> Therapeutic hypothermia is a method of treatment being trialled for use in ischaemic stroke patients. In this treatment the brain is deliberately cooled in an attempt to slow the death of brain tissue downstream of a blood clot to buy the doctors time to remove the clot. A number of methods of cooling the brain have been investigated by various researchers including cooling of the scalp, cooling of the cerebral spinal fluid and cooling of the blood supply to the brain. This PhD project will use numerical engineering tools (FEM) to model the heat transfer in the brain and assess the performance of these different brain-cooling methods. The project will be performed in collaboration with an ongoing clinically based research project which is assessing the performance of a blood cooling scheme for inducing therapeutic hypothermia. The numerical project will use measurements obtained from the clinical work to validate the simulations. The work will be performed in collaboration with staff from Canberra Hospital.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Model the thermal regulation process in the brain.</li> <li>• Conduct detailed transient FEM simulations of brain cooling via the different cooling strategies.</li> <li>• In collaboration with clinical specialists, blood-cooling strategies will be modelled and validated</li> <li>• Some experimental support for the clinical work may be needed to measure temperature distributions using infrared thermography during clinical MRI scans</li> </ul>	

## FLOW VISUALISATION

<b>Project:</b>	<b><i>Image Processing of Axi-symmetric Interferograms for Flow Field Visualisation</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>A/Prof Harald Kleine (<a href="mailto:h.kleine@adfa.edu.au">h.kleine@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Murat Tahtali (<a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a>)</i>
<p><b>Background:</b> One of the ongoing projects in this group is the investigation of axisymmetric compressible flows that are established when a shock wave exits an open shock tube. This rather simple scenario generates a large number of secondary waves and flow features, and the details of this process are not fully clarified. We have conducted a number of studies to investigate this flow pattern, and one of the test campaigns has yielded a large number of time-resolved interferometric visualisation results such as the ones shown below. One important task that to-date has not been tackled is to evaluate the obtained results to extract information on the density distribution in this flow. This information is crucial for a comparison with other experimental data and the results of numerical simulation.</p> <p><b>Objectives:</b> High-speed interferograms of an axi-symmetrical flow field are used to visualise its expansion. Without unwrapping the fringe patterns, the analysis remains mainly qualitative. However, a technique called the Abel transform, similar to tomography, can be used to unwrap the fringe patterns and obtain pressure gradients. The project</p>	

described here has the aim of developing a computational tool that can reconstruct an axisymmetric density distribution from interferograms of high-speed flows. These interferograms are provided as time-resolved records, which can then be used to determine how the density field develops in space and time.

**Description of work:**

It is expected that this project will deliver a fast and efficient algorithm that allows one to determine the density distribution in a transient, axisymmetric flow field recorded in sequences of line-of-sight interferometric visualisations. The principal techniques for image acquisition are well established and a large amount of expertise and high-class equipment for this purpose is available in the School. There already exists a large amount of image data that is suitable for the proposed analysis. Image registration algorithms that have been developed in the School for atmospheric imaging can be adapted and expanded to this application.

<b>Project:</b>	<b><i>Reconstruction of three-dimensional flow patterns from line-of sight visualisations</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	A/Prof Harald Kleine ( <a href="mailto:h.kleine@adfa.edu.au">h.kleine@adfa.edu.au</a> )
<b>Co Supervisor:</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )

**Background:**

Density-sensitive flow visualisation techniques such as shadowgraphy, schlieren or interferometry have a so-called line-of sight character. This poses serious problems when the flow field is three-dimensional, as the visualisation record can only provide a projected view of the flow which will not reveal how the flow changes along the line of sight. A possible solution is to apply a tomographic approach, where several projected views, each taken from a different view angle, are combined to reconstruct the flow field in all its spatial dimensions. An example of such visualisations is given below. One piece of information that is very important for the design of vehicles travelling at supersonic speeds is the knowledge of the exact shape of shock fronts, contact surfaces and expansion zones. This information can be extracted from the aforementioned tomographic views.

**Objectives:**

The quantitative analysis of three-dimensional compressible flows remains one of the major challenges in fluid mechanics, and only few and specialised attempts have been made to tackle this problem. Typical visualisations of such flows have a line-of-sight character, that is, they integrate all information of the flow along the depth of the flow field. It is the aim of this project to develop robust and efficient algorithms that can be used to extract the spatial distribution of the flow field from adequate visualisations, with special emphasis on sequences of images obtained from time-resolved recordings. The high number of such image records – typically more than 100 in a single experiment – poses a particular challenge as the algorithm for image processing has to be highly efficient and fast. The final goal of the project is to create a tool that allows one to reconstruct how three-dimensional features observed in a high-speed compressible flow evolve with time.

**Description of work:**

- It is expected that this project will deliver a fast and efficient algorithm that allows one to reconstruct a three-dimensional, transient flow field from a sequence of line-of-sight visualisations, obtained with techniques such as schlieren or interferometry. This project will deal with the general case of a fully three-dimensional flow and the main objective is to determine the three-dimensional shape of the observed flow features. The principal techniques for image acquisition are well established and a large amount of expertise and high-class equipment for this purpose is available in the School. There already exists a large amount of image data that is suitable for the proposed



analysis. Image registration algorithms that have been developed in the School for atmospheric imaging can be adapted and expanded to this application.

## GEOTECHNICAL AND INFRASTRUCTURE ENGINEERING

<b>Project:</b>	<b><i>Behaviour and stabilisation of potentially liquefiable alumina tailings</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	A/Prof S.R. Lo ( <a href="mailto:r.lo@adfa.edu.au">r.lo@adfa.edu.au</a> ) & Dr Rajah Gnanendran
<p><b>Objectives:</b>          Alumina tailings, commonly known as red mud, are potentially liquefiable. Its disposal and stabilisation is of directly relevance to both Australia and China. The primary objectives of our research in this area are:</p> <ul style="list-style-type: none"> <li>• Understanding the liquefaction behaviour of red mud.</li> <li>• Developing innovative solutions in stabilisation red mud. At present we intend to focus on two approaches:             <ul style="list-style-type: none"> <li>○ Using chemical additives</li> <li>○ Using e-PVD</li> </ul> </li> </ul> <p><b>Description of Study:</b>          We intend to take in 1 to 2 PhD candidates to conduct PhD research in this pioneering area.</p> <ul style="list-style-type: none"> <li>• The research approach can be based on experimental studies, mathematical modelling and finite element analysis.</li> <li>• We intend to incorporate the critical soil mechanics framework, and hopefully developed constitutive (mathematical) modelling.</li> <li>• In the case of e-PVD, finite element studies will be used to modelling the electro-osmotic consolidation process.</li> </ul>	

<b>Project:</b>	<b><i>Behaviour of granular base materials as unsaturated geomaterials.</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	A/Prof S.R. Lo ( <a href="mailto:r.lo@adfa.edu.au">r.lo@adfa.edu.au</a> ) & Dr Rajah Gnanendran
<p><b>Objectives:</b>          Motorways have to be designed to very high performance level to ensure safety at high car speed. One component that controls the performance of a motorway pavement system is the behaviour of road foundation constructed with granular base (GB) subject to cyclic loading. A granular base (GB) material is a heavily compacted well-graded silty sandy gravel. It may be unbound (ie no cementing agent added) or stabilised (ie with cementing agent added to give an unconfined compressive strength of ~2MPa). Traditional pavement design is based on empirical rules, and the associated prescriptive requirements may place severe environmental pressure because of the need of extensive quarrying and haulage over long distances. Furthermore, some of the empirical rules on fines content, role of cement additives are inconsistent.</p> <p>As part of an effort to develop analysis-based design for pavement foundations, a new research area, referred to as "<i>Pavement Geotechnics</i>", has been initiated recently.</p> <p>A significant component of pavement geotechnics is on material behaviour and modelling. As the pavement foundation material is in an unsaturated state its behaviour of is also governed by the fundamentals of unsaturated soil mechanics. We are the only research group in Australia, and one of the few internationally, that have a track record in this area of research.</p>	

**Description of Study:**

We intend to take in one PhD (maybe two if we have outstanding applicants) to conduct PhD research in this pioneering area. The research work involves:

- Conducting cyclic triaxial testing on GB materials (unbound or stabilized) with using unsaturated soil mechanics testing technology.
- Synthesizing the test results to establish the stress state parameters (including matric suction) for characterizing the influence of fines. This in return will ensure under top model the role of fines using initial stress state parameters.
- Characterizing the cumulative effects of load repetitions framed in term of stress state parameters.

<b>Project:</b>	<b><i>Liquefaction of silty geo-materials materials</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	A/Prof S.R. Lo ( <a href="mailto:r.lo@adfa.edu.au">r.lo@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Rajah Gnanendran
<b>Objectives:</b>	
Liquefaction in (loose near-saturated) granular material is confusing as it can be triggered by both rapid monotonic loading and/or cyclic loading. Furthermore most studies are based on either clean sand or sand with a small amount of fines. However, a silty soil can also liquefy. Both mine tailings and coal ash are silt that may be prone to liquefaction. The primary objectives of our research in this area are:	
<ul style="list-style-type: none"> <li>• Advancing the modelling of the influence of fines on sandy soil by having a unifying framework for both static and cyclic liquefaction.</li> <li>• Understanding the liquefaction of silts, and hopeful extend our liquefaction theories for sandy soil to silty soil.</li> <li>• Understanding the effects of slight unsaturation on liquefaction behaviour.</li> <li>• The influence of the soil grains being crushable.</li> </ul>	
<b>Description of Study:</b>	
We intend to take in 1 to 2 PhD candidates to conduct PhD research in this pioneering area.	
<ul style="list-style-type: none"> <li>• The research approach is largely experimental and using our specially developed in-house triaxial stations that can perform both instability testing and impart cyclic stress pulses of varying (in a given test) waveform. One of such station also incorporates unsaturated soil testing technologies.</li> <li>• We intend to synthesise/ interpret the experimental findings within the critical soil mechanics framework, and hopefully developed constitutive modelling to characterise liquefaction behaviour.</li> <li>• For study on silty soil, we will be using actual coal ash from a particular ash disposal site. This also allows some insights into the effects of crushable grains, noting that some of the grains of coal ash are crushable glass particles.</li> </ul>	

<b>Project:</b>	<b><i>Pavement geotechnics: Behaviour of subgrade under cyclic loading.</i></b>
<b>Program Code:</b>	1631
<b>Supervisor:</b>	A/Prof S.R. Lo ( <a href="mailto:r.lo@adfa.edu.au">r.lo@adfa.edu.au</a> ) & Dr Rajah Gnanendran
<b>Objectives:</b>	
Similar to Project “ <i>Behaviour of granular base materials as unsaturated geomaterials.</i> ” but the focus is on in situ soil as functioning as pavement foundation.	

<b>Project:</b>	<b><i>Soft clay engineering involving sensitive soil or rate dependent soil (or both)</i></b>
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<b>Program Code:</b>	1631
<b>Supervisor:</b>	A/Prof S.R. Lo ( <a href="mailto:r.lo@adfa.edu.au">r.lo@adfa.edu.au</a> ) & Dr Rajah Gnanendran
<b>Objectives:</b>	
<p>The challenge of geotechnical work involving thick deposits of soft clay is well known in infrastructure engineering. The primary objectives of our research work in soft clay engineering are:</p> <p>Advancing the modelling of geo-structures on soft soil (in the context of infrastructure engineering). The advances can be made at the constitutive (material) modelling level or at the analysis model level or both.</p> <p>Development of innovative solutions, including but not limited to use of geosynthetics.</p>	
<b>Description of Study:</b>	
<p>Several PhD projects involving a combination of experimental, constitutive modelling, and FEA-based case studies can be configured depending on the aptitude of the student.</p>	

## GUIDANCE AND CONTROL

<b>Project:</b>	<b><i>Integrated Guidance and Control of Underwater Vehicles</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Sreenatha G Anavatti ( <a href="mailto:s.anavatti@adfa.edu.au">s.anavatti@adfa.edu.au</a> )
<b>Objectives:</b>	
<p>The proposed work is aimed at integrated guidance and control of AUV. The work involves the development of an overall objective of combining the two schemes and the development of the two subsystems in a coupled fashion. Intelligent systems like Fuzzy Logic and Neural Network provide very good platform for handling non-linear coupled and time-varying systems. These techniques will be applied to design the integrated guidance and control system. Dynamic path planning will be utilised for the guidance scheme to avoid collisions.</p>	

## HIGH SPEED AND AERODYNAMICS

<b>Project:</b>	<b><i>Modelling of NO Fluorescence for nonequilibrium thermometry and velocimetry at high speeds</i></b>
<b>Program Code:</b>	1663
<b>Supervisor:</b>	Dr Sean O'Byrne ( <a href="mailto:s.obyrne@adfa.edu.au">s.obyrne@adfa.edu.au</a> )
<b>Co-Supervisor:</b>	A/Prof Andrew Neely ( <a href="mailto:a.neely@adfa.edu.au">a.neely@adfa.edu.au</a> )
<b>Objectives:</b>	
<p>This project builds upon previous successful projects in the school related to understanding the physical processes involved with boundary layer separation in hypersonic flows in thermal nonequilibrium. We have developed a suite of experimental techniques based upon laser-induced fluorescence of the nitric oxide molecule that are capable of measuring translational temperature, rotational temperature, vibrational temperature and velocity in low-density flows. The purpose of the project is to develop a framework in which direct simulation Monte Carlo (DSMC) calculations can be used to better design the experiments performed using our techniques by simulating the fluorescence expected from these computational simulations.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Develop a cutting-edge model for nitric oxide fluorescence that includes saturation, absorption quenching and thermal nonequilibrium processes.</li> <li>• Use this model to generate fluorescence maps from DSMC-generated maps</li> </ul>	

<p>of flow field quantities</p> <ul style="list-style-type: none"> <li>• Develop a new algorithm using Bayesian statistical methods that can generate velocity maps from fluorescence images while minimising the amount of tunnel run data for a given degree of uncertainty in the results</li> </ul>
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## MECHANICAL ENGINEERING

<b>Project:</b>	<b><i>Development of a PIV for micro-flows using non-laser based method</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Jong-Leng Liow (<a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a>)</i>
<p><b>Objectives:</b>          To develop an LED based PIV and the associated analysis program to measure flow characteristics of micro-channels.          The use of particle image velocimetry (PIV) in fluid flow is an important analytical and diagnostic tool, particularly for ensuring that the simulation results are validated by experimental measurements on the flow field of interest. In recent years, there has been active development of PIV for studying micro-flows. A major drawback is the use of laser based techniques for illuminating the region of interest but stricter requirements have restricted the use of high intensity lasers. Currently the illumination power of LEDs has increased tremendously and the green wavelength LED has a wavelength close to that of the lasers used for PIV. It is proposed to develop a PIV system using LED rather than laser. In parallel a code will be developed to analyse the images obtained from the PIV setup.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Develop a simplified set-up with the current microscope set-up to illuminate the test section with LED based high intensity flashes.</li> <li>• Develop PIV procedures to extract flow velocity data and methods to optimise data recovery as the signals can be faint.</li> <li>• Extend the framing rate to allow for high framing rate micro-PIV.</li> <li>• Validate the micro-PIV system by measuring the velocity field of liquid flows in micro-channels.</li> </ul> <p><b>Pre-requisites:</b>          The prospective student(s) should have some experience in programming in C++ as this is a useful platform for the development of the PIV analysis software.</p>	

<b>Project:</b>	<b><i>Development of Genetic Programming Methods for Rule Extraction and Knowledge Representation</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Tapabrata Ray (<a href="mailto:t.ray@adfa.edu.au">t.ray@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	An appropriate Co-supervisor will be identified.
<p><b>Brief:</b> Concept design is a critical step in the process of design where multiple promising concepts are identified. Development of effective and efficient optimization methods to support concept design is a challenge as the number of variables representing a concept might vary from one to another while there could be some commonality in terms of several set of variables. The objective is to develop optimization methods that are capable of handling such classes of problems.</p> <p><b>Skills Required:</b> Good Matlab coding skills will be required. An understanding of optimization methods and in particular population based approaches such as Evolutionary Algorithms would be useful.</p> <p>More details of the research activities at</p>	

<http://seit.unsw.adfa.edu.au/research/sites/mdo/>

<b>Project:</b>	<b><i>Development of Methods to Solve Multifidelity Optimization Problems</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Tapabrata Ray ( <a href="mailto:t.ray@adfa.edu.au">t.ray@adfa.edu.au</a> )
<b>Co-Supervisor</b>	An appropriate Co-supervisor will be identified.
<b>Brief:</b> In reality, most design optimization problems involve computationally expensive analysis. The aim of this work is to develop methods that can simultaneously deal with estimates arising from multifidelity analysis codes. The use of such multifidelity estimates during the course of optimization is the second phase of the project.  <b>Skills Required:</b> A candidate from Computer Science/Engineering would be preferred. Good coding skills in C#/C++/MATLAB is required. An understanding of optimization methods and in particular population based approaches such as Evolutionary Algorithms would be useful.  More details of the research activities at <a href="http://seit.unsw.adfa.edu.au/research/sites/mdo/">http://seit.unsw.adfa.edu.au/research/sites/mdo/</a>	

<b>Project:</b>	<b><i>Development of Methods for Flowfield Prediction</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Tapabrata Ray ( <a href="mailto:t.ray@adfa.edu.au">t.ray@adfa.edu.au</a> )
<b>Co-Supervisor</b>	An appropriate Co-supervisor will be identified.
<b>Brief:</b> There is an ongoing need to understand fluid flows. Computation of such flowfields are computationally expensive and only a limited set of flowfields can be numerically simulated or identified experimentally. The aim of the project is to be able to develop a mathematical model for flowfield prediction given a set of snapshots.  <b>Skills Required::</b> A candidate with a good Mathematics background would be preferred. Good coding skills in C#/C++/MATLAB is required. An understanding of optimization methods, approximation methods and numerical methods to solve differential equations would be useful.  More details of the research activities at <a href="http://seit.unsw.adfa.edu.au/research/sites/mdo/">http://seit.unsw.adfa.edu.au/research/sites/mdo/</a> :	

<b>Project:</b>	<b><i>Encapsulated drop formation in micro-channels</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Jong-Leng Liow ( <a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a> )
<b>Objectives:</b> The formation of liquid drops using micro-channels has been put forward by many researchers. The advantage of using micro-channels is that the shearing of a liquid by a second liquid can be used to control the size and type of drops that are formed. Micro-devices with simple or complex channels can be configured and produced that will allow a sequence of steps to be applied to the drop formation and the drops formed. This gives rise to the possibility of creating micro-factories that can take the raw material (liquid) and produce a product that has characteristics for a particular application (drops with coating and trace chemicals present). This project will look at the formation of droplets that encapsulate multiple droplets of other liquids and model the drop formation process  <b>Description of Work:</b>	

- Carry out a survey of the current status with encapsulated drop formation using micro-devices.
- Design and manufacture micro-devices for encapsulated drop formation using the micro-milling facility available.
- Study the characteristics of encapsulated drop formation using Newtonian and non-Newtonian fluids.
- Develop a model to predict the drop encapsulation processes.

<b>Project:</b>	<b><i>Incorporation of material layers, circuits and other small scale features into micro-devices with end milling</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Jong-Leng Liow (<a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>The use of micro-end milling gives rise to a 2.5D structure which is based on the base material that is being milled. However, a single base material is limited in its properties. For example, use of a plastic means that electricity cannot be conducted. Hence sensor signals cannot be collected for measurement. Layers of other material can be built on the base material and then micro-machined to provide useful structures. This can be done as many times as possible to form a 3-D structure where signals can be transmitted and other physical effects can be incorporated through different materials. Thereafter the micro-device can be packaged similar to the computer chips. This project will study the conditions for deposition of different material for micro milling using a variety of methods including spin coating and electro deposition.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Familiarisation with the area of spin coating and electro deposition.</li> <li>• Develop methods to optimise spin coating and electro deposition of material that can then be easily micro machined to produce micro-devices.</li> <li>• Investigate and model the conditions for optimising the spin coating and electro deposition of material.</li> </ul>	

<b>Project:</b>	<b><i>Measurements of CO and CO<sub>2</sub> in an automobile exhaust</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Sean O'Byrne (<a href="mailto:s.obyrne@adfa.edu.au">s.obyrne@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Alan Fien (<a href="mailto:a.fien@adfa.edu.au">a.fien@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>This project aims to develop an automobile exhaust sensor using diode laser absorption spectroscopy of the CO and CO<sub>2</sub> molecules in a motor vehicle while the vehicle is being driven. This capability can be used to determine whether the engine is running too lean or too rich and, if implemented in each branch of the exhaust manifold, can make measurements sufficiently quickly to resolve the processes occurring during each part of the 4-stroke internal combustion cycle. Such a sensor can be used to keep the engine operating at peak and can sense when the engine operation needs to be tuned over the lifetime of a vehicle</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Develop computational models of the absorption process and quick-fitting routines to determine temperature and species concentrations in the vehicle exhaust.</li> <li>• Implement a diode-laser-based sensor using a vertical cavity surface-emitting laser that can measure exhaust composition and temperature in a car while it is running, at frequencies in excess of 100 Hz.</li> <li>• Compare the output of the sensor to standard methods of measuring exhaust composition.</li> </ul>	

<b>Project:</b>	<b><i>Micromachining of plastics using micro-end mills</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Jong-Leng Liow ( <a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a> )
<p><b>Objectives:</b>  This project aims to 1) provide an understanding of the mechanics of the micro-end milling process, and 2) develop a novel way of manufacturing micro-devices that is applicable to plastic materials. The manufacture of micro-devices is currently primarily by lithography or soft polymer moulding, which limits them to silicon, glass and soft carbon based polymers as their starting material. This also places limitations on the scope of micro-devices that can be produced. Although developments are being carried internationally to expand the processes available for micro-device manufacture, the CNC machining process found in every mechanical workshop and industry has not been developed to any significant extent for the manufacture of micro-devices. The use of plastics for micro-device manufacturing has been expanding rapidly but there is no research as to the behaviour of plastics during micromachining.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Carry out cuts with end-mills (diameters from 25 to 200 micrometres) and vary the feed-rate, rpm of the end-mill, depth and width of cut, and base materials (soft plastic through to hard metals).</li> <li>• Measure the surface roughness and accuracy of the cut using the atomic force microscope (AFM) available in ITEE.</li> <li>• Develop a model to predict the surface roughness and cut accuracy, taking into account end-mill deflection, material properties and cutting parameters</li> </ul>	

<b>Project:</b>	<b><i>Numerical simulation of drop formation in micro-channels via VOF/Level set methods and immersed boundary methods</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Jong-Leng Liow ( <a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a> )
<p><b>Objectives:</b>  Develop immersed boundary methods and VOF/Level set methods for the numerical simulation of multiphase fluid flows in micro-channels.</p> <p>The use of numerical simulation is a convenient means of understanding the two-phase flow in a micro-device. The flow of two or more phases requires the accurate tracking of the fluid interfaces as surface tension is an important physical parameter. Discretisation of the surface tension term often gives rise to parasitic currents or error that can grow with time and distort the results. Currently, the use of the volume of fluid method is a well-known technique for modelling two phase flow problems. An equally promising approach is that of the level set method. It is proposed that it is possible to merge the better attributes of both techniques to bring about a more accurate method for multi-phase flow simulation.</p> <p>The use of a structured grid for modelling provides efficiency over an unstructured grid. However, there are drawbacks. The structure grid has many unused cells when modelling a micro-device resulting in wastage of memory and calculations on cells with no fluid. The use of a structured grid also gives rise to difficulties in correctly modelling geometries that are not rectangular but curved. Recent work has been done on using the immersed boundary method and extending it to 3-D problems for VOF based codes, using higher order discretisation (pseudo spectral accuracy) and improving the speed and robustness of the solution of the algebraic equations through the use of preconditioning and Krylov methods. Recent advances in the tracking of the liquid-liquid and gas-liquid interface include high order interface reconstruction (Liovic et al. 2006) has not been incorporated into current CFD packages and significant smearing of the interface limits the accuracy of the results. The project will look at building on earlier work in 2D and 3D multi-phase codes for</p>	

micro-fluidics simulation and incorporating the newer ideas as outlined. The effect of surface tension on the accuracy of the code as well as the 3 phase contact line will be looked at to improve the code for multiple fluid interfaces.

**Description of Work:**

- Continue development of a volume of fluid code for multiphase simulation incorporating the immersed boundary method to handle irregular boundaries.
- Improve the current preconditioned generalized residual method (which is a member of the Krylov subspace method) to provide better stability when solving the algebraic equations with the immersed boundary method coded.
- Applying the code to study drop and bubble formation in micro-channels where the code is validated through results from experimental work being carried out in the supervisor's research group.

**Pre-requisites:**

The prospective student(s) is expected to be able to program in Fortran as this requires the writing of computational fluid dynamics code. An understanding of numerical methods in the solution of the equations of fluid flow will be an asset.

<b>Project:</b>	<b><i>Surfactant effects on droplet formation in micro fluidic channels – MD modelling</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	<i>Dr Jong-Leng Liow (<a href="mailto:j.liow@adfa.edu.au">j.liow@adfa.edu.au</a>)</i>

**Objectives:**

Droplet formation in micro fluidic channels and micro-devices has significant applications in chemical and biological processing as well as in biomedical engineering. The diameter of the droplet formed is critically dependent on the physical properties of the dispersed phase and the dynamics of fluid flow. Surface or interfacial tension of the liquid-air, liquid-liquid and solid-liquid interfaces of the dispersed phase is one of the most important properties affecting the droplet formation mechanism. Other properties such as the viscosity of the dispersed phase and the concentration of the surfactants can also affect the droplet formation and the droplet diameter. This project will:

- investigate the effects of the polysaccharide concentration in the dispersed phase on the viscosity of the solution using Molecular Dynamics (MD) simulations
- investigate the interfacial forces between the surfactant and the water/polysaccharide mixture at the critical concentrations and determining liquid-liquid interfacial tension using MD simulations;
- develop a hybrid MD and micro-fluid mechanics code to simulate the droplet formation process.

**Description of Work:**

- Familiarisation with the NAMD MD code.
- Build a model of a polysaccharide molecule(s) and carry out modelling of the motion of the molecule within a micro-channel to investigate slip effects and non-Newtonian flow behaviour.
- Relate the results to the behaviour of the polysaccharide molecule(s) to experimental results on the drop formation in micro-channels.
- There may be a possibility at the later stages of the project to spend time with collaborators in USA on this molecular dynamics project.

**Pre-requisites:**

The prospective student(s) is expected to have some familiarity with experience in computer programming and use of computational packages and an understanding of chemistry



## NEURAL NETWORKS

<b>Project:</b>	<b><i>Bio-control application of Neural Networks</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Sreenatha G Anavatti ( <a href="mailto:s.anavatti@adfa.edu.au">s.anavatti@adfa.edu.au</a> )
<b>Objectives:</b> This research proposes the development of computational algorithms for gene sequencing using neural networks. This is turning out to be a very hot topic of research with computational biologists. Significant effort and collaboration between engineering scientists and biologists all over the world is put in this direction. The potential of the research lies in reducing the computational effort using clustered, parallel neural networks or suitable other algorithms. This research work will have a collaborator from CSIRO who is an expert in gene sequencing.	

## UNMANNED AERIAL VEHICLES

<b>Project:</b>	<b><i>Control of height and speed using visual sensing in a UAV</i></b>
<b>Program Code:</b>	1663
<b>Supervisor:</b>	Dr Matt Garratt ( <a href="mailto:m.garratt@adfa.edu.au">m.garratt@adfa.edu.au</a> )
<b>Objectives:</b> In past work, non-visual sensing modes (e.g. GPS) have been combined with visual sensing to determine either range given speed or speed given range. The problem of how vision might be used in a standalone mode without a secondary sensing mode has not been tackled. For example, is it possible to use image motion to determine height above terrain when there is no available measure of ground speed? Preliminary experimental work suggests that bees deliberately impart a lateral sinusoidal displacement of known amplitude upon their flight path in order to generate image motion in a defined way. As the velocities corresponding to the lateral wiggle are a function of the amplitude, the bees would be able to deduce range from the lateral image motion and thereby control their height. Apparently, bees can also regulate their flight speed based on the longitudinal image motion. With range known from lateral optic flow and forward speed known from longitudinal optic flow, the bees are able to regulate both speed and height using the one sensory system. The objective of this project is to investigate whether such a scheme could be implemented on an unmanned helicopter.	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Using existing in-house rotorcraft simulation, develop a robust scheme for controlling the height and speed of a helicopter from simulated image motion.</li> <li>• Refine the algorithm to incorporate obstacle avoidance techniques. Implement and test on a UNSW Canberra unmanned helicopter.</li> </ul>	

<b>Project:</b>	<b><i>Flight Control System for UAVs</i></b>
<b>Program Code:</b>	1663
<b>Supervisor:</b>	Dr Sreenatha G Anavatti ( <a href="mailto:s.anavatti@adfa.edu.au">s.anavatti@adfa.edu.au</a> )
<b>Objectives:</b> This research proposes the development and implementation of flight control systems for school's fixed wing UAV. Currently, we have flight tested fuzzy logic and neural network based controllers for simple flight paths. These need to be developed further to include manoeuvring paths and for various types of missions. Development of on-board implementable control logics is a challenging problem for UAVs since the payload capacity is restricted along with restricted computational power. Hence, the development of control algorithms needs to cater for these restrictions and provides the impetus for newer tools.	

<b>Project:</b>	<i>Miniature Vision Sensors for UAVs.</i>
<b>Program Code:</b>	1663
<b>Supervisor:</b>	<i>Dr Matt Garratt (<a href="mailto:m.garratt@adfa.edu.au">m.garratt@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>The objective of the proposed thesis is to investigate and develop a small embedded vision sensor for control of an Unmanned Aerial Vehicle (UAV). The work will leverage the unique parallel processing architecture of Field Programmable Gate Arrays (FPGA) to develop a novel, small, low-power unit for determining optic flow and stereo range. This work will build on preliminary work demonstrated at UNSW Canberra that shows that it is possible to compute optic flow using FPGA</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Determination of the most efficient algorithm for processing of optic flow and stereo, taking in to account the parallelisation possible with an FPGA. This stage will be progressed in MATLAB. Initial work will focus on use of the optic flow interpolation algorithm. Later work will look at alternative and more elaborate algorithms for calculating image motion.</li> <li>• Implementation of algorithms in embedded hardware. This step will make use of existing hardware at UNSW Canberra initially, but may involve design of new circuits to support high performance FPGA chips.</li> </ul>	
<p>Once the algorithms are proven on a real-UAV, work will progress towards use of the optic flow information in a feedback loop to control the trajectory of one of the UNSW Canberra UAV platforms.</p>	

## Information Technology and Electrical Engineering

### ADAPTIVE SYSTEMS

<b>Project:</b>	<i>An Artificial Brain to Play GO</i>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Michael Barlow</i>
<b>Objectives:</b>	
<p>Developing a computer system that is capable of playing GO at a professional level is one of the greatest challenges facing artificial intelligence research at the moment. This project will look at advanced artificial intelligence techniques to build a human-competitive professional GO player. The project will develop a large-scale neural-based system to model strategies at both the tactical and strategic levels of GO. The research will focus on a computational neural architecture for GO inspired by a number of models in human psychology.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Understanding neural architectures, strategies, and thinking models</li> <li>• Understanding a number of architectures and models in Cognitive Science</li> <li>• Developing a large-scale neural architecture for GO</li> <li>• Developing multi-stage methodologies for training the architecture</li> <li>• Testing the competitiveness of the GO player</li> </ul>	



<b>Project:</b>	<b><i>Robots that tell Stories</i></b>
<b>Program Code:</b>	<i>1643 or 1885</i>
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Michael Barlow</i>
<p><b>Objectives:</b>  Storytelling is the art of narrating stories. Computer generated stories are common in virtual world. However, the research in this area relies to a large extent to scripted stories or stories with fixed themes. A robot that interacts with human should not use a fixed storyboard or fixed themes. The interaction requires from the robot to adapt in a changing environment. This project aims at equipping a robot with the ability of telling stories on the fly. These stories will be auto-generated by the Robot based on the situations it will encounter in the environment.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Developing an understanding of basic linguistics and the principles of natural language processing</li> <li>• Developing an understanding of Chomsky Hierarchy and formal grammar</li> <li>• Develop methodologies for representing and evolving stories</li> <li>• Testing the methodology and scoring it against human-generated stories.</li> </ul>	

## AIR TRAFFIC MANAGEMENT

<b>Project:</b>	<b><i>Multiple Queue Management for Ground-Air Interaction</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> One of the most fascinating types of interaction in an Air Traffic environment occurs in the Airport area, where ground movements interact with air movements. Understanding this interaction, identifying ways to simulate it efficiently, and modelling it properly require efficient algorithms for managing multiple inter-dependent queues. This project aims at developing a new algorithm in this direction.</p> <p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-performance computing environment using C or JAVA</li> <li>• Good knowledge of Queuing Theory, Flow Modelling, and Discrete Event Simulation</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review</li> <li>• Creating a new algorithm that is fast and scalable for multiple inter-dependent queues interaction</li> <li>• Testing the new algorithm</li> </ul>	

<b>Project:</b>	<b><i>Evaluation Algorithms for Future Air Traffic Concepts</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> The Air Traffic Environment is changing, with many exciting concepts being introduced across the globe. Evaluating these concepts require a modelling and simulation environment and algorithms to identify any problems quickly and efficiently. The group developed efficient simulation environment for this purpose, as well as evaluation algorithms. This project will extend this work with producing novel algorithms for the evaluation that are better than the existing ones.</p> <p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-</li> </ul>	

- performance computing environment using C or JAVA
- Good knowledge of stochastic processes

**Description of work:**

- A literature review of evaluation algorithms, Monte Carlo Simulation, Sampling Techniques, and others
- Creating a new algorithm that is fast and scalable for massive search spaces
- Testing the new algorithm

<b>Project:</b>	<b><i>Scalable Air Traffic Management Simulation Environment</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> The Air Traffic Environment is changing, with many exciting concepts being introduced across the globe. The group developed an efficient simulation environment for this purpose. The objective of this project is to design and implement a new simulation environment with new features. Because of confidentiality, these features won't be discussed here, but they represent challenges that need to be overcome.</p>	
<p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-performance computing environment using C or JAVA</li> <li>• Good understanding of Simulation and Simulation Architectures</li> </ul>	
<p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review</li> <li>• Designing and implementing the new simulation environment</li> <li>• Evaluating the simulation</li> </ul>	

## ARTIFICIAL INTELLIGENCE

<b>Project:</b>	<b><i>Generative Design of Adaptive Virtual Worlds</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Dr Kathryn Merrick (<a href="mailto:k.merrick@adfa.edu.au">k.merrick@adfa.edu.au</a>) Web: <a href="http://www.itee.adfa.edu.au/~s3229187">www.itee.adfa.edu.au/~s3229187</a></i>
<p><b>Objectives:</b> A new generation of persistent virtual worlds such as <i>Second Life</i> and <i>There</i> has opened the way for new kinds of remote environments to support commerce, education, defence, health, design and other industries. Design approaches for virtual places to support these industries have drawn on architectural concepts from the physical world. However, virtual places offer possibilities beyond physical places, including remote collaboration, adaptive spaces and intelligent environments. The objective of the project is to develop new models for generative design of adaptive virtual worlds.</p>	
<p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Survey of existing literature for computational creativity and generative design, including cellular automata, shape grammars and motivated agents</li> <li>• Design of computational models of artificial agents capable of creative, generative design behaviour in virtual environments</li> <li>• Implementation of the models in simulated applications or in live virtual worlds such as <i>Second Life</i> and <i>There</i></li> <li>• Evaluation of the application using empirical metrics, case studies or user</li> </ul>	

studies. This will include comparison to existing techniques for generative design.

<b>Project:</b>	<b><i>Learning How to Learn Using Computational Models of Motivation</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Dr Kathryn Merrick ( <a href="mailto:k.merrick@adfa.edu.au">k.merrick@adfa.edu.au</a> )
<p><b>Objectives:</b>            Computational models of motivation – such as novelty, interest and curiosity – can provide a way for artificial agents to select their own learning goals. Agents identify highly motivating experiences then learn how to repeat those experiences. Existing work with motivated agents has focused agents with a fixed learning mechanism to learn about highly motivating goals. This project will develop new motivated learning approaches in which agents are also motivated to select between different action approaches in different situations. This may include reflexive responses, learning by trial-and-error or learning by mimicry</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Review of psychological literature describing motivation and learning.</li> <li>• Design computational models of motivation that can mediate between different learning approaches.</li> <li>• Implement the models in simulation and at least one live application, such as virtual world or the <i>Lego Mindstorms NXT</i> robotic platform.</li> <li>• Evaluate the models using empirical metrics and/or case studies. This may include comparison to existing computational models of motivation or motivated learning.</li> </ul>	

<b>Project:</b>	<b><i>Mimic This: Societies of Curious Robots</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Dr Kathryn Merrick ( <a href="mailto:k.merrick@adfa.edu.au">k.merrick@adfa.edu.au</a> )
<p><b>Objectives:</b>            In robotic systems, curious agents offer a way for developmental robots to select their own goals. Such robots have a range of potential applications, including support for tool use, fault tolerance and robot reconfigurability. Existing work with curious robots has focused on reward based learning approaches such as reinforcement learning. Such robots can learn by trial-and-error, but cannot draw on the experiences of other robots. This project will develop new models for curious robots that can learn to mimic interesting behaviours of other robots using supervised learning techniques. Models will be implemented and tested on the <i>Lego Mindstorms NXT</i> platform.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Review of relevant robotics and artificial intelligence literature</li> <li>• Design computational models of curious supervised learning for continuous, real-world environments.</li> <li>• Implement the models on the <i>Lego Mindstorms NXT</i> platform</li> <li>• Evaluate the models using empirical metrics and/or case studies. This may include comparison to existing computational models of motivation or motivated learning.</li> </ul>	

## ATMOSPHERIC SCIENCE AND ASTRONOMY

<b>Project:</b>	<b><i>Adaptive modal superposition mirror</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Andrew Lambert ( <a href="mailto:a.lambert@adfa.edu.au">a.lambert@adfa.edu.au</a> )
<p><b>Objectives:</b>            Traditional adaptive optics (AO) deformable mirrors use segmented actuator patterns requiring elaborate manufacturing techniques. The range of surface curvatures used for corrective action can be described by Zernike polynomials, which are a sequence of orthogonal polynomials on the unit circle. The vibration modes of a circular membrane exhibit striking similarities to Zernike polynomials; in fact, they can be all expressed as functions of Bessel functions. This leads to the possibility of using a vibrating membrane mirror in adaptive optics. The objective of this project is to design, manufacture and test a modeshape mirror capable of reproducing the essential Zernike polynomials to be used in adaptive optics.</p> <p>This project involves design and conduct of laser experiments, high levels of signal processing and analysis techniques as well as possible numerical modelling.</p>	

<b>Project:</b>	<b><i>Multiple Object Adaptive Optic</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Andrew Lambert ( <a href="mailto:a.lambert@adfa.edu.au">a.lambert@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Murat Tahtali
<p><b>Objectives:</b>            Large Field of View telescopes observe celestial objects through regions of atmosphere that are different and temporally changing. Traditional adaptive optics (AO) techniques involving single mirror correction will only correct a small region of this atmospheric effect, and typically destroy imagery outside this region. It is possible to assign different correcting elements to each region, but the logistical difficulty and light loss in determining the distortion at each region and the actual shape taken by the corrector, mean that other techniques must be investigated to predict the turbulent structure and evolution across the whole field of view from a limited set of measurements. Non-optical methods must also be designed to determine the state of each corrector. This project will involve design of correctors, wavefront sensors, and control algorithm design to address MOAO implementations</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Investigate commercial and custom designed deformable mirrors; Determine non-optical methods for determining their shape;</li> <li>• Develop algorithms for the prediction of turbulence evolution both spatially and temporally from limited observations of optical wavefronts;</li> <li>• Design control algorithms within embedded FPGA hardware for the manipulation of wavefront sensed data to control an array of deformable mirrors; Implementation of such a system on a small wide-field of view telescope as a proof-of-principle suitable for adoption of large telescope instrumentation.</li> </ul> <p>The project will involve laboratory work, materials science, simulation and algorithm development, astronomical observation, and development of high-speed digital and analog electronics.</p>	

## BIOMETRIC SECURITY

<b>Project:</b>	<b><i>3D Fingerprint Identification</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<b>Co-Supervisor</b>	Prof Ian Petersen
<p><b>Objectives:</b> Conventional authentication mechanism relies on password or possession of token. However, password and token cannot genuinely identify a person as both password and token can be presented by someone else. Biometrics such as fingerprint, face, iris etc are quite uniquely representing individual. Therefore they are good tools for identity authentication. This project investigates latest biometrics authentication technology, i.e., 3D fingerprint identification.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing existing 3D fingerprint identification algorithms</li> <li>• Investigating 2D fingerprint to 3D fingerprint mapping algorithms</li> </ul> <p><b>Skills Required::</b> Good math background especially statistics and concrete programming skills. Image processing knowledge will be a plus.</p>	

<b>Project:</b>	<b><i>Biometric Cancellable Template Design</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b> Conventional authentication mechanism relies on password or possession of token. However, password and token cannot genuinely identify a person as both password and token can be presented by someone else. Biometrics such as fingerprint, face, iris etc are quite uniquely representing individual. Therefore they are good tools for identity authentication. However, biometrics stored in the template also needs to be protected. This project investigates how to protect biometrics stored in the template.</p> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing existing cancellable template algorithms</li> <li>• Designing new cancellable template algorithms</li> </ul> <p><b>Skills Required::</b> Good math background especially statistics and concrete programming skills.</p>	

<b>Project:</b>	<b><i>General Biometrics Security</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b> Conventional authentication mechanism relies on password or possession of token. However, password and token cannot genuinely identify a person as both password and token can be presented by someone else. Biometrics such as fingerprint, face, iris etc are quite uniquely representing individual. Therefore they are good tools for identity authentication. This project investigates the latest development in the field of biometrics such as bio-cryptography etc. This project is in collaboration with Carnegie Mellon University (USA).</p> <p><b>Description of work:</b></p>	

- Studying and analysing existing relevant biometrics security algorithms
- Designing new algorithms

**Skills Required::**

Good math background especially statistics and concrete programming skills. Image processing or machine learning will be a plus.

## COGNITIVE ENGINEERING

<b>Project:</b>	<b><i>Emotional Linguistic Cues to Play Games</i></b>
<b>Program Code:</b>	<i>1643 or 1885</i>
<b>Supervisor:</b>	<i>Prof. Hussein Abbass Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a></i>
<p><b>Objectives:</b> A true gaming experience occurs when the human becomes situated and embodied within the game. Integrating the human emotion in a game would engage the human and improve the game experience. This project will build a model to extract linguistic cues that capture human emotion and integrate these cues in an intelligent manner within a game. The project will develop an artificial intelligence model to extract and integrate these cues within a game.</p> <p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Good programming skills</li> <li>• Good knowledge of signal and speech processing</li> <li>• Ability to learn or good understanding of cognitive linguistics</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review of models for human emotion</li> <li>• A literature review of linguistic cues for human emotion</li> <li>• Creating an artificial intelligence model to extract emotion-based linguistic cues</li> <li>• Creating an artificial intelligence model to integrate the extracted cues with a gaming environment</li> <li>• Testing the system.</li> </ul>	

<b>Project:</b>	<b><i>Adapting Games to Human Mental Resources</i></b>
<b>Program Code:</b>	<i>1643 or 1885</i>
<b>Supervisor:</b>	<i>Prof. Hussein Abbass Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a></i>
<p><b>Objectives:</b> Engaging in a game can be mentally demanding. It is difficult to estimate the long-term impact of mental load of the gaming experience. This project will develop artificial intelligence models to extract cues of cognitive load and use these cues to adjust and adapt a game to maintain and sustain a healthy gaming experience. Cognitive load is defined here as the rate of depletion of mental resources as a player engages and plays a game.</p> <p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Good programming skills</li> <li>• Good knowledge of signal and speech processing</li> <li>• Ability to learn or good understanding of cognitive psychology</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review of models for cognitive load</li> <li>• A literature review of cognitive load in games</li> <li>• Creating an artificial intelligence model to measure indicators for mental resources</li> <li>• Creating an artificial intelligence model to integrate the information on mental</li> </ul>	



- resources with a gaming environment
- Testing the system.

<b>Project:</b>	<b><i>Controlling games using the eye</i></b>
<b>Program Code:</b>	<i>1643 or 1885</i>
<b>Supervisor:</b>	<i>Prof. Hussein Abbass Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a></i>
<p><b>Objectives:</b> Eye tracking is a fast evolving technology. Currently, a number of problems exist in many eye-tracking systems when head movements occur, and other sources of noise interfere with the video signal. This project is to develop efficient and fast techniques for generating a smooth and robust control of objects on a screen using artificial intelligence models. The expected outcome of this project is a better eye tracking system and an artificial intelligence model that integrates eye movement with actions in a game environment.</p> <p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Good programming skills</li> <li>• Good knowledge of signal and speech processing</li> <li>• Ability to learn or good understanding of cognitive psychology</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review of eye tracking technologies and methods</li> <li>• A literature review of cues that can be extracted from the eye and eye movements</li> <li>• Creating an artificial intelligence model for eye tracking</li> <li>• Creating an artificial intelligence model to integrate the cues from the eye tracking model within a game</li> <li>• Testing the system</li> </ul>	

## COMPUTATIONAL DECISION MAKING

<b>Project:</b>	<b><i>Interdependent Combinatorial Optimization in Complex Systems</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> This project aims at understanding the dynamics of interdependency between combinatorial optimization problems. In complex systems, it is natural that two or more sub-systems are interconnected. Each of these sub-systems attempts to optimize its own performance. However, the optimal solution for one sub-system depends on the optimal solution for the other sub-systems. This interdependency is not understood well in the combinatorial optimization literature. This project will make a breakthrough in this area.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Understanding what makes a combinatorial optimization problem hard</li> <li>• Developing a framework for analysing interdependency of combinatorial optimization problems</li> <li>• Developing methodologies for solving interdependent combinatorial optimization problems.</li> <li>• Testing the competitiveness of the different methodologies.</li> </ul>	

<b>Project:</b>	<b><i>Computational Scenario Planning for Disaster Management</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>

**Objectives:**

Scenarios are pen-pictures of plausible futures, used for strategic planning. The aim of this project is to expand the horizon of scenario-based planning through computational models that are able to aid the analyst in the planning process of a disaster. The investigation builds upon the advances of Information and Communication Technology (ICT) to create a novel, flexible and customizable computational capability-based planning methodology that is practical and theoretically sound. The project relies on fusing skills in Strategic Management and Scenario Planning with Evolutionary Computation, Simulation, and Graph Theory.

**Description of Work:**

- Developing an understanding of scenario planning
- Building skills in evolutionary computation, computational intelligence, simulation and graph theory
- Developing methodologies for representing and simulating large scale disaster scenarios
- Evaluating the system on a number of real-world situations.

## COMPUTATIONAL INTELLIGENCE

<b>Project:</b>	<b><i>Noise Multi-objective Evolutionary Algorithms</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof. Hussein Abbass Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a></i>
<p><b>Objectives:</b> Real world problems almost always have multiple objectives that need to be optimized simultaneously despite the conflict that may exist among these objectives. Evolutionary multi-objective optimisation (EMO) is an efficient way to solve these problems. The objective of this project is to develop new EMO algorithms that are able to scale-up to many objectives under high level of noise. The successful manifestation of such algorithms will be tested on large-scale combinatorial real-world optimization problems in domains such as air traffic flow management and planning.</p>	
<p><b>Expected Background Knowledge:</b></p> <ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-performance computing environment using C or JAVA</li> <li>• Good understanding of Search and Evolutionary Computation</li> </ul>	
<p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• A literature review of evolutionary multi-objective optimization algorithms</li> <li>• Creating new scalable evolutionary multi-objective optimization algorithms</li> <li>• Testing the new algorithms</li> <li>• Using the most efficient algorithm in real-world problem solving</li> </ul>	

<b>Project:</b>	<b><i>Evolutionary Algorithms Through Adaptive Decomposition</i></b>
<b>Program Code:</b>	<i>1885</i>
<b>Supervisor:</b>	<i>Prof. Hussein Abbass Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a></i>
<p><b>Objectives:</b> Evolutionary algorithms are implicitly parallel search techniques inspired by evolutionary principles. Work in evolutionary algorithms can take many forms including biologically motivated models and statistical modelling of an optimization problem. The objective of this project is to develop decomposition techniques for evolutionary algorithms in optimization and/or machine learning problems. The decomposition needs to be self-organizing, as such, it is not a fixed predefined scheme of decomposition.</p>	



<b>Expected Background Knowledge:</b>	
<ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-performance computing environment using C or JAVA</li> <li>• Good understanding of Optimisation theory</li> </ul>	
<b>Description of work:</b>	
<ul style="list-style-type: none"> <li>• A literature review of evolutionary algorithms for optimization and/or machine learning problems</li> <li>• A literature review of decomposition techniques</li> <li>• Creating a new evolutionary algorithm technique that is based on self-organized decomposition principles</li> <li>• Testing the new technique</li> </ul>	

<b>Project:</b>	<b><i>Neural Networks for Big Data</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof. Hussein Abbass</i> Email: <a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>
<b>Objectives:</b> Big data are massive datasets in the order of terabytes and beyond. Scaling up neural networks to datasets of this size is not a trivial task. The objective of this project is to design neural networks that can discover relationships in Big Data efficiently.	
<b>Expected Background Knowledge:</b>	
<ul style="list-style-type: none"> <li>• Knowledge or demonstrated ability to do programming in parallel high-performance computing environment using C or JAVA</li> <li>• Good understanding of Neural Networks</li> </ul>	
<b>Description of work:</b>	
<ul style="list-style-type: none"> <li>• A literature review of Neural Networks and Big Data</li> <li>• Creating new algorithms for Neural Networks to handle Big Data</li> <li>• Testing the new algorithms</li> </ul>	

## COMPUTER SCIENCE

<b>Project:</b>	<b><i>Agent based evolutionary algorithms for solving constrained multi-objective optimization problems</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>A/Prof Ruhul Sarker</i> ( <a href="mailto:r.sarker@adfa.edu.au">r.sarker@adfa.edu.au</a> )
<b>Objectives:</b> The objective of this research is to develop a new agent based evolutionary algorithm for solving multi-objective constrained optimization problems.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Studying and analysing the existing multi-agent and evolutionary computation based approaches for solving different optimization problems.</li> <li>• Designing and developing a new agent based evolutionary algorithm for solving small and medium scale constrained multi-objective optimization problems.</li> <li>• Analysing the algorithm performance and carrying out the sensitivity analysis of different parameters required by the algorithm.</li> <li>• Solving a reasonable number of well-known benchmark problems and comparing them with the state-of-the-art algorithms.</li> </ul>	
<b>Skills Assumed:</b> Knowledge of optimization /operations research /management science and good	

computer programming skills.

<b>Project:</b>	<b><i>Job-shop scheduling with production interruption</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	A/Prof Ruhul Sarker ( <a href="mailto:r.sarker@adfa.edu.au">r.sarker@adfa.edu.au</a> )
<b>Objectives:</b> The objective of this research is to develop a new evolutionary algorithm for solving and resolving job-shop scheduling problems when the production process is interrupted by any internal or external factors.	
<b>Description of Work:</b> <ul style="list-style-type: none"><li>• Studying and analysing the job-shop scheduling problems and their solution approaches.</li><li>• Designing and developing a new evolutionary algorithm for solving and resolving medium scale job-shop scheduling problems where the production can be interrupted by internal and external factors.</li><li>• Analysing the algorithm performance and carrying out the sensitivity analysis of different parameters required by the algorithm.</li><li>• Solving a reasonable number of benchmark problems and comparing them with the state-of-the-art algorithms (if any).</li></ul>	
<b>Skills Assumed:</b> Knowledge of optimization /operations research /management science and good computer programming skills.	

<b>Project:</b>	<b><i>Multi-methodology for constrained optimization</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	A/Prof Ruhul Sarker ( <a href="mailto:r.sarker@adfa.edu.au">r.sarker@adfa.edu.au</a> )
<b>Objectives:</b> The objective of this research is to develop a new solution approach by combining multiple evolutionary and related algorithms within a population based stochastic search structure for solving constrained optimization problems.	
<b>Description of Work:</b> <ul style="list-style-type: none"><li>• Studying and analysing the existing evolutionary computation based approaches and traditional optimization techniques for solving constrained optimization problems.</li><li>• Designing and developing a new solution approach where multiple evolutionary and related algorithms will explore the solution space in parallel by exchanging information at a regular interval.</li><li>• Analysing the algorithm performance and carrying out the sensitivity analysis of different parameters required by the algorithm.</li><li>• Solving a reasonable number of well-known benchmark problems and comparing them with the state-of-the-art algorithms.</li></ul>	
<b>Skills Assumed:</b> Knowledge of optimization /operations research /management science and good computer programming skills.	

<b>Project:</b>	<b><i>Solving large scale multi-objective optimisation problems using evolutionary algorithms</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	A/Prof Ruhul Sarker ( <a href="mailto:r.sarker@adfa.edu.au">r.sarker@adfa.edu.au</a> )
<b>Objectives:</b> The objective of this research is to develop a new evolutionary algorithm for solving large-scale multi-objective constrained optimization problems by dividing the tasks	

and using parallel machines.

**Description of Work:**

- Studying and analysing the existing evolutionary multi-objective algorithms for solving single and multi-objective constrained optimization problems.
- Designing and developing a new evolutionary algorithm for solving large-scale multi-objective constrained optimization problems that will allow an intelligent way of dividing the tasks for implementation in parallel machines.
- Analysing the algorithm performance and carrying out the sensitivity analysis of different parameters required by the algorithm.
- Solving a reasonable number of well-known benchmark problems and comparing them with the state-of-the-art algorithms.

**Skills Assumed:**

Knowledge of optimization /operations research /management science and good computer programming skills.

## CONTROL THEORY AND CONTROL APPLICATIONS

<b>Project:</b>	<b><i>Consensus, Estimation and Control in Complex Large-Scale Quantum Systems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> )
<b>Objectives:</b>	
<p>Advances in experimental physics are leading to exciting new possibilities in the area of quantum technology. The dynamics of quantum systems are fundamentally different from classical systems. New methods in control theory are needed to allow for these dynamics and to exploit the opportunities arising. The control challenges in these emerging quantum technologies require the control of systems with complex interactions of many particles and subsystems, as well as decoherence effects resulting from interaction with the environment. The aim is to build a substantial research effort to address these challenges by developing new theories of consensus, synchronisation, estimation and control for complex large-scale quantum systems. <i>This project is supported by an Australian Research Council Laureate Fellowship for Professor Petersen</i></p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• This research will involve fundamental control theory research in the area of Consensus, Estimation and Control in Complex Large-Scale Quantum Systems</li> </ul>	

<b>Project:</b>	<b><i>High-Bandwidth Control for Unmanned Helicopters</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Hemanshu R Pota ( <a href="mailto:h.pota@adfa.edu.au">h.pota@adfa.edu.au</a> ) <a href="http://www.ee.adfa.edu.au/staff/hrp/">http://www.ee.adfa.edu.au/staff/hrp/</a>
<b>Co-Supervisor</b>	Dr Matt Garrat ( <a href="mailto:m.garratt@adfa.edu.au">m.garratt@adfa.edu.au</a> )
<b>Objectives:</b>	
<p>This PhD work is a part of the project to develop high bandwidth control methods and advanced dynamic modelling for Rotorcraft Unmanned Aerial Vehicles (RUAVs). This will enable new roles such as the precision landing of RUAVs to the moving deck of a ship in rough seas. This and numerous other potential RUAV tasks are presently limited by the simple controllers used for such a responsive dynamic system. High-bandwidth control will be achieved by: a) developing higher fidelity modelling of helicopter dynamics, b) application of non-linear control techniques with novel extensions, c) sensing critical but previously unmeasured states of the helicopter</p>	

system, and d) flight test validation. The advances will expand RUAV uses in many military and civilian applications.

**Description of Work:**

- Design on acceleration measurement control for disturbance rejection
- Design of state feedback optimal H-infinity Controllers for unmanned helicopters
- Implementation of the control algorithms on high fidelity simulation and special experimental test rig

<b>Project:</b>	<b><i>High Precision Control of Agricultural Equipment</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Hemanshu R Pota ( <a href="mailto:h.pota@adfa.edu.au">h.pota@adfa.edu.au</a> ) <a href="http://www.ee.adfa.edu.au/staff/hrp/">http://www.ee.adfa.edu.au/staff/hrp/</a>
<b>Co-Supervisor</b>	Dr Ray Eaton ( <a href="mailto:r.eaton@unsw.edu.au">r.eaton@unsw.edu.au</a> )
<b>Objectives:</b> This PhD is a part of the project to develop robust control methodologies to precisely guide articulated off-road vehicles and attached trailers which are affected by slip. The significance in the research lies in the generic hybrid modelling approach to vehicle control, whereby the generic nature and relative simplicity of a kinematic model is beneficial in determining the trajectory tracking controller, yet the benefits of consideration of the vehicle's dynamics are also afforded without explicitly needing to know them. It is expected that a new class of non-linear control methodologies will be developed and experimentally verified, which deliver robust and precise trajectory-tracking performance for slip affected vehicles.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Obtaining velocity kinematic models of tractor-implement system with side-slip velocities</li> <li>• Obtaining input-output pairs for the dynamic model which satisfy passivity conditions</li> <li>• Design of controllers for the velocity kinematic that incorporate passive dynamic models</li> <li>• Implementation of the controller on the experimental tractor-trailer system</li> </ul>	

<b>Project:</b>	<b><i>Interconnected Power Systems and Complex Dynamic Networks</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Hemanshu R Pota ( <a href="mailto:h.pota@adfa.edu.au">h.pota@adfa.edu.au</a> ) <a href="http://www.ee.adfa.edu.au/staff/hrp/">http://www.ee.adfa.edu.au/staff/hrp/</a>
<b>Co-Supervisor</b>	Prof David J. Hill ( <a href="mailto:david.hill@anu.edu.au">david.hill@anu.edu.au</a> )
<b>Objectives:</b> Analysis of complex dynamical networks has been used to predict synchronisation of nodes with similar dynamics and certain types of network configurations. Interconnected power systems form a complex dynamical network, but there is neither an apparent regularity in the interconnections nor do all the nodes have identical dynamics. Traditionally interconnected power systems are analysed using tools which penalise strong interconnections but the practical reality is that strong interconnections help in synchronising the system. Complex dynamical network analysis rewards strong interconnections so it is natural to analyse interconnected power systems in this framework. The PhD work will involve the analysis and control of power systems with large wind generators.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Literature review of complex dynamical network analysis with irregular networks and non-identical nodes.</li> </ul>	

- Modelling of power systems with large wind generation.
- Design of controllers in the complex dynamical networks' framework for synchronising nodes with non-identical generation nodes.

<b>Project:</b>	<b><i>Learning Control and Performance Optimisation of Complex Quantum Systems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Daoyi Dong ( <a href="mailto:d.dong@adfa.edu.au">d.dong@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> ) <a href="http://routh.ee.adfa.edu.au/P1.html">http://routh.ee.adfa.edu.au/P1.html</a>
<p><b>Objectives:</b> Quantum Technology has been recognised as one of the most promising frontier technologies. Although great progress has already been made, a lot of fundamental research is still needed for this area to become mature enough to foster wider practical applications. Much research in this area can be formulated as quantum control problems. Quantum control theory is drawing wide attention with research in this regard involving controllability, optimal control, feedback control, etc. A challenging task is the development of new theories and algorithms for the control analysis and synthesis of complex quantum systems. Learning control has been proven to be a potential design method for optimising control performance for complex quantum systems. The objective of this project is to develop new learning algorithms to enhance control performance in the engineering of complex quantum systems. This project is in collaboration with Prof Rabitz at Princeton University (USA).</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Formulate a collection of practical tasks arising in the quantum domain as control problems for complex quantum systems with a well-defined performance index.</li> <li>• Develop new learning algorithms to achieve improved control performance for complex quantum systems.</li> </ul>	

<b>Project:</b>	<b><i>Modelling and control of quantum nanosystems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Matthew Woolley ( <a href="mailto:m.woolley@adfa.edu.au">m.woolley@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> )
<p><b>Objectives:</b> Recent experiments have demonstrated the quantum-coherent control of electromagnetic, electronic and mechanical degrees of freedom. These experiments have been motivated both by the prospects of quantum computation, quantum simulation and quantum communication, and by fundamental interest in novel quantum dynamics. Of particular interest are many-body superconducting quantum circuits and optomechanical systems, as well as the non-equilibrium dynamics of quantum conductors. Here we will develop proposals for the observation of novel dynamics and the realisation of quantum information processing protocols in these systems. Ideally, this will lead to implementation with experimental colleagues. Projects will likely involve collaboration with senior members of the ARC Centre of Excellence in Engineered Quantum Systems and international colleagues.</p> <p><b>Description of Work:</b> This project will require the use of the analytical tools of quantum mechanics, quantum optics, mesoscopic condensed matter theory and control theory. Computer algebra systems, such as <i>Mathematica</i>, will be heavily used. Numerical analysis will also be required. The work will be theoretical, rather than experimental, though an understanding of contemporary quantum</p>	

physics experiments will be developed.

<b>Project:</b>	<b><i>Quantum Estimation and Control Algorithms with Applications to Quantum Optical Systems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Daoyi Dong ( <a href="mailto:d.dong@adfa.edu.au">d.dong@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Elanor Huntington ( <a href="mailto:e.huntington@adfa.edu.au">e.huntington@adfa.edu.au</a> )
<p><b>Objectives:</b>  Quantum Technology has been recognised as one of the most promising frontier technologies. Although great progress has already been made, a lot of fundamental research is still needed for this area to become mature enough to foster wider practical applications. Much research in this area can be formulated as quantum estimation and control problems. Parameter estimation (e.g., quantum state estimation, quantum phase estimation) and control design are two of critical tasks in the development of quantum technology. The objective of this project is to develop new theories and methods to enhance estimation and control capabilities as applied to quantum optical systems.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Formulate a collection of practical tasks arising in quantum optics as estimation and control problems with a well-defined performance index.</li> <li>• Develop new theories and algorithms to achieve improved estimation and control performance for quantum optical systems.</li> </ul>	

<b>Project:</b>	<b><i>Quantum-inspired learning algorithms with applications to quantum control</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Daoyi Dong ( <a href="mailto:d.dong@adfa.edu.au">d.dong@adfa.edu.au</a> )
<p><b>Objectives:</b>  Quantum information processing is a rapidly developing field. Some results have shown that quantum computation can more efficiently solve some difficult problems than the classical counterpart. Some methods have also been explored to connect quantum computation and machine learning. For example, the quantum-computing version of artificial neural network has been studied from the pure theory to the simple simulated and experimental implementation. Quantum or quantum-inspired evolutionary algorithms have been proposed to improve the existing evolutionary algorithms. Taking advantage of quantum computation, some novel algorithms inspired by quantum characteristics will not only improve the performance of existing algorithms on traditional computers but also promote the development of related research areas such as quantum computers and machine learning.</p> <p>On the other hand, the development of quantum control theory has been recognised as one of key tasks for practical quantum technology. Learning control has been proven to be a potential design method for optimising control performance for complex quantum systems. Quantum-inspired learning algorithms may be especially suitable for specific quantum control tasks. The objective of this project is to develop new quantum-inspired learning algorithms and apply these algorithms to enhance control performance in the engineering of quantum systems. This project is in collaboration with Prof Tarn at Washington University (USA).</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Develop new quantum-inspired learning algorithms (e.g., quantum-inspired PSO algorithm, quantum-inspired differential evolution algorithm) and test their learning performance by simulation</li> <li>• Apply these new quantum-inspired learning algorithms to several typical</li> </ul>	



quantum control problems and compare the control performance with existing design methods

<b>Project:</b>	<b><i>Research in Decentralized and Distributed Robust Control</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof V. Ougrinovski ( <a href="mailto:v.ougrinovski@adfa.edu.au">v.ougrinovski@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian Petersen
<p><b>Objectives:</b>            Interconnected control systems are widespread in engineering, defence and communications applications. Examples of such systems include a team of unmanned aerial vehicles pursuing a set of coordinated objectives, a platoon of vehicles on the highway, an array of actuated micro-electromechanical systems (MEMS), to name a few. Such systems are coupled dynamically or via team objective constraints and are characterized by a high level of complexity including modelling uncertainties and changes in the system configuration. The project will look into methodologies of robust control design for distributed and large-scale uncertain systems, which make use of the interconnection structure of the system.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Develop new mathematical methodologies of robust control design for uncertain distributed and large-scale nonlinear interconnected systems. Possible theoretical applications and models involve control of large systems consisting of interacting agents, control of large-scale networked systems.</li> <li>• The project will involve mathematical research in the area of modern control theory.</li> </ul>	

<b>Project:</b>	<b><i>Robust Control of Quantum Ensembles</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Daoyi Dong ( <a href="mailto:d.dong@adfa.edu.au">d.dong@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> ) <a href="http://routh.ee.adfa.edu.au/P1.html">http://routh.ee.adfa.edu.au/P1.html</a>
<p><b>Objectives:</b>            Quantum Technology has been recognised as one of the most promising frontier technologies. Although great progress has already been made, a lot of fundamental research is still needed for this area to become mature enough to foster wider practical applications. Much research in this area can be formulated as quantum control problems. Quantum control theory is drawing wide attention with research in this regard involving controllability, optimal control, feedback control, etc. Although a number of results on control design of single quantum systems have been presented, there are few results for the control analysis and synthesis of quantum ensembles. A quantum ensemble consists of a large number of single quantum systems. Quantum ensembles have wide applications in emerging quantum technology including quantum computation, long-distance quantum communication, and magnetic resonance imaging. The objective of this project is to develop new theories and methods to enhance control capabilities and robustness in the engineering of quantum ensembles. This project is in collaboration with Prof Rabitz at Princeton University (USA).</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Formulate a collection of practical tasks arising in the quantum domain as control problems for quantum ensembles with a well-defined performance index.</li> <li>• Develop new theories and control algorithms to achieve improved control performance for quantum ensemble control problems.</li> </ul>	



<b>Project:</b>	<b><i>Robust scanning controllers for Atomic Force Microscopes (AFM)</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Hemanshu R Pota ( <a href="mailto:h.pota@adfa.edu.au">h.pota@adfa.edu.au</a> ) <a href="http://www.ee.adfa.edu.au/staff/hrp/">http://www.ee.adfa.edu.au/staff/hrp/</a>
<b>Co-Supervisor</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> ) <a href="http://routh.ee.adfa.edu.au/~irp/P1.html">http://routh.ee.adfa.edu.au/~irp/P1.html</a>
<p><b>Objectives:</b> The overall aim of this project is to increase the image scan rates of scanning AFM. Our control applications research laboratory has a scanning AFM. The work in this project involves both theoretical design of controllers and their experimental implementation. The AFM consists of a three degrees-of-freedom piezoelectric stack, a cantilever, and an optical arrangement to measure the cantilever tip-position. The image is the cantilever tip-position as the sample is moved in the x-y direction. Presently a PhD student is working to increase the x-y scan rate of this AFM. The proposed PhD is to include the cantilever dynamics and z-position loop in the design of the controller.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Model the z-position loop using experimental data and theoretical analysis.</li> <li>• Obtain a suitable representation of the hysteresis nonlinearities and sensor noise.</li> </ul>	

<b>Project:</b>	<b><i>Secure control and estimation</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	A/Prof Valeri Ougrinovski ( <a href="mailto:v.ougrinovski@adfa.edu.au">v.ougrinovski@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian R. Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> )
<p><b>Objectives:</b> The emergence of technologies relying on information networks have brought into prominence new challenges in the area of cyber-security concerned with security of industrial control and data acquisition systems. This project will involve research into the theory of cyber secure distributed control and estimation systems networks, focused on systems cooperation in the presence of strategic adversaries. It will develop methodologies for mitigation of stealthy attacks on complex control systems interconnected in the topology of a network. These methodologies will provide a systematic means for achieving a trade-off between system performance and its resilience to cyber threats of malicious nature.</p> <p>There is a number of directions this research can take, therefore more than one student are welcome to undertake this project.</p> <p><b>Description of Work:</b> This project involves mathematical modelling and analysis of control systems cooperating over communication networks as well as numerical simulations of developed control and estimation algorithms.</p>	

## FORENSIC INSTRUMENTATION

<b>Project:</b>	<b><i>Analysis of bulk organic explosives for forensic laboratories</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Charles Harb ( <a href="mailto:c.harb@adfa.edu.au">c.harb@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Elanor Huntington
<p><b>Objectives:</b> Analysis of bulk organic explosives is a straightforward task for well-equipped forensic laboratories, but it is more difficult for them to analyse trace amounts of organic explosive residues; this usually requires an elaborate sequence of solvent</p>	

extraction from swabs and some form of chromatographic or electrophoretic separation. Suitable detection techniques include ion mobility spectrometry (IMS), mass spectrometry and thermal energy analysis, however, such analytical systems lack the sensitivity to analyse explosive residues in vapour samples because of the very low vapour pressures. We aim to develop a cavity-enhanced spectroscopic instrument as a high-throughput screening tool for trace explosive detection, and potentially for other threats such as biological or chemical hazards. The method that we shall use to achieve this aim is **cavity ringdown spectroscopy (CRDS)**, which is a laser-based direct-absorption technique. CRDS offers a significant increase in sensitivity, sufficient to permit detection of organic explosives in the vapour phase.

**Description of Work:**

- Design and build the CRDS System;
- Design and build the detection and modulation/demodulation systems;
- Make measurements on different substances of interest, and catalog the data.
- Investigate algorithms to pattern match the database with unknown samples.

## HIGH FREQUENCY ENGINEERING

<b>Project:</b>	<i>Antennas in Dissipative Media</i>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Greg Milford ( <a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a> )
<p><b>Objectives:</b> The application of modern telecommunications networking protocols and inexpensive electronics has created a new paradigm for underwater (sub-sea) communications, with many potential military, scientific and commercial applications. Systems using radio frequency (RF) electromagnetic wave propagation offer a solution to some of the limitations of underwater acoustic systems. However the correct specification and design of the underwater antenna is essential to achieve the desired performance with an RF underwater system. Additionally, body-worn or in-vitro antennas experience a similar dissipative electromagnetic environment, hence the scope of this project isn't necessarily restricted to sub-sea applications. This project will investigate the fundamental behaviour of insulated and bare conductors immersed in a dissipative medium, and develop a quantitative understanding of the reactive and radiated field coupling mechanisms between antennas in a dissipative medium. This understanding will then be applied to develop antenna design procedures that maximise communication link performance for the specified frequency, bandwidth, range and lossy medium parameters.</p>	
<p><b>Expected Background knowledge and skills:</b></p> <ul style="list-style-type: none"> <li>• Good theoretical understanding of electromagnetic and microwave engineering</li> <li>• Good programming skills and experience with one or more computational tools. (Matlab, C, Fortran, etc).</li> <li>• Experience with commercial circuit and full wave simulation tools desirable.</li> </ul>	
<p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• From first principles investigate the behaviour of antennas in a dissipative medium.</li> <li>• Apply this knowledge to the design of underwater antennas for various application scenarios (bandwidth or data rate, range, physical size and shape, etc).</li> <li>• Devise and conduct open-water experiments to validate analytical predictions of radio link performance.</li> </ul>	

<b>Project:</b>	<b><i>Dispersion Engineering of Transmission Line Metamaterial Structures</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Greg Milford (<a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a>)</i>
<p><b>Objectives:</b>  The non-conventional propagation characteristics of left hand transmission lines (LH TL) offer a new degree of freedom for the design of high frequency wave-guiding and wave-radiating components. A distinguishing feature of LH TL structures is the nature of the frequency dependent propagation coefficient, from left-handed to right-handed as frequency increases across the pass-band. A number of interesting applications have been proposed for 1D and 2D LH TL structures (frequency selective waveguides, leaky wave antennas, etc), however accurate characterisation and control of the dispersion characteristic is necessary for these ambitions to be realised. This project will investigate the application of evolutionary computation (EC) methods to the optimisation-based extraction of the LH TL unit cell dispersion characteristic from frequency response data. As this extraction process is based on equivalent circuit modelling of the unit cell structures, the project will also involve investigations into the selection of appropriate equivalent circuit models for various LH TL structures to accurately capture the unit cell's frequency dependence. The application of these techniques to better LH TL unit cell design will also be explored.</p> <p><b>Expected Background knowledge and skills:</b></p> <ul style="list-style-type: none"> <li>• Good theoretical understanding of electromagnetic and microwave engineering</li> <li>• Good programming skills and experience with one or more computational tools. (Matlab, C, Fortran, etc).</li> <li>• Experience with commercial circuit and full wave simulation tools desirable.</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Investigate planar topologies that produce LH TL unit cells, and develop appropriate equivalent circuit models for these structures.</li> <li>• Determine the applicability and limitations of using equivalent circuit based optimisation methods for extracting the dispersion characteristic from simulated and measured frequency response data.</li> <li>• Use this knowledge to devise new LH TL structures with superior performance characteristics.</li> <li>• Design, fabricate and characterise the performance of demonstration LH TL structures.</li> </ul>	

<b>Project:</b>	<b><i>Nonlinear Metamaterials for Terahertz Applications</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Greg Milford (<a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> Planar antenna structures are well suited to portable communications devices due to their small size, low cost and ease of integration with associated electronics. The design of these antennas generally requires use of full-wave electromagnetic simulators to include the effects of the conducting and dielectric environment surrounding the radiator. Unfortunately accurate full-wave simulations can be computationally expensive, thereby making the design process that necessarily requires multiple simulations a costly process. This project will investigate the application of evolutionary computation (EC) methods to planar antenna design, with a view to supplementing the electromagnetic simulations with optimisation based modelling of the antenna's structure and performance, such that fewer full-wave simulations need to be used. This will require tight coupling of the optimiser and electromagnetic simulator to minimise the computational cost in arriving at the optimum antenna design.</p>	

**Expected Background knowledge and skills:**

- Good theoretical understanding of electromagnetic and antenna engineering.
- Good programming skills and experience with one or more computational tools (Matlab, C, Fortran, etc).
- Experience with commercial circuit and full wave simulation tools desirable.

**Description of work:**

- Determine the applicability and limitations of EC methods to planar antenna design.
- Develop methods of integrating full-wave electromagnetic simulators with the EC optimisers to minimise the overall computation cost.
- Use this approach to devise new antennas with superior performance characteristics.
- Design, fabricate and characterise selected antennas to demonstrate the methods developed in this project.

<b>Project:</b>	<b><i>Optimisation Aided Design of Planar Antenna Structures</i></b>
<b>Program Code:</b>	<b>1643</b>
<b>Supervisor:</b>	<i>Dr Greg Milford (<a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<b>Objectives:</b> Planar antenna structures are well suited to portable communications equipment due to their small size, low cost and ease of integration with associated electronics. The design of these antennas generally requires use of full-wave electromagnetic simulators to include the effects of the conducting and dielectric environment surrounding the radiator. This project will investigate the application of evolutionary computation (EC) methods to the optimisation of antenna structures to achieve the specified design goals, with a view to determining which algorithms work best under various circumstances. This will require tight coupling of the optimiser and electromagnetic simulator to minimise the computational cost in arriving at the optimum antenna design.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Determine the applicability and limitations of EC methods to planar antenna design</li> <li>• Develop methods of integrating full-wave electromagnetic simulators with the EC optimiser to minimise the overall computation cost</li> <li>• Use this approach to devise new antennas with superior performance characteristics.</li> </ul>	

<b>Project:</b>	<b><i>Stability and Control of Nonlinear Transmission Line Metamaterials</i></b>
<b>Program Code:</b>	<b>1643</b>
<b>Supervisor:</b>	<i>Dr Greg Milford (<a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<b>Objectives:</b> The inclusion of nonlinear (NL) elements in a distributed left-handed transmission line (LH TL) structure adds an extra dimension to the dispersion engineering potential of these structures. It has been shown that these distributed nonlinear structures display a range of unstable behaviour similar to that observed with lumped devices (eg. radio frequency power amplifiers) and homogenous bulk materials (eg. harmonic generation in nonlinear optical materials). This project will investigate the mechanisms responsible for instability in NL LH TL structures. Previous research at UNSW Canberra has led to methods for detecting and predicting Hopf-type bifurcations in these structures, but much more work needs to be undertaken to further develop theoretical and numerical methods to describe	

these structures. The knowledge and insight gained from this analysis would then be used to devise design strategies to control and/or exploit these instabilities.

**Expected Background knowledge and skills:**

- Good theoretical understanding of electromagnetic and microwave engineering.
- Good programming skills and experience with one or more computational tools (Matlab, C, Fortran, etc).
- Experience with commercial circuit and full wave simulation tools desirable.

**Description of work:**

- Investigate the application of traditional control systems theory to NL LH TL structures for stability analysis and performance characterisation.
- Apply these analysis techniques to the design of NL LH TL structures.
- Develop techniques for fabricating and controlling distributed nonlinearities.
- Fabricate and characterise planar NL LH TL structures with distributed nonlinearities for harmonic generation and/or parametric amplification.

<b>Project:</b>	<b><i>Subsea Radiowave Propagation</i></b>
<b>Program Code:</b>	<b>1643</b>
<b>Supervisor:</b>	<i>Dr Greg Milford (<a href="mailto:g.milford@adfa.edu.au">g.milford@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Prof Hussein Abbass (<a href="mailto:h.abbass@adfa.edu.au">h.abbass@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> The frequency dependent attenuation of radiowave propagation in seawater has traditionally restricted undersea radio wave communication to very low carrier frequencies or very short link distances. Recently the proposal to adapt modern wireless communication and networking technology to the underwater environment has generated renewed interest in short range radiowave links. Accurate knowledge of the propagation characteristics, in particular attenuation and phase velocity, or alternatively the sea water media's conductivity and permittivity, is essential for accurate radiowave link analysis and design. This project will investigate the dependence of sea water conductivity and permittivity on frequency, salinity, temperature and electric field strength, and examine the consequences for radiowave link design. This will require an in-depth study of the relationship between the chemistry of aqueous solutions and their effective electrical parameters. An essential aspect of this project is experimental validation of theoretical and electromagnetic simulation predictions.</p> <p><b>Expected Background knowledge and skills:</b></p> <ul style="list-style-type: none"> <li>• Good theoretical understanding of electromagnetic and microwave engineering.</li> <li>• Good programming skills and experience with one or more computational tools (Matlab, C, Fortran, etc).</li> <li>• Experience with commercial circuit and full wave simulation tools desirable.</li> </ul> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Study the fundamental behaviour of salt water chemistry to gain a deep level understanding of the electromagnetic properties of salt water solutions.</li> <li>• Develop laboratory based simulation and measurement methods for characterising the electrical properties of salt water solutions.</li> <li>• Apply this knowledge of the salt water's electrical behaviour to design radiowave links that exploit the dispersive media properties to achieve desirable link performance.</li> <li>• Devise and conduct open-water experiments to validate analytical predictions of radio path behaviour.</li> </ul>	

## IMAGE PROCESSING

<b>Project:</b>	<b><i>Automated digitising and cataloguing of insects and plants</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Andrew Lambert ( <a href="mailto:a.lambert@adfa.edu.au">a.lambert@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> ) Dr John LaSalle ( <a href="mailto:john.lasalle@csiro.au">john.lasalle@csiro.au</a> ) Dr Robert Furbank ( <a href="mailto:Robert.Furbank@csiro.au">Robert.Furbank@csiro.au</a> )
<p><b>Objectives:</b> The objective of this thesis is to develop an automated 3D digitising and cataloguing platform for insects and plants. The specimen will be digitised into a 3D model and, through feature extraction, catalogued using an adaptive algorithm.</p> <p>This project involves design of opto-mechanical equipment and the development of image processing software.</p>	

<b>Project:</b>	<b><i>General Image Processing</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<b>Co-Supervisor</b>	
<p><b>Objectives:</b> This project investigates image processing related issues such as medical image encryption, transmission, e-health and pattern recognition etc.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing related image processing algorithms</li> <li>• Designing new algorithms</li> </ul> <p><b>Skills Required::</b> Good math background especially statistics, solid image processing knowledge and concrete programming skills.</p>	

## INFORMATION & COMMUNICATION

<b>Project:</b>	<b><i>E-government service design, implementation and benefit realisation</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Dr Ahmed Imran ( <a href="mailto:a.imran@adfa.edu.au">a.imran@adfa.edu.au</a> ), Dr Tim Turner ( <a href="mailto:t.turner@adfa.edu.au">t.turner@adfa.edu.au</a> )
<b>Co-Supervisor</b>	
<p><b>Objectives</b> Public sector ICT and e-government is quickly transforming the structure and service delivery of government agencies across the world. This study aims to investigate e-government intervention design at different levels (such as Government to Government, G2G or Government to Citizen, G2C) through a single/ multiple case studies to add new knowledge, best practices and challenges associated with such interventions in different countries.</p> <p><b>Description of Work</b></p> <ul style="list-style-type: none"> <li>• Studying of diffusion and adoption theories, nature and characteristics of public sector ICT / organisational culture impacting ICT.</li> <li>• Studying of information system design issues and flaws, value measurement of public sector ICT</li> </ul>	



- In-depth case study of one/ several ICT interventions in the public sectors
- Critical analysis and reflection of the case

#### **Skills Required**

- Qualitative study techniques, research skills, information system fundamentals. Knowledge and experience in the public sector will be an advantage

<b>Project:</b>	<b><i>ICT for development (ICT4D research); challenges of an ICT intervention an implementation in an unusual context</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Dr Ahmed Imran ( <a href="mailto:a.imran@adfa.edu.au">a.imran@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/ahimran/">http://seit.unsw.adfa.edu.au/staff/sites/ahimran/</a>
<b>Co-Supervisor</b>	
<b>Objectives</b>	
<p>The objective of this research is to add to the body of knowledge on the complexity and challenges within the developing country context in order to design better information systems for specific contexts. The environment, culture and influence of politics and power will be explored and analysed in relation to information system intervention and implementation. Role of IT in development has different meaning. The study will have scope to explore its development potentiality and societal benefit, particularly in societies belong to the other side of the digital divide.</p>	
<b>Description of Work</b>	
<ul style="list-style-type: none"> <li>• Study of ICT for development, societal benefit and implications, diffusion and innovation theories, relevant Information system theories. understanding the culture and people in developing countries</li> <li>• Critical analysis and reflection of the case</li> <li>• Field work in developing country</li> </ul>	
<b>Skills Required</b>	
<ul style="list-style-type: none"> <li>• Qualitative study techniques, research skills, Information system fundamentals, knowledge and experience in developing country will be an advantage.</li> </ul>	

## **LASER INSTRUMENTATION**

<b>Project:</b>	<b><i>Continuously Tuneable Wavelength-Measurement Technology for Optical DWDM Communication Systems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	A/Prof Charles Harb ( <a href="mailto:c.harb@adfa.edu.au">c.harb@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Elanor Huntington
<b>Objectives:</b>	
<p>This project is designed to address the needs for the next generation of tuneable optical wavelength sources for optical telecommunications, biotechnology, antiterrorism, and medical diagnostics. We propose to develop a simple, accurate, extremely fast, low cost, and compact wavelength meter for use with tuneable lasers. The proposed system will increase the speed for testing tuneable lasers – by factors of thousands (or millions). If successful, this technology can replace large, bulky wavemeters and optical spectrum analysers with compact, fast modules. It tunes tuneable lasers more precisely, diagnoses DWDM channels more economically, and provides tuneable intelligence for optical telecommunications.</p>	



**Description of Work:**

- Design and build the wavelength locking system;
- Design and build the detection and modulation/demodulation systems;
- Make measurements at different wavelengths, and catalogue the data;
- Investigate digital signal processing techniques that compare the data with an unknown wavelength.

<b>Project:</b>	<b><i>Hyperspectral Data Representation for Signal Enhancement</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Xiuping Jia (<a href="mailto:x.jia@adfa.edu.au">x.jia@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>As the advance of the technology in sensor design and manufacture, hyperspectral imagers have become available since late of 80s. A typical hyperspectral data cube is composed of about 100 to 200 spectral measurements and provides rich spectral information of the ground cover materials, in general. However, not all the measurements are important and essential for individual applications where users have their focused culture or natural classes of interest. The use of the unnecessary measurements creates difficulties in machine learning processing and reduces the reliability of thematic mapping. Another problem is that the original measures may not be the distinct features. Data representation is required to generate better signatures of the classes of interest. In this project, supervised feature selection and generation will be investigated. The outcome is significant practically and scientifically.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Examine the materials spectral characteristics quantitatively</li> <li>• . Evaluation of current feature selection and generation methods</li> <li>• Develop new effective techniques</li> <li>• Implement and validation</li> </ul>	

<b>Project:</b>	<b><i>Large scale network measurement</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Weiping Zhu (<a href="mailto:w.zhu@adfa.edu.au">w.zhu@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<p>A large network as the Internet is often divided into a number of domains (like ISPs) and all domains are independently managed. One ISP cannot access other ISPs networks. However, we need to find the characteristics of the whole network, such as link-level loss rates, link level delay distribution, available bandwidth, network topology. etc. to understand the network behaviours. Using the characteristics, we can further to set up models and study the interactions between different components. The key question here is how to find those characteristics without direct measurement, simply rely on end-to-end measurement. The research at this moment are focused on the following three areas:</p>	
<ol style="list-style-type: none"> <li>a) Loss tomography, which aims to estimate/infer loss rates of each link by end-to-end observation. We have some good results for a tree topology and is going to extend them into a general topology</li> <li>b) Delay tomography, which is for estimating delay distribution. In this area, we also have some good results by using sequential imputation. The work needs to be extending to general topology.</li> <li>c) Temporal tomography, which aims to find the temporal/spatial correlations, such as transition matrix, of the links. In this situation, observations are related to each other, as Markov chain. With transition matrix, we will be able to understand the temporal correlation between network states. Hidden Markov model, etc. are under investigation to uncover the temporal information.</li> <li>d) Spatial tomography, in contrast to temporal tomography, aims to find</li> </ol>	

spatial correlation between links in a network, such as a link has heavy delay, whether this delay will have any impact to its neighbours and by how much.

Topology estimation/identification can use in some bioinformatics techniques, such as inferring motif.

<b>Project:</b>	<b><i>Stochastic Network Control</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Weiping Zhu ( <a href="mailto:w.zhu@adfa.edu.au">w.zhu@adfa.edu.au</a> )
<b>Objectives:</b>	TCP has been used in the Internet for 30 years. Despite of its success, it has shown the sign of strain. Previously used feedback control falls short of providing what we want, in particular the necessity to handle the dynamics of traffic. Network community starts to worry about this but has not come out with a rescue. This research aims to build a stochastic model that considers the impact of feedback delay on the additive increase and multiplicative decrease used by TCP, and investigate the degree of the impact on the resource utilization, transmission rate, transport latent, jitter, etc. The findings will lead to a proposal of a new protocol.

<b>Project:</b>	<b><i>Subpixel Information Retrieval from Remote Sensing Data</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Dr Xiuping Jia ( <a href="mailto:x.jia@adfa.edu.au">x.jia@adfa.edu.au</a> )
<b>Objectives:</b>	Remote sensing image data generated by various sensors, especially, hyperspectral sensors, have limited spatial resolution. Subpixel signal retrieval is challenging. One of the issues is the collinearity when a least squared solution is involved. The problem damages the subsignal inversion robustness. This project will investigate the problem and develop effective solutions.  The outcome is significant practically and scientifically.
<b>Description of Work:</b>	<ul style="list-style-type: none"> <li>• Examine the collinearity problem quantitatively</li> <li>• . Evaluation of current studies</li> <li>• Develop the techniques to overcome the problem</li> <li>• Implement and validation</li> </ul>

<b>Project:</b>	<b><i>Super Resolution of Remote Sensing Data</i></b>
<b>Program Code:</b>	1643 or 1845
<b>Supervisor:</b>	Dr Xiuping Jia ( <a href="mailto:x.jia@adfa.edu.au">x.jia@adfa.edu.au</a> )
<b>Objectives:</b>	Remote sensing image data generated by various sensors, especially, hyperspectral sensors, have limited spatial resolution. It is valuable to improve the resolution via post processing. Mathematical modelling and computer power can be used to generate finer classification map than the original pixel resolution. Super resolution has been investigated in different ways in recent years, including super resolving data and super resolving decision. There are wide issues and research in this area. The outcome is significant practically and scientifically
<b>Description of Work:</b>	<ul style="list-style-type: none"> <li>• Evaluation of current studies</li> <li>• Improve the modelling or reducing computational complexity</li> <li>• Implement real data processing framework.</li> </ul>

<b>Project:</b>	<b><i>Traffic control over overlayed networks</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Weiping Zhu (<a href="mailto:w.zhu@adfa.edu.au">w.zhu@adfa.edu.au</a>)</i>
<b>Objectives:</b> The emergence of Ipv6 allows a node to use multiple paths connecting itself to a destination to transfer data for high performance. The questions that one needs to consider are: <ul style="list-style-type: none"> <li>• How to select paths dynamically that can maximize its performance?</li> <li>• How to distribute packets to each path that can balance the traffic on the available paths?</li> <li>• How avoid competition with other users (game theory in distributed control)?</li> <li>• How to predict traffic on each path/link (related to network tomography)</li> <li>• Relay selection and functions</li> <li>• Interconnection between overlays</li> <li>• Whether the above steps will lead to a stable system?</li> </ul> <p>We have some basic results in this direction, but a lot of them require further investigation</p>	

## NETWORKING

<b>Project:</b>	<b><i>General Networking</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Jiankun Hu (<a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a>) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a></i>
<b>Objectives:</b> This project investigates latest development in Networking such as P2P etc..	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Studying and analysing P2P networking and applications algorithms</li> <li>• Designing new algorithms</li> </ul>	
<b>Skills Required::</b> Good math background especially statistics, solid networking knowledge and concrete programming skills.	

<b>Project:</b>	<b><i>Internet of Things</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Jiankun Hu (<a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a>) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a></i>
<b>Co-Supervisor</b>	<i>Prof Ian Petersen</i>
<b>Objectives:</b> Internet of things is considered as a next big topic in networking. This project investigates latest development in Internet of Things.	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Studying and analysing Internet of Things algorithms</li> <li>• Designing new Internet of Things algorithms</li> </ul>	
<b>Skills Required::</b> Good math background especially statistics, solid networking knowledge and concrete programming skills.	

## NETWORK SCIENCE, WEB SCIENCE AND MANAGEMENT

<b>Project:</b>	<i>Identifying Influential Actors in Evolutionary Complex Networks</i>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Dr Alireza Abbasi (a.abbasi@adfa.edu.au)</i>
<p><b>Objectives:</b>            The thorough understanding and modelling of the selection mechanisms in the evolution of networks can help to predict and manage the structural changes of the networks over time. This research aims to investigate quantitatively the network evolution processes during the evolution of real complex networks and also the behavioural attachment patterns of the actors who are affecting on the network changes. This requires the use of nature-inspired algorithms and techniques and further development of a theoretical framework for networks evolution and adaptation through the use of different multi-disciplinary theories. One of the important outputs of this study is to identify actors that facilitate the network evolution which has implication for decision makers and managers to control the way networks evolve.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Understanding network dynamics and the structural factors driving the changes</li> <li>• Understanding the behaviours of actors which affects their link formation during the evolution of networks</li> <li>• Understanding the flow and diffusion of resources (information) over the network</li> <li>• Developing mathematical modelling and simulation techniques for extending the existing models of network dynamics and evolution</li> <li>• Evaluating the models against the existing methods and techniques</li> </ul>	

<b>Project:</b>	<i>Utilising Social Media for Effective Emergency Response Management</i>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Dr Alireza Abbasi (a.abbasi@adfa.edu.au)</i>
<p><b>Objectives:</b>            Information communication technologies and in particular social media platforms have been extensively used during emergencies and natural disasters for exchanging information between public (citizens often on the scene) and authorities. This research aims to investigate how the new technologies enhance the individuals and communities' resilience against emergencies and disasters. To do so, it is required to determine, classify, and critically assess the patterns of information exchange between different parties involved in managing disasters, particularly between public and authorities, which can advance the level of situational awareness gained from public and facilitate more effective decision making.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Understanding emergency and disaster management challenges especially in regards to communication and data collection and dissemination</li> <li>• Understanding the impact of ICT, including digital and social media, information systems and knowledge management systems, on the performance of organizations and their personnel</li> <li>• Understanding how ICT supports better functioning of individuals and communities, including public / private organizations.</li> <li>• Developing a system to extract and process the valuable public (online) data and provide beneficial information for managers and decision makers</li> <li>• Developing new methods / tools for measuring the resilience of the community against emergencies and natural disasters</li> </ul>	

<b>Project:</b>	<b><i>Mining and Analysing Social Networks for Business Applications</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Dr Alireza Abbasi (a.abbasi@adfa.edu.au)</i>
<p><b>Objectives:</b>  This research includes the techniques and methods to extract and analyse the (online) interaction of people and organizations using available digital information or social media such as social networking sites, wikis, forums and blogs in order to develop business applications. This research addresses both technical and social challenges such as data gathering and management issues; stability, reliability and precision of data for the social, cultural, legal and ethical issue for the later challenges. This study aims to improve the efficiency of business operations through providing opportunities for adopting and exploiting new technologies.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Understanding the techniques, algorithms and tools for mining and analysing the interaction data available online</li> <li>• Understanding the big data challenges</li> <li>• Understanding the technology adoption models</li> <li>• Developing models, tools and techniques for utilising and exploiting new technologies effectively to improve business processes and performance</li> </ul>	

## NETWORK SECURITY

<b>Project:</b>	<b><i>General Cyber Security</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Jiankun Hu (<a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a>)</i> <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b>  This project investigates general cyber security issues such as access control, social engineering, face book, privacy etc.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing existing relevant cyber security algorithms</li> <li>• Designing new algorithms</li> </ul> <p><b>Skills Required::</b>  Good math background especially statistics, solid networking knowledge and concrete programming skills.</p>	

<b>Project:</b>	<b><i>Host-based Intrusion Detection</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	<i>Prof Jiankun Hu (<a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a>)</i> <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b>  Firewalls cannot prevent new attacks. This project investigates how to detect attacks that have penetrated the firewalls.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing existing host-based intrusion detection algorithms</li> <li>• Designing new host-based intrusion detection algorithms</li> </ul> <p><b>Skills Required::</b>  Good math background especially statistics, solid networking knowledge and concrete programming skills.</p>	

<b>Project:</b>	<b><i>Network Intrusion Detection</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b> Network attacks are happening daily and have caused huge damage to our society. This project investigates latest network intrusion detection technology such as DDoS attack detection.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Studying and analysing existing network intrusion detection algorithms</li> <li>• Designing new network intrusion detection algorithms</li> </ul> <p><b>Skills Required:</b> Good math background especially statistics, solid networking knowledge and concrete programming skills.</p>	

<b>Project:</b>	<b><i>Wireless Sensor Network Security</i></b>
<b>Program Code:</b>	1885
<b>Supervisor:</b>	Prof Jiankun Hu ( <a href="mailto:J.hu@adfa.edu.au">J.hu@adfa.edu.au</a> ) <a href="http://seit.unsw.adfa.edu.au/staff/sites/hu/">http://seit.unsw.adfa.edu.au/staff/sites/hu/</a>
<p><b>Objectives:</b> Wireless network especially sensor networks are pervasive. This project investigates security issues in wireless sensor networks such as key management and back hole detection.</p> <p><b>Description of Work:</b> Studying and analysing existing sensor network security algorithms Designing new sensor network security algorithms</p> <p><b>Skills Required:</b> Good math background especially statistics, solid networking knowledge and concrete programming skills</p>	

## OPTICAL DEVICES

<b>Project:</b>	<b><i>Automated digitising and cataloguing of insects and plants</i></b>
<b>Program Code:</b>	1661
<b>Supervisor:</b>	Dr Murat Tahtali ( <a href="mailto:m.tahtali@adfa.edu.au">m.tahtali@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr John LaSalle ( <a href="mailto:john.lasalle@csiro.au">john.lasalle@csiro.au</a> ) Dr Robert Furbank ( <a href="mailto:Robert.Furbank@csiro.au">Robert.Furbank@csiro.au</a> )
<p><b>Objectives:</b> The objective of this thesis is to develop an automated 3D digitising and cataloguing platform for insects and plants. The specimen will be digitised into a 3D model and, through feature extraction, catalogued using an adaptive algorithm.</p> <p>This project involves design of opto-mechanical equipment and the development of image processing software.</p>	

<b>Project:</b>	<b><i>Plasmonic nano-antennas at optical wavelengths.</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Dr Haroldo T. Hattori (<a href="mailto:h.hattori@adfa.edu.au">h.hattori@adfa.edu.au</a>)</i> <i>Prof Elanor Huntington (<a href="mailto:e.huntington@adfa.edu.au">e.huntington@adfa.edu.au</a>)</i>
<p><b>Objectives:</b> Plasmonic waves are electromagnetic excitations that propagate at the interface between dielectrics and metals (surface waves). Devices based upon the propagation of plasmonic waves have opened the possibility of developing very compact optical devices. Among a multitude of plasmonic optical devices, nano-antennas offer the most promising applications. These nano-antennas generate high intense electrical fields in very small regions, which allow the selective attraction of certain nano-particles, investigate molecular processes in living cells and create new biological and chemical sensors</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Design these nano-antennas to operate with semiconductor materials (GaAs or InP platforms).</li> <li>• Integrate these nano-antennas with active devices such as quantum dot lasers.</li> <li>• Examine the possibility of creating novel bio-sensors and novel bio-imaging systems.</li> <li>• Fabricate these devices with either focused ion beam milling systems and/or electron beam.</li> <li>• Lithography and reactive ion etching systems</li> <li>• Characterise the fabricated nano-antennas and test it with selective biological applications.</li> </ul>	

## QUANTUM OPTICS

<b>Project:</b>	<b><i>Experiments in Coherent State Quantum Computing</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	<i>Prof Elanor Huntington (<a href="mailto:e.huntington@adfa.edu.au">e.huntington@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>A/Prof Charles Harb</i>
<p><b>Objectives:</b> There is considerable international research effort focused on the development of viable quantum computer technologies. Linear Optical Quantum Computing has proven to be a successful test-bed for experimental quantum computation with seminal experimental demonstrations of quantum logic operations on single photons. All of these schemes encode the quantum information on two different modes of an optical field and are known as "dual-rail" encoding schemes. A series of alternative, potentially superior, optical quantum computation schemes have been proposed based on "single-rail" encoding schemes.</p> <p>Single-rail optical quantum computing is an alternative, and potentially superior, approach to optical QC. The basis states are coherent states (multi-photon states that exhibit classical optical coherence) that can be created deterministically from well-stabilised lasers. Such states are non-orthogonal, but can serve as qubits under appropriate conditions.</p> <p>Such experiments will require quantum optics outside the realm of coincident measurement techniques and involve real-time quantum control, thus providing new techniques of direct relevance to our other optical quantum computation schemes. The goal of this project is to demonstrate basic quantum logic operations on non-classical optical states suitable for single-rail encoding schemes. Successful completion of this project has the potential to demonstrate an alternative optical quantum computation scheme which may be more amenable to scale-up than existing schemes.</p>	



**Description of Work:**

- Design and build the “cat-state” source;
- Design and build the detection systems;
- Measure the states and compare to theoretical models.

<b>Project:</b>	<b><i>Optimal control of Quantum Optical Systems</i></b>
<b>Program Code:</b>	1643
<b>Supervisor:</b>	Prof Elanor Huntington ( <a href="mailto:e.huntington@adfa.edu.au">e.huntington@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Prof Ian Petersen ( <a href="mailto:i.petersen@adfa.edu.au">i.petersen@adfa.edu.au</a> ) <a href="http://routh.ee.adfa.edu.au/~irp/P1.html">http://routh.ee.adfa.edu.au/~irp/P1.html</a>

**Objectives:**

There is considerable international research effort focused on the development of viable quantum computer technologies. Linear Optical Quantum Computing has proven to be a successful test-bed for experimental quantum computation with seminal experimental demonstrations of quantum logic operations on single photons. All of these schemes encode the quantum information on two different modes of an optical field and are known as "dual-rail" encoding schemes. A series of alternative, potentially superior, optical quantum computation schemes have been proposed based on "single-rail" encoding schemes.

Single-rail optical quantum computing is an alternative, and potentially superior, approach to optical QC. The basis states are coherent states (multi-photon states that exhibit classical optical coherence) that can be created deterministically from well-stabilised lasers. Such states are non-orthogonal, but can serve as qubits under appropriate conditions.

Such experiments will require quantum optics outside the realm of coincident measurement techniques and involve real-time quantum control, thus providing new techniques of direct relevance to our other optical quantum computation schemes.

The goal of this project is to demonstrate the application of modern control techniques such as LQG, H-infinity and Kalman filtering to non-classical optical states suitable for optical quantum computation.

**Description of Work:**

- Design and build the non-classical plant;
- Define H-infinity control objectives;
- Design and construct optimal controllers.

## UNDERWATER NETWORKS

<b>Project:</b>	<b><i>High Capacity Underwater Networks</i></b>
<b>Program Code:</b>	1885 or 1643
<b>Supervisor:</b>	Prof Michael Frater ( <a href="mailto:m.frater@adfa.edu.au">m.frater@adfa.edu.au</a> )

**Objectives:**

This project is part of a larger program to build a low-cost, large-scale, high-capacity underwater sensor network consisting of thousands of nodes. The aim of this project is to understand the bounds on the performance of underwater networks, and to develop better networking protocols.

**Description of Work:**

- Apply ideas from information theory to underwater networks
- Investigate scalability of networking protocols for underwater networks
- Develop improved protocols for underwater networks.

<b>Project:</b>	<b><i>Distributed Processing in Underwater Sensor Networks</i></b>
<b>Program Code:</b>	<i>1885 or 1643</i>
<b>Supervisor:</b>	<i>Prof Michael Frater (<a href="mailto:m.frater@adfa.edu.au">m.frater@adfa.edu.au</a>)</i>
<p><b>Objectives:</b>  This project is part of a larger program to build a low-cost, large-scale, high-capacity underwater sensor network consisting of thousands of nodes. The aim of this project is to develop algorithms for sharing and processing sensor data from large numbers of low-quality sensors. Applications include measurement of environmental data such as ocean currents, and direction finding for underwater transmitters.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Investigate suitability of distributed processing algorithms for underwater networks</li> <li>• Adapt and improve selected algorithms for the underwater environment</li> <li>• Implement algorithms in a large-scale sensor network.</li> </ul>	

## WIRELESS COMMUNICATIONS & SIGNAL PROCESSING

<b>Project:</b>	<b><i>Networks Wireless Self Organising</i></b>
<b>Program Code:</b>	<i>1643</i>
<b>Supervisor:</b>	<i>Dr. Mark C. Reed (<a href="mailto:m.reed@adfa.edu.au">m.reed@adfa.edu.au</a>)</i>
<p><b>Objectives:</b>  The aim of this project is to research self-organizing wireless Heterogeneous Networks (HetNets) and specifically investigate techniques and methods to improve the performance of such systems. The goal is to develop a simulation environment of a Self Organising Heterogeneous Network and realize new performance enhancing approaches to self-organising networks. The candidate should have excellent programming skills with motivation and a desire to learn about a new area. Skills in wireless communications and mathematics are highly desirable.</p> <p><b>Description of Work:</b>  The work will involve simulations and mathematical analysis of wireless cellular networks to assist in developing novel outcomes. MATLAB is the simulation platform of choice.</p>	

<b>Project:</b>	<b><i>Compressed Sensing for Radar and Radio Communications</i></b>
<b>Program Code:</b>	<i>1643</i>
<b>Supervisor:</b>	<i>Dr. Mark C. Reed (<a href="mailto:m.reed@adfa.edu.au">m.reed@adfa.edu.au</a>)</i>
<p><b>Objectives:</b>  The aim of this project is to research compressed sensing techniques for Radar and communication systems. Specifically this project will investigate techniques and methods to improve the performance and efficiency of Radar and radio communication systems. The goal is to develop a simulation environment and use mathematical analysis to validate the results. The candidate should have excellent programming skills with motivation and a desire to learn about a new area. Skills in wireless communications and mathematics are highly desirable.</p> <p><b>Description of Work:</b>  The work will involve simulations and mathematical analysis of radar and wireless radio systems with the aim of developing novel outcomes. MATLAB is the simulation platform of choice.</p>	

## SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

<http://hass.unsw.adfa.edu.au/>

For all of the research areas listed below, please contact the Postgraduate Coordinator, A/Prof Craig Stockings:

[hasspgresearch@adfa.edu.au](mailto:hasspgresearch@adfa.edu.au) <<mailto:hasspgresearch@adfa.edu.au>>.

**INTERNATIONAL AND POLITICAL STUDIES PROGRAM** International Relations (IR) theory Cosmopolitanism and global politics International organisations Political and social theory Ethics and world politics International political theory (IPT) Ethics of war/just war theory Questions of moral responsibility and agency/moral agency Human rights Democracy and democratisation Terrorism Critical approaches to international relations The role of political ideas Theories of citizenship State personhood Political culture Respect and toleration Social cohesion and national identity Liberal multiculturalism Breastfeeding and state policy Political economy and economic ideas Asian politics & Asian regional security Australian politics and foreign/defence policy Politics and international relations of Southeast Asia Australia-Asia relations Australian political history Burma 19th and 20th century Sarawak Arabs in southeast Asian history and politics Southeast Asian politics Alternative security agendas and policy Critical approaches to war, strategy and peace Ethnic conflict Ethics of intelligence collection Ethics of secession International statecraft Critical security studies anticipatory war 'Preventive' and 'pre-emptive' self defense Responsibility to protect/humanitarian intervention Convergence of aid and security policy Air power Korea · Politics and international relations of Southeast Asia · Australia-Asia relations · Terrorism · Maritime security issues · Non-traditional security.

**HISTORY PROGRAM** · History of the two World Wars · Australian history · Australian military history · Cold War conflicts · German history · British & Empire history (including colonial defence) · Economic history · Asian history · Naval history.

**SOUTHEAST ASIAN SOCIAL INQUIRY PROGRAM** · Agency and local politics in post-authoritarian and decentralised Indonesia · Indonesian literature and cultural history · Islam and globalisation · labour issues · Local community and disaster relief · Religion and social development in Southeast Asia **ENGLISH PROGRAM** · Australian literature and literary history in all aspects · War literature and the cultural representation of conflict · Scholarly editing and bibliography · Book history, censorship, and literary production and reception · American studies · Film and literary adaptation studies · Postcolonial and indigenous literatures · Early modern and nineteenth-century British literature.

**ETHICS PROGRAM** · Applied Ethics · Business Ethics · Theoretical Ethics · Military Ethics & the Ethics of Conflict · Ethical Decision-making · Political Philosophy

**SCHOOL OF PHYSICAL, ENVIRONMENTAL &  
MATHEMATICAL SCIENCES**

<http://pems.unsw.adfa.edu.au/>

**APPLIED MATHEMATICS**

<b>Project:</b>	<b><i>Efficient Operation of Bioreactors using Nonlinear Dynamical Systems Theory</i></b>
<b>Program Code:</b>	1881
<b>Supervisor:</b>	A/Prof H.S. Sidhu ( <a href="mailto:h.sidhu@adfa.edu.au">h.sidhu@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Mark Nelson
<b>Project Description &amp; Objectives:</b>	
<p>A recent novel strategy, using two bioreactors in series with one forcing the other, has shown promising results in terms of yield improvement. Work so far has been preliminary, and has relied only upon numerical calculations. This approach is not only slow but has been reported to omit optimum operating conditions. This interdisciplinary project will apply systematic, efficient and robust mathematical techniques from dynamical systems theory to such reactor engineering problems. We will also establish a general framework by which multiple reactor chemical or bioengineering systems (such as sludge wastewater treatment plants, production of ethanol via fermentation tanks) can be efficiently investigated to determine optimum reactor performance.</p>	

<b>Project:</b>	<b><i>Developing realistic models for stressed ecosystems</i></b>
<b>Program Code:</b>	1881
<b>Supervisor:</b>	Dr Zlatko Jovanoski ( <a href="mailto:z.jovanoski@adfa.edu.au">z.jovanoski@adfa.edu.au</a> )
<b>Co-Supervisor</b>	A/Prof Harvinder Sidhu and Dr Isaac Towers
<b>Project Description and Objective:</b>	
<p>Many ecosystems are “stressed” when external perturbations such as pollution, land clearing and sudden shocks to the environment arise. However, most current models that are used by ecologists do not take the changing environment into consideration. Recent models developed by our group directly couple the dynamics of one or two species with their environments. This is achieved by treating the carrying capacity, a proxy for the state of the environment, as a state variable in the governing equations of the model. Thereby, any changes to the environment can be naturally reflected in the survival, movement and competition of the species within the ecosystem.</p> <p>In the case of two competing species (such as the classical predator-prey models) with variable carrying capacity, we have shown from our earlier work that the dynamics can be different. Here, the ultimate state for the ecosystem depends on the developmental rate of the environment (for instance rehabilitation of the environment). For a range of values below some threshold, persistence of both species which are in equilibrium with its environment can occur. However, beyond this threshold, the prey always dies out. This has immediate consequences relating to conservation that may need to be addressed. In other words, it may be necessary</p> <p>Our current models, however, do not adequately represent realistic ecosystems. The species have a single age-structure and both the species and environment change instantaneously to external perturbations and stressors.</p> <p>In reality, the feedback about the state of the environment (available resources) reaches with a delay due to various factors such as generation and maturation periods, differential resource consumption with respect to age-structure, hunger</p>	

threshold levels, migration and diffusion of populations, markedly differing birth rates in interaction species and delays in behavioural responses to a changing environment.

Realistic models must account for these disparate sources of feedback by incorporating (multiple) time delays. In other contexts, it is known that delays can cause instability in the system giving rise to oscillatory or even chaotic dynamics.

We will employ a combination of analytic and numerical methods to investigate the dynamics of an ecosystem with time delays. Of particular importance is to establish critical values for the onset of instabilities which often signals changes in the dynamics of the ecosystem. This can lead to a better understand of the long term survivability of a particular species whose environment is stressed.

<b>Project:</b>	<b><i>Multi-step combustion mode</i></b>
<b>Program Code:</b>	<i>1881</i>
<b>Supervisor:</b>	<i>A/Prof H.S. Sidhu (<a href="mailto:h.sidhu@adfa.edu.au">h.sidhu@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Zlatko Jovanoski and Dr Isaac Towers</i>
<b>Project Description &amp; Objectives:</b>	
<p>Inefficient combustion arising from instabilities during industrial processes adversely affects the environment and has serious safety and economic implications. Current modelling schemes are (i) single-step kinetics which oversimplify the process; (ii) detailed schemes that allow only numerical investigation without providing a deeper understanding of the underlying behaviour. To enable a better understanding of combustion dynamics we will investigate reactions ranging from two- to multi-step kinetics in several configurations using mathematical tools developed by our group. In the process, we will be tackling the fundamental problem of efficient algorithms for analysing the stability of solutions from differential equations. This has immediate applications to various fields of science.</p>	

<b>Project:</b>	<b><i>Nonlinear Effects in Bent Optical Waveguides</i></b>
<b>Program Code:</b>	<i>1881</i>
<b>Supervisor:</b>	<i>Dr Zlatko Jovanoski (<a href="mailto:z.jovanoski@adfa.edu.au">z.jovanoski@adfa.edu.au</a>)</i>
<b>Project description:</b>	
<p>A detailed theoretical study of non-linear effects in bent optical waveguides is proposed. This involves the numerical modelling and solution of the equations describing the propagation of light in non-linear bent waveguides. With the continuing development of optical communications systems it is fundamentally important to understand how light beams that have intensities in the non-linear regime are affected by bends in the waveguide. Once this behaviour is modelled, the potential exists to exploit the polarization and pulse propagation properties of non-linear light beams in bent structures to systematically design optical devices for use in future all-optical communication systems.</p>	
<p>The specific aims are:</p> <ul style="list-style-type: none"> <li>• To begin the basic mathematical analysis using continuous-wave theory that will be used to synthesize the theory of bends and nonlinearities.</li> <li>• To extend the basic theory to include the effects of polarisation, taking into account different waveguide structures. This is the first stage of this grant proposal.</li> <li>• To build into the theory the effect of propagating frequency-dependent pulses, and comparing results to continuous-wave theory.</li> <li>• To move to a more advanced mathematical regime and examine the full theory of bends and nonlinearity, where now the nonlinearity may be high enough to change the transverse modal field.</li> </ul>	

<b>Project:</b>	<b><i>Optimizing performance of chemical reactions via periodic operation</i></b>
<b>Program Code:</b>	1881
<b>Supervisor:</b>	<i>A/Prof H.S. Sidhu (<a href="mailto:h.sidhu@adfa.edu.au">h.sidhu@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Prof A.A. Adesoji &amp; Dr Mark Nelson</i>
<b>Project Description &amp; Objectives:</b>	
<p>The project examines the use of mathematical analysis to determine the best parameters for minimum resource use for a exothermic chemical reactor (such as that used for the production of hydrogen (a clean fuel) from liquefied petroleum gas). This makes the new reactor applicable to petrochemical and fuel cell industries for both stationary and mobile purposes like cars, space craft and oil tankers.</p> <p>More specifically the project aims to:</p> <ul style="list-style-type: none"> <li>Evaluate the unsteady-state model for the periodic flow catalytic reactor (PFCR) in order to provide a basis for computer-aided prediction of its performance for wide ranging input conditions as may be encountered in practical situations.</li> </ul> <p>Optimize cycle parameters (frequency, split, etc) to achieve thermal self-sustainability simultaneously with coke minimization in the PFCR and hence, establish a dynamic optimal control strategy for product selectivity for either stationary or mobile application.</p>	

<b>Project:</b>	<b><i>Pattern formation in a predator-prey model with nutrient enrichment</i></b>
<b>Program Code:</b>	1881
<b>Supervisor:</b>	<i>Dr Isaac Towers (<a href="mailto:i.towers@adfa.edu.au">i.towers@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Zlatko Jovanoski and A/Prof Harvinder Sidhu</i>
<b>Project Description and Objective:</b>	
<p>Ecological systems are characterised by the interaction between species and their natural environment. Such interaction may occur over a wide range of spatial and temporal scales.</p> <p>Predator-prey dynamics change when the environment is no longer constant but changes with the presence of a biotic or an abiotic resource. The effect of the resource is accounted for by including an addition rate equation to the predator-prey model. In this project the carrying capacity of both the predator and prey are assumed to depend on the resource density. In this way we can model the effect of environmental enrichment on the stability of the predator and prey populations. This leads to the so called ratio-depend models. The ratio-dependent predator-prey models are known to exhibit very rich temporal dynamics.</p> <p>On the other hand, we live in a spatial world, and spatial patterns are ubiquitous in nature, these patterns modify the temporal dynamics and stability properties of population densities at a range of spatial scales, their effects must be incorporated in temporal ecological models that do not represent space explicitly.</p> <p>Pattern formation in nonlinear complex systems is one of the central problems of the natural, social, and technological sciences. Spatial patterns and aggregated population distributions are common in nature and in a variety of spatiotemporal models with local ecological interactions.</p> <p>We investigate the emergence of a ratio-dependent predator-prey system with resource enrichment and reaction-diffusion. We seek to understand the effect of nutrient enrichment on the process of pattern formation. Specifically,</p> <p>:</p> <ul style="list-style-type: none"> <li>understand the combined effects of enrichment and of diffusion on pattern</li> </ul>	



- formation,
- investigate how enrichment changes the symmetry-breaking bifurcations that lead to spatiotemporal patterns and their stability.
- determine if stationary patterns are sensitive to the initial conditions,
- establish the role enrichment plays on spatially chaotic patterns.

Although this project is theoretical in nature, it may however be applicable to an aquatic community in a real marine environment.

## ASTRONOMY

<b>Project:</b>	<b><i>Star Formation in Dark Clouds</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr Robert G. Smith ( <a href="mailto:r.smith@adfa.edu.au">r.smith@adfa.edu.au</a> )
<b>Objectives:</b> This project examines star formation in dark clouds in the plane of the galaxy.	
<b>Background:</b> The earliest stages of star formation which can be reasonably studied are when a dense core forms within a dusty envelope in a dark cloud. This is followed by the formation of a disk and bipolar outflows. As the star evolves, the envelope transfers all its mass to the disc and the disc in turn transfers this to the core (which will eventually become a star) and the outflows disappear. Each of these stages has characteristic signatures which can be seen in different parts of the spectrum, radio, infrared and optical. The problem is recognizing which dark clouds are likely to form stars and determining what type (i.e. mass) of star is likely to be formed. One step on the way to understanding these problems is identifying and studying more stars at this stage of their evolution.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Initially, data from available online catalogues of infrared observations (2MASS and Spitzer GLIMPSE) will be used to first map the dust density distribution in the dark cloud regions to locate likely sites of recent star formation and then (from the catalogue colours), to identify candidate Young Stellar Objects (YSOs) within these clouds;</li> <li>• Subsequently, the YSO's will be studied using ground-based infrared, optical and radio telescopes to identify their evolutionary status and characterize their disks and/or envelopes;</li> <li>• The initial dust density distributions will be combined with existing radio atomic and molecular line surveys for those dark clouds in which YSO's are identified to distinguish between those with and without star formation.</li> </ul>	

## ATMOSPHERIC PHYSICS AND METEOROLOGY

<b>Project:</b>	<b><i>A new Radio Acoustic Sounding System (RASS) for probing fog</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr John Taylor ( <a href="mailto:j.taylor@adfa.edu.au">j.taylor@adfa.edu.au</a> )
<b>Objectives:</b> To develop a combined acoustic and electromagnetic instrument, a RASS, that operates in the 2.4 to 3.0 GHz band and is able to resolve the temperature structure in the lowest 150 m of the nocturnal boundary layer. This instrument will then be utilized in an investigation of methods for predicting local fog formation and clearance.	



**Description of Work:**

- We have a RASS that operates at a radio frequency of 1.275 GHz. The initial part of this project would be to use this as the basis of a “mini” RASS that operates at approximately twice the frequency, hence has double the spatial and temporal resolution, of the present instrument.
- Once the developed and tested we could use the temperature and wind profiles from the RASS and a high frequency sonar to test a range of models for fog formation and clearance. Earlier work suggests that a dynamical one-dimensional model may be useful for “now casting” fog clearance.

<b>Project:</b>	<b><i>Development and application of an improved electromagnetic wind profiler.</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr John Taylor ( <a href="mailto:j.taylor@adfa.edu.au">j.taylor@adfa.edu.au</a> )
<b>Objectives:</b>	
To improve the range and resolution of our existing 1275 MHz boundary layer wind profiler by incorporating pulse coding and compare the wind and turbulence information from this instrument with the Bureau of Meteorology’s operational 70 MHz spaced antenna profiler located at Canberra Airport.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• We have a prototype 1275 MHz boundary layer wind profiler that we used for a successful field experiment in south eastern Australia in 2000. We would like to modify this system to include pulse coding to improve its range and resolution. The initial part of this project would involve working on the hardware and software for the system.</li> <li>• Once completed, we would look at data obtained simultaneously from our 1275 MHz system and the Bureau of Meteorology's operational 70 MHz boundary layer wind profiler installed at Canberra airport. This part of the project would focus on the information about the atmosphere that can be acquired by having these two systems (almost) co-located.</li> </ul>	

<b>Project:</b>	<b><i>Testing the representation of boundary layer turbulence in mesoscale meteorological models</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr John Taylor ( <a href="mailto:j.taylor@adfa.edu.au">j.taylor@adfa.edu.au</a> )
<p>The numerically-based forecasting of mesoscale meteorological phenomena, such as sea breezes, thunderstorm outflows and other density-driven flows, are dependent on the accuracy of the turbulence parameterization in the model. This is because density-driven flows in the atmosphere are generally embedded within the atmospheric boundary layer, and characteristics such as their propagation speed and velocity structure will be dependent on the vertical exchange of momentum within the boundary layer.</p> <p>Ground-based remote sensing instrumentation provides information on some key atmospheric turbulence parameters beyond the height range that is readily accessible to surface- and tower-based instrumentation, and over much longer periods of time than can be acquired with airborne sensors such as aircraft or moored balloons and kites.</p> <p>Within the Lower Atmosphere Research Group in the School of PEMS, UNSW Canberra, there is an extensive set of spectral data from acoustic wind profilers, or SODARs (SOund Detection And Ranging systems), collected in regions in Australia ranging from tropical far northern Queensland to the Canberra region in south eastern Australia. A wide range of interesting mesoscale phenomena have been captured in this data. The principles of deriving turbulence information from sodar data are relatively well understood, so that this data set provides a valuable resource</p>	

for testing the turbulence parameterisations built into mesoscale models.

The objectives of this project would be:

1. To complete the analysis of the sodar data set to extract turbulence parameters and estimates of the parameter reliability;
2. Compare cases from the sodar data set with selected numerical runs for a range of flow phenomena: sea breezes and plateau winds; frontal systems; convective outflows; atmospheric solitary waves; etc.
3. Use a statistical approach to compare model predictions with observations over the full periods of the available data sets.

The Lower Atmosphere Research Group in PEMS has used the meteorology component of the CSIRO model TAPM (The Air Pollution Model) in previous studies, and it will also be used in addressing objectives 2 and 3 above. For the case study component (2) we intend to access numerical simulations from other mesoscale models such as MM5. This component of the work will be in collaboration with the Centre for Dynamical Meteorology and Oceanography at Monash University, who were also involved in the northern Queensland sodar deployments as part of ARC DP0558793.

## CHEMISTRY

<b>Project:</b>	<b><i>Dinuclear ruthenium complexes as therapeutic agents</i></b>
<b>Program Code:</b>	1871
<b>Supervisor:</b>	<i>A/Prof Grant Collins</i> ( <a href="mailto:g.collins@adfa.edu.au">g.collins@adfa.edu.au</a> )
<b>Brief outline of proposed research</b>	
<p>We have recently demonstrated the potential of inert bulky dinuclear ruthenium complexes as DNA and RNA binding agents. These ruthenium complexes show a significant selectivity and affinity for non-duplex structures <input type="checkbox"/> loops. They bind non-covalently in the minor groove and preferentially target specific non-duplex DNA/RNA sites by matching the shape, symmetry and functionalities of the metal complex to the nucleic acid target. However, for a dinuclear ruthenium complex to be converted into a therapeutic agent requires significantly stronger binding at non-duplex sites that control a disease (such as cancer and HIV-AIDS). The aim of the proposed research is to synthesise analogues of our current dinuclear ruthenium complexes that can covalently bind non-duplex sites. Two basic approaches are proposed for the ruthenium complexes: (i) the incorporation of labile chloro ligands, and (ii) the incorporation of “dangling” amines, which upon intracellular activation can covalently react with DNA/RNA.</p> <p>Di- and trinuclear ruthenium complexes containing chloro groups or “dangling” amines will be prepared, and their binding to specific non-duplex DNA and RNA structures will be examined by nuclear magnetic resonance (NMR) spectroscopy. In addition, the intracellular transport and organelle localisation will be studied using confocal microscopy. Finally, all the analytical results will be correlated with the determined therapeutic effect against a variety of disease types.</p>	

<b>Project:</b>	<b><i>New compounds of iridium for use in supramolecular assemblies</i></b>
<b>Program Code:</b>	1871
<b>Supervisor:</b>	<i>Dr Lynne Wallace</i> ( <a href="mailto:l.wallace@adfa.edu.au">l.wallace@adfa.edu.au</a> )
<b>Objectives:</b>	
<p>This project will involve the development of synthetic methods for the preparation of novel redox-active iridium(III) complexes that have the potential for use in many areas such as nanotechnology, photovoltaic devices or anti-cancer therapy. The redox and optical properties of the new species will be characterized and their suitability for incorporation into supramolecular assemblies will be investigated.</p>	

**Description of Work:**

- Synthesize and purification of new and established iridium(III) polypyridyl complexes, both mononuclear and multinuclear.
- Investigate the electrochemical and spectroscopic behaviour of the free complexes in various media to extend our knowledge of such systems; and utilise this knowledge in the design of new complexes.
- Extend the work to include measurements on host-guest species and multinuclear complexes and assess their potential for use in various types of supramolecular assemblies such as molecular switches, photovoltaics or electrochromic devices.

<b>Project:</b>	<b><i>Studies in desalination and water treatment</i></b>
<b>Program Code:</b>	1871
<b>Supervisor:</b>	Prof Ric Pashley ( <a href="mailto:r.pashley@adfa.edu.au">r.pashley@adfa.edu.au</a> )

**Brief outline of the proposed research project**

There are several projects in desalination and water treatment. Each project is directly linked to commercial applications.

1. We recently developed a novel bubble column evaporator (BCE) method for measuring the latent heat of vaporization ( $\Delta H_v$ ) of concentrated salt solutions. [see: *J. Phys. Chem. B* 113, 9311-9315 (2009).] However, although established in principle, the method used was crude and hence only gave values to about 3% accuracy. There is a need to develop an improved method which will enable new values to be obtained for concentrated electrolyte solutions, above 1M. A second part of this project involves the study of the BCE as new method for the controlled production of fine particles.
2. The two main industrial processes for seawater desalination are membrane reverse osmosis (SWRO) and thermal distillation (such as MSF methods). However, both methods have some serious disadvantages. Mixed bed ion exchange resins have been used for many years to remove scale-forming ions such as  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  from feed water and to produce distilled quality water from tap water. However, this process could, in principle, also be applied to the desalination of seawater, overcoming the main disadvantages of the current methods. The aim of the project is to develop a specifically designed ion exchange resin suitable for the efficient desalination of seawater and brackish water.
3. We previously established that at high salt concentrations, air bubble columns can be produced at high bubble volume fractions without the bubbles coalescing. As they pass through the column, these bubbles rapidly pick up water vapour, which can then be condensed to produce high drinking quality water. This system will be developed and studied for its potential application as a sustainable, energy efficient seawater desalination process.
4. We are currently working with a NSW company on a new combined blackwater/greywater household treatment and recycling system. Currently, 17% of households in Australia treat their waste water on site. Mostly they use septic tanks which are hard to maintain and often leak contaminated water into the groundwater. A novel household treatment and recycling unit will not only prevent this contamination but will also reduce household water usage.

## CHEMISTRY/PHYSICS/MATHEMATICS

<b>Project:</b>	<b><i>Interactions in Biological Systems</i></b>
<b>Program Code:</b>	1871, 1881
<b>Supervisor:</b>	A/Prof Cliff Woodward ( <a href="mailto:c.woodward@adfa.edu.au">c.woodward@adfa.edu.au</a> )
<p><b>Objectives:</b> Molecular interactions, such as the hydrophobic force, van der Waals interactions and electrostatics are of great importance in the study of many biological systems. For example, interactions between proteins are vital for the explanation of many diseases and cures. Furthermore, the interaction of bio-molecules and man-made molecules (such as drugs and polymer) are of great importance to the pharmacy industry. This project uses a range of theoretical methods to study these interactions. These include mathematical modelling and computer simulation. It involves collaboration between theoreticians and experimentalists in Sweden and Brazil.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• develop theoretical methods for the description of interactions in bio-systems</li> <li>• develop computer algorithms for numerical solutions of the theory</li> <li>• apply the methods to a range of model scenarios including those determined by experimental partners</li> <li>• Related publication: Lund, Mikael; Jungwirth, Pavel; <b>Woodward, CE.</b> <i>Phys Rev Letts</i>, <u>100</u>(25), 258105/1-258105/4, <b>2008</b></li> </ul>	

<b>Project:</b>	<b><i>Study of Ionic Liquids</i></b>
<b>Program Code:</b>	1871, 1881
<b>Supervisor:</b>	A/Prof Cliff Woodward ( <a href="mailto:c.woodward@adfa.edu.au">c.woodward@adfa.edu.au</a> )
<p><b>Objectives:</b> Ionic Liquids are a new class of environmentally friendly liquids that are set to revolutionize modern industry. We have begun a study of the properties of ionic liquids, together with researchers in industry in Australia, as well as researchers in Sweden. Our study uses mathematical techniques that we have developed in our group for polymeric fluids, in order to study the equilibrium properties of ionic liquids at charged interfaces and in the presence of nanoparticles. Our work will also investigate the dynamical properties of ionic liquids, especially electro-kinetic phenomena.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• develop methods, based on density functional theory, suitable for application to ionic liquids</li> <li>• develop computer algorithms for numerical solutions of the theory</li> <li>• apply the methods to a range of model scenarios including those determined by industrial partners</li> <li>• Related publication: <b>Woodward, CE.</b>; Forsman, J.,. <i>Phys Rev Letts</i> <u>100</u>(9), 098301/1-098301/4,. <b>2008</b></li> </ul>	

<b>Project:</b>	<b><i>Theory of Nanoparticle Polymer Mixtures</i></b>
<b>Program Code:</b>	1871, 1881
<b>Supervisor:</b>	A/Prof Cliff Woodward ( <a href="mailto:c.woodward@adfa.edu.au">c.woodward@adfa.edu.au</a> )
<p><b>Objectives:</b> We will use state of the art theoretical methods to study the microscopic structure of nanoparticle/polymer mixtures. These systems are important for many applications in science engineering and medicine. Specific applications include: self-healing materials; detection methods for security applications; drug release; quantum dots etc.</p>	

The suitable candidate for this project will be in the area of either mathematics, computer science or chemical/materials engineering. This project will use novel mathematical and computational modelling, so the applicant needs to have a background in these areas.

**Description of Work:**

- develop methods, based on density functional theory, suitable for application to nanoparticle/polymer mixtures
- develop computer algorithms for numerical solutions of the theory
- apply the methods to a range of model scenarios
- related publication: Forsman, J, **Woodward, C E**, *Phys Rev Letts* 94(11), 118301/1-118301/4, **2005**

## GEOGRAPHY

<b>Project:</b>	<b>Alternative food economies and urban agriculture in Australian cities</b>
<b>Program Code:</b>	
<b>Supervisor:</b>	<i>Alec Thornton</i>
<b>Co-Supervisor</b>	<i>Scott Sharpe</i>
<b>Objectives:</b> A key aim of this study is to understand local attitudes and perceptions towards various forms of urban agriculture (e.g. community, market and backyard gardens) as a contributor to alternative local food networks. The urgent research problem that this project will address is identifying pathways for cities to improve local food security in an era of rapid urbanisation, escalating food costs and global warming. Expected outcomes of this study are to (a) determine the relevance of local alternative food networks to communities and city councillors and (b) constraints and opportunities for civic engagement in urban food production.	
<b>Description of Work:</b> This project will involve qualitative and quantitative research methods, in the form of interviews and questionnaire surveys of those engaged in urban agriculture. Participant observation and action research are also considered.	

<b>Project:</b>	<b><i>Bystander Anti-racism: a study of enablers and constraints</i></b>
<b>Program Code:</b>	<i>1081</i>
<b>Supervisor:</b>	<i>Dr Scott Sharpe</i>
<b>Co-Supervisor</b>	
<b>Objectives:</b> Well-publicised incidents of racial vilification have raised the issue of the role of bystanders in combating or condoning such actions. Preliminary work suggests that a lack of bystander action in racist incidents can compound the injury suffered since victims perceive this lack as tacit support for the perpetrators of such actions. Yet should 'speaking out' be the only strategy? More recently, researchers have drawn attention to a series of more subtle actions and everyday incivilities that form the backdrop for these more obvious incidents and which increase the sense of hostility racialised subjects feel in public space. Sharpe and Hynes have indicated that direct approaches to speaking out against racism are not without potential deleterious effects, especially in the case of more subtle events, since they risk entrenching victimhood and further racialising subjectivities.	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Contribute to the theorisation of the 'event'</li> <li>• Distinguishing between intensive and extensive concepts of racialised</li> </ul>	

<ul style="list-style-type: none"> <li>• subjectivity</li> <li>• Examining the range of variables that enables or constrains bystanders for standing up for victims of racial abuse</li> <li>• Examining how context and geography shapes bystander responses to racist incidents</li> <li>• Exploring some of the more subtle forms or both racial incivilities and ‘slow anti-racism’</li> <li>• Investigate the role of new media in shaping perceptions of public incidents of racism</li> </ul>
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<b>Project:</b>	<b>Biofuels Research, Policy and Adoption in Agricultural Systems</b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	A/Prof Stuart Pearson ( <a href="mailto:stuart.pearson@adfa.edu.au">stuart.pearson@adfa.edu.au</a> )
<b>Objectives:</b> To improve the understanding of the drivers of biofuel research, policy and agricultural adoption in Australia and China.	
<b>Description of work:</b> <ul style="list-style-type: none"> <li>• Complete an environmental scan to develop a systematic understanding of the drivers of biofuel policy in Australia and China.</li> <li>• Develop insights into the similarities and differences in the ways biofuel research, policy and adoption occurs in Australia and China.</li> <li>• Explore the way risk and uncertainty emerge in the way biofuel research, policy and adoption in agriculture occurs.</li> <li>• Determine the most useful analytical framework for evaluating the impact of biofuel research on policy and agricultural practice.</li> </ul>	

<b>Project:</b>	<b>Comparative analysis of Australia and China’s marine resources management approaches and scenarios for the future</b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	A/Prof Stuart Pearson ( <a href="mailto:stuart.pearson@adfa.edu.au">stuart.pearson@adfa.edu.au</a> )
<b>Objectives:</b> To improve the understanding of the drivers in Australia and China’s approaches to Ocean (or Coastal) management and develop credible future scenarios to inform discussion.	
<b>Description of Work:</b> <ul style="list-style-type: none"> <li>• Complete an environmental scan to develop a systematic understanding of the drivers of ocean (or coastal) policy in Australia and China with a focus on the slow-moving variables and possible triggering events.</li> <li>• Develop a set of scenarios that are built out of the existing evidence and trends to discuss.</li> <li>• Interview managers, regulators, investors and other stakeholders about the ways these scenarios interact with current models of change.</li> <li>• Determine the usefulness of environmental scanning to identify opportunities and threats in Ocean policy.</li> </ul>	

<b>Project:</b>	<b><i>Implications of peak oil (energy stress) on lifestyles in urban and rural environments in Australia</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	Dr Paul Tranter ( <a href="mailto:paul.tranter@adfa.edu.au">paul.tranter@adfa.edu.au</a> ) Dr Scott Sharpe ( <a href="mailto:scott.sharpe@adfa.edu.au">scott.sharpe@adfa.edu.au</a> )
<b>Objectives:</b> Based on recent spikes in global oil prices, this project examines implications for	



quality of life in urban and rural locations in Australia.

**Possible themes:**

- Impact of increased oil prices on children's rights and freedoms
- Development of policies to respond to or adapt to increased oil prices
- Impact of oil prices on food production, health, and transport
- Oil alternatives in rural and urban Australia.
- Increased oil price and its affects on community

<b>Project:</b>	<b><i>Investigating the use and design of static and interactive cartograms</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	Dr Amy Griffin ( <a href="mailto:a.griffin@adfa.edu.au">a.griffin@adfa.edu.au</a> )
<b>Objectives:</b>	Static and animated cartograms are becoming more commonly used (and misused) as forms of data visualization in a number of disciplines and in the mass media. The main objectives of this project are to 1) compare the ability of users to understand information in cartograms generated with a variety of different algorithms and 2) to compare the performance of cartograms with other forms of representing thematic information (e.g., choropleth maps).
<b>Description of Work:</b>	<ul style="list-style-type: none"><li>• Generate static and interactive cartograms using a number of different algorithms/methodologies.</li><li>• Design and carry out user studies that investigate the perceptual and cognitive processes cartogram readers employ when viewing cartograms.</li><li>• Develop a series of design guidelines that can be used to help cartogram producers generate cartograms that are effective in representing thematic data.</li></ul>

<b>Project:</b>	<b><i>Maps and emotions</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	Dr Amy Griffin ( <a href="mailto:a.griffin@adfa.edu.au">a.griffin@adfa.edu.au</a> )
<b>Co-Supervisor</b>	
<b>Objectives:</b>	Cartographers studying the use of maps have devoted considerable attention to understanding the perceptual and cognitive processes involved in map reading, and have developed several sets of guidelines for designing maps that are useful to end users. However, cartography as a field has almost completely ignored the role of emotions in map use. This is despite the fact that psychologists know that emotions are important for many processes we undertake using maps, such as decision making. The objective of this project is to develop methods that can reliably measure a map reader's emotional state both in the lab and 'in the wild'.
<b>Description of Work:</b>	This project involves the development of methodological procedures to measure emotional states, and that lead to reliable and robust information about how people feel when undertaking a variety of map reading tasks. Case study applications that demonstrate the utility of including measurements of emotional states when studying map use will also be developed.



<b>Project:</b>	<b><i>Marina development in Australia and China – organising the knowledge of environmental and economic impacts</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	A/Prof Stuart Pearson ( <a href="mailto:stuart.pearson@adfa.edu.au">stuart.pearson@adfa.edu.au</a> )
<p><b>Objectives:</b> To improve the understanding of the issues associated with marina developments in Australia and China with the purpose of improving decision-making.</p> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Complete environmental fieldwork in Australia to describe the current legal, social, economic and environmental impacts</li> <li>• Integrated this with an understanding of the way these are organised and managed by local and regional governments.</li> <li>• Identify the opportunities that integrated management provides in change management, development controls, tenure, access, offsets, water quality and safety</li> <li>• Assess options, including polycentric governance models to provide more adaptive and participative management of coastal zone issues associated with marinas.</li> </ul>	

<b>Project:</b>	<b><i>Marine Parks: Sustainable Growth in Conservation</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	A/Prof Stuart Pearson ( <a href="mailto:stuart.pearson@adfa.edu.au">stuart.pearson@adfa.edu.au</a> )
<p><b>Objectives:</b> To explore the use of Marine Protected Areas to achieve environmental and political outcomes in Australia and China.</p> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Develop an understanding of the arrangement of marine parks in Australia and the rationale and process of their declaration.</li> <li>• Explore the issues associated with marine protected areas from a variety of viewpoints.</li> <li>• Identify risks and opportunities associated with Marine Protected Areas and how these might be managed.</li> <li>• Develop an evaluative and knowledge framework for evaluating marine protected areas.</li> </ul>	

<b>Project:</b>	<b><i>Research Impact in Australia and China</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	A/Prof Stuart Pearson ( <a href="mailto:stuart.pearson@adfa.edu.au">stuart.pearson@adfa.edu.au</a> )
<p><b>Objectives:</b> To improve the understanding of research impact and the drivers of research investment in Australia and China's natural resource management fields.</p> <p><b>Description of work:</b> The impact of research done on natural resource management (the management of soils, water, fish stocks, biodiversity or vegetation) is a fertile area that offers benefits to private and public investors around the World. However, it is also challenging to track the impact of the research investment. Because of complexity in attribution, spill-overs, discounting and program design there is considerable confusion about the marginal returns on additional research investments. There is a need to better understand how research impact can be evaluated and how improvements can be included in ongoing research programs.</p> <ul style="list-style-type: none"> <li>• Complete an environmental scan to develop a systematic understanding of the drivers of natural resource management research investment decisions in Australia</li> </ul>	

and China.

- Develop specific case-study insights into the ways research programs procure knowledge to achieve impact from the triple bottom line perspective (social, environmental and economic)
- Explore the ways risk and uncertainty knowledge of natural resource management are considered in research investments.
- Determine or develop the most useful analytical framework for evaluating the impact of research to guide practice, policy and research.

<b>Project:</b>	<b><i>Resource governance for sustainable community development and economic growth</i></b>
<b>Program Code:</b>	<i>1081</i>
<b>Supervisor:</b>	<i>Dr Alec Thornton (a.thornton@unsw.edu.au)</i>
<b>Co-Supervisor</b>	<i>Prof Satish Chand (s.chand@adfa.edu.au)</i>
<p><b>Objectives:</b>  This study aims to (a) analyse the power relationships existing between foreign mining companies and governments in developing countries where they operate and (b) the legitimacy of 'good governance' claims amidst negotiations between these companies and governments that seek to trade natural resource wealth for GDP growth. So-called 'good governance' is the exercise of power in the management of economic and social resources for development. In addition to good governance, transparency and accountability by all stakeholders in the national extractive industry are essential ingredients for economic performance. Project objectives are to develop frameworks for extractive industries in post-conflict regions to operate as a productive asset, based on the principles of sustainable development, which will grow the economy without undermining indigenous people residing in mining affected areas.</p> <p><b>Description of Work:</b>  This research will use a resource governance approach in a quantitative and qualitative examination of extractive industry/host country relationships, to determine to what extent government policy and foreign investment in resource extraction can contribute to economic and social development.</p>	

<b>Project:</b>	<b><i>Seeing environmental change from tree growth</i></b>
<b>Program Code:</b>	<i>1081</i>
<b>Supervisor:</b>	<i>A/Prof Stuart Pearson (stuart.pearson@adfa.edu.au)</i>
<p><b>Objectives:</b>  To improve the understanding of the drivers of tree growth in Australia's semi-arid environments using tree rings and correlations to circulation systems.</p> <p><b>Description of work:</b></p> <ul style="list-style-type: none"> <li>• Complete environmental fieldwork in semi-arid Australia to recover wood samples with a research team.</li> <li>• Develop insights into the ocean and atmosphere circulation systems that drive regional climates that are recorded in the trees' growth.</li> <li>• Collect environmental data and concepts to interpret ring width variations measured using a microscope.</li> <li>• Analyse the ring widths and other data to identify key drivers of environmental change in Australian semi-arid environments and in surrounding oceans.</li> </ul>	

<b>Project:</b>	<b><i>Uncertainty visualization</i></b>
<b>Program Code:</b>	1081
<b>Supervisor:</b>	Dr Amy Griffin ( <a href="mailto:a.griffin@adfa.edu.au">a.griffin@adfa.edu.au</a> )
<b>Co-Supervisor</b>	
<p><b>Objectives:</b>  All kinds of scientific endeavours involve measurement. No scientific measurement is perfect – that is to say, measurements include errors. Policy makers then take data and make decisions based upon that data (at least sometimes!). However, often, policy makers have little to no understanding of the uncertainties that are related to that data and do not take them into account when making decisions. Typically these uncertainties, if they are reported at all, are communicated with tables that are easily ignored by data end users. Therefore, having good ways of communicating uncertainties to data users is critically important to improving the extent to which decision making processes take data uncertainty into account. The objective of this project is to develop and empirically test new methods for representing uncertainty in spatially referenced data with the end users of that data.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Develop uncertainty representation methods that can be applied to geospatial data.</li> <li>• Design and carry out user studies to test the effectiveness of these representation methods for supporting decision making.</li> <li>• Develop ways in which we can encourage GIScientists to regularly use and adopt visual methods for representing uncertainty in geospatial data.</li> </ul>	

## OCEANOGRAPHY

<b>Project:</b>	<b><i>Characterisation of ocean forecast errors from an ocean forecasting system</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ) and Dr Gary Brassington, Bureau of Meteorology
<b>Co-Supervisor</b>	
<p><b>Description of Work:</b>  A state-of-the-art prediction system makes several assumptions about the errors of the observing system, the ocean models, the atmospheric forcing and data assimilation methodology. Correctly modelling and estimating these errors and validating or improving these assumptions is critical to further improving performance. This project will focus on the available database of forecast innovations and increments from the BLUElink ocean prediction system and determine the systematic bias as well as the statistical distribution. Specific methods will then be developed to deconstruct and attribute error to different components of the system as well as hypothesis testing.</p>	

<b>Project:</b>	<b><i>Generalised dependence for the ocean sea drag</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ), Prof Alex Babanin, Swinburne University and Prof. Guan Changlong (OUC)
<b>Co-Supervisor</b>	
<p><b>Description of Work:</b>  The sea---drag coefficient is the main property which is employed to parameterise the air---sea interactions in large---scale models, from engineering applications to climate research. Over the last 30 years, however, scatter of the experimental dependences for the sea drag parameterised as a function of wind speed and/or</p>	

wave age did not improve. The proposed project would intend to develop a generalised parameterisation of the sea drag as a function of multiple environmental forcings, for use in meteorological, climate and ocean engineering applications.

<b>Project:</b>	<b><i>Impact of East Australian Current observations Tasman Sea eddies in an ocean model</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ) and Dr Eric Schulz, Bureau of Meteorology
<b>Co-Supervisor</b>	
<b>Description of Work:</b>	
<p>Can observations of the East Australian Current using a HF ocean surface radar improve model forecast skill of meso-scale eddies in the Tasman Sea?</p> <p>The study will use observations at Coffs Harbour (30S, 153E) which extend approximately 100 km east across the East Australian Current (EAC) and perform assimilation impact studies on a domain encompassing upstream of Coffs Harbour, the EAC separation (at approximately Smoky Cape, 31 S), and the Tasman front (across to New Zealand), with a particular emphasis on meso-scale eddies.</p>	
<b>OSR observations</b>	
<p>The HF OSR measures surface currents in the top few tens of centimetres of the ocean, on a few km resolution with a range of around 100km over 10 minute time scales. The OSR is part of the IMOS ACORN facility and is planned to commence operation in February 2012. Routine data delivery could be expected by mid 2012. Observations show the EAC is largely barotropic, so OSR should be representative of the depth-integrated current.</p>	
<b>The Ocean Model CLAM? Assimilation</b>	
<p>The HF OSR provides currents in regions where the two radars overlap (and the subtended angles of the ray are greater than ~20 Outside of this region there is another equally extensive area where there is only one useful current vector component resolved. While not suited to visual interpretation, single current vector components can be assimilated into ocean models.</p> <p>The model already assimilates altimetry, SST and temperature and salinity profiles, so any skill improvement will be in excess of this. The assimilation of HF OSR observations may also be useful in the situation where altimetry is degraded (due to loss of satellites or other problems). It would be useful to quantify the impact of assimilating OSR currents in the absence (or reduction) of altimetry.</p> <p>Possible candidate data-sets for skill evaluation are feature tracking, surface drifters (these are probably drogued to a few metres depth), or synTS. The first two sources will probably generate sparse data-sets. Maybe the evaluation will be achieved by looking at the increments in SSH?</p>	
<b>Links to other Work</b>	
<p>We have previously looked at the impact of observations on models using the error estimates in the data assimilation system (Oke <i>et al.</i>, 2009). It would be instructive to see how data withholding experiments compare to the observation network design study tool.</p> <p>Oke, P. R., Sakov, P. &amp; Schulz, E.W., 2009, A comparison of shelf observation platforms for assimilation in an eddy-resolving ocean model, <i>Dynamics of Atmospheres and Oceans</i>, 48, 121-142, doi:10.1016/j.dynatmoce.2009.04.002.</p>	

<b>Project:</b>	<b><i>Internal Tides and Waves in the South China Sea</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	<i>Dr Robin Robertson (<a href="mailto:r.robertson@adfa.edu.au">r.robertson@adfa.edu.au</a>)</i>
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>• Learn to use a prominent ocean circulation model</li> <li>• Investigate internal tides and waves in the South China Sea</li> </ul>	
<b>Description of Work:</b>	
<p>Large internal tides exceeding 50 m have been observed in the South China Sea. These tides generate internal waves and induce mixing on the continental shelf. They also induce non-linear solitons. The goal of this project is to investigate the internal tide and wave fields in the South China Sea using both hydrostatic and non-hydrostatic models. The model results will be compared to observational data. This work has implications for the regional oceanography of the South China Sea and for investigations of internal tides and waves in other active regions, such as Australia's North West Shelf.</p>	

<b>Project:</b>	<b><i>International Group for High Resolution Sea Surface Temperature (GHR SST) TWP+ data set</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	<i>Dr Xiao Hua Wang (<a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a>) and Dr Helen Beggs, Bureau of Meteorology</i>
<b>Description of Work:</b>	
<p>Helen Beggs leads the GHR SST Tropical Warm Pool Diurnal Variability (TWP+) Project which aims to quantify diurnal warming of the surface ocean over the Tropical Warm Pool to the north of Australia and to validate and compare various diurnal variation models over this region.</p> <p>The <b>International Group for High Resolution Sea Surface Temperature (GHR SST) TWP+ data set</b> would be a great resource for any PhD student with a background in either physical oceanography, air-sea heat exchange, marine meteorology and/or satellite oceanography. Further information on the TWP+ Project can be found at <a href="https://www.ghrsst.org/ghrsst-science/science-team-groups/dv-wg/twp/">https://www.ghrsst.org/ghrsst-science/science-team-groups/dv-wg/twp/</a> &lt;<a href="https://www.ghrsst.org/ghrsst-science/science-team-groups/dv-wg/twp/">https://www.ghrsst.org/ghrsst-science/science-team-groups/dv-wg/twp/</a>&gt; . The <b>GHR SST Workshop on Tropical Warm Pool and High Latitude SST Issues</b> (Melbourne, 5-9 March 2012) would be an excellent opportunity for a new PhD student to choose a TWP+ related research project that matches their interests and abilities. The workshop will focus on presentations relating to initial research for the TWP+ Project and using the TWP+ data set during the three working days of the GHR SST workshop. Further information on the GHR SST Workshop can be found at <a href="https://www.ghrsst.org/ghrsst-science/Meetings-and-workshops/workshop-on-tropical-warm-pool-and-high-latitude-issues/">https://www.ghrsst.org/ghrsst-science/Meetings-and-workshops/workshop-on-tropical-warm-pool-and-high-latitude-issues/</a> &lt;<a href="https://www.ghrsst.org/ghrsst-science/Meetings-and-workshops/workshop-on-tropical-warm-pool-and-high-latitude-issues/">https://www.ghrsst.org/ghrsst-science/Meetings-and-workshops/workshop-on-tropical-warm-pool-and-high-latitude-issues/</a>&gt; including a draft agenda which lists the current TWP+ research activities.</p>	

<b>Project:</b>	<b><i>Nepheloid layers in the Changjiang (Yangtze River) estuary</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	<i>Dr Xiao Hua Wang (<a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a>)</i>
<b>Co-Supervisor</b>	<i>Dr Houjie Wang, OUC; Dr Weibin Guan, Second Institute of Oceanography, State Oceanic Administration, China</i>
<b>Objectives:</b>	
<p>This project will characterize the nepheloid layers in the Changjiang estuary and develop new numerical models to investigate these layers. It will examine the role of the nepheloid layers in determining coastal ocean dynamics and in transporting sediments from the river to the East China Sea. A comparison study of the nepheloid layer and sediment processes before and after the construction of the Three Gorges Dam (TGD) will also be conducted in this project.</p>	

**Description of Work:**

- Collect and synthesize pre- and post-TGD sediment, hydrology and meteorology data from the Changjiang estuary and build a multivariate marine and meteorological database for model forcing, validation and calibration;
- Develop high resolution hydrodynamics and sediment transport models that are capable of reproducing nepheloid layer process in Changjiang estuary;
- Combine observations and models of Changjiang estuary to extend our knowledge about the structure and evolution of nepheloid layers and extent to which current theory and models can make reliable and general predictions of these layers pre- and post-TGD.

<b>Project:</b>	<b><i>Nonlinear response of western boundary currents to variable wind forcing</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Andrew Kiss ( <a href="mailto:A.Kiss@adfa.edu.au">A.Kiss@adfa.edu.au</a> ) <a href="http://www.unsw.adfa.edu.au/pems/research/kiss/">http://www.unsw.adfa.edu.au/pems/research/kiss/</a>
<p><b>Objectives:</b> This project will investigate the nonlinear response of western boundary currents (WBCs, such as the Kuroshio) to variations in wind forcing. Western boundary currents have intrinsic variability due to their instabilities, but they are also driven (indirectly) by winds which have their own time-dependence, such as an annual cycle. Observed WBC variability may therefore be due to the interaction between intrinsic instabilities and variations in wind forcing. Western boundary currents are nonlinear, and initial investigations (Kiss, 2007) have shown that their response to variable forcing includes nonlinear resonance and chaos, as expected for a driven nonlinear oscillator.</p> <p>The chaotic response is particularly interesting, because it leads to variability on timescales far longer than either the forcing variability or the intrinsic WBC variability, which may possibly play a role in climate variability.</p> <p><b>Description of Work:</b> The project will investigate this problem using MITgcm, Q-GCM or a similar model, using a dynamical systems (“chaos theory”) approach to analyse the dynamics. Initial experiments will use an idealized “box ocean” to cleanly reveal the physics. Further work could investigate the effects of more realistic bathymetry and boundary shape, and also the effects of two-way ocean-atmosphere coupling.</p> <p><b>Reference:</b> A. E. Kiss (2007) “Nonlinear resonance and chaos in an ocean model”, Proc. CSIRO Centre for Complex System Science &amp; COSNet. Workshop on Turbulence and Coherent Structures in Fluids, Plasmas, and Granular Flows, The Australian National University, 10 - 13 January 2006, World Scientific Lecture Notes in Complex Systems.</p>	

<b>Project:</b>	<b><i>Predictive mapping of seabed cover, benthic habitats, benthic biodiversity using multibeam bathymetry and backscatter data</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ) and Dr Zhi Huang, Geoscience Australia
<b>Co-Supervisor</b>	
<p><b>Description of Work:</b> Coastal marine benthic environment, which is dreadfully under-studied, has significant economic and conservation values. Sustainable management of this</p>	



marine ecosystem requires high quality physical and biological datasets on the benthic environment and scientific evidence on the interactions between these physical and the biological variables. Modern multibeam sonar systems, with different sonar frequencies, are capable of accurately mapping large area of seabed from water depth of a few metres to thousands metres. They can provide high-resolution and near-complete coverage of bathymetry and acoustic backscatter data for mapping seabed substrata, benthic habitats and benthic biota.

The proposed project would involve intensive field campaigns collecting multibeam data, water column data, sediment samples and biological data. The collaboration with OUC is critical for the collection and analysis of these data. We would provide expertise in the areas of data analysis, modelling and result interpretation.

<b>Project:</b>	<b><i>Sediment transport dynamics in the Great Barrier Reef, Queensland, Australia</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Xueen Chen, OUC
<b>Objectives:</b>	
<p>Due to land clearance and grazing in the catchment areas of the Great Barrier Reef (GBR) rivers, the inshore regions of the GBR are subject to enhanced fluxes of suspended sediments from river runoff, causing bleaching and disappearance of nearshore coral reefs. This project will, for the first time, combine observation and numerical models to investigate the sediment transport dynamics in the GBR region. By quantifying the sediment transport and defining its pathways from rivers to the outer shelf of the GBR, the proposed research will directly address the water quality issues of the GBR, thus help to better evaluate the impact of the land degradation on, and manage and protect the GBR marine ecosystem that offers Australia with tremendous economic, social and cultural values.</p>	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Collect and synthesise published historic sediment, hydrology and meteorology data from the shelf of the Great Barrier Reef (GBR) and build a multi-variate marine and meteorological database for model forcing, validation and calibration</li> <li>• Develop high resolution hydrodynamics and sediment transport models that are capable of reproducing nepheloid layer process on the shelf of the GBR;</li> <li>• Combine observations and models of the GBR shelf to investigate the dynamics of nepheloid layers and extent to which current theory and models can make reliable and general predictions of nepheloid layers</li> <li>• Also, sediment transport and pathways from the nearshore zone to the outer shelf of the GBR within and above the nepheloid layers will be investigated. The nepheloid layer effect on the BBL hydrodynamics and coastal ocean circulation will be determined.</li> </ul>	

<b>Project:</b>	<b><i>The Influence of Monsoons and the Southern Oscillation on Transport and Mixing in the Indonesian Seas</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Robin Robertson ( <a href="mailto:r.robertson@adfa.edu.au">r.robertson@adfa.edu.au</a> )
<b>Co-Supervisor</b>	Dr Susan Wijffels, CSIRO, Hobart, Tasmania, Australia
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>• Learn to use a prominent ocean circulation model</li> <li>• Improve transport simulations and estimates of mixing for the Indonesian Seas</li> <li>• Determine the links between the transport and mixing and monsoons and the Southern Oscillation</li> </ul>	



**Description of Work:**  
 Present estimates of the transport through the Indonesian Seas from simulations fail to correctly estimate the flow. Crude estimates of the tidal currents and mixing have been shown to improve these estimates. By incorporating mean currents into tidal simulations and simulating both the currents and the tides properly, further improvements will be gained. The student will perform simulations using a widely-used ocean model and investigate the dependence of the transport and mixing on the winds and conditions associated with monsoons and El Nino/La Nina. This work has important implications both regionally for climate in the Austral-Asian region and globally for the thermohaline circulation or global conveyor belt.

<b>Project:</b>	<b><i>Tidal Influences on the Amundsen Ice Shelf (or other ice shelves)</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Robin Robertson ( <a href="mailto:r.robertson@adfa.edu.au">r.robertson@adfa.edu.au</a> )
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>• Learn to use a prominent ocean circulation model</li> <li>• Determine the amount of melting of the ice shelf attributable to tides</li> <li>• Investigate lifting and flexure of the ice shelf by tides.</li> </ul>	
<b>Description of Work:</b>	
<p>Collapse of the West Antarctic Ice Sheet (WAIS) is expected to raise sea level by 6 m, a potentially disastrous event. The Amundsen Ice Shelf, believed to be a key lynchpin for the WAIS, is melting at a rate over 10 times faster than other Antarctic ice shelves. Along with the melt ponds, tides are believed to be a significant factor in ice shelf dynamics and thermodynamics. In this project, the student will simulate tides in the Amundsen Sea, including the ice shelf cavities. Using the model results, the student will quantify tidal effects on the ice shelf, including lifting, flexure, and melting from below.</p>	

<b>Project:</b>	<b><i>Tides, Sea Ice, and the Thermohaline Circulation</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Robin Robertson ( <a href="mailto:r.robertson@adfa.edu.au">r.robertson@adfa.edu.au</a> )
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>• Learn to use a coupled sea ice-ocean model</li> <li>• Determine tidal effects on sea ice</li> <li>• Investigate tidal influences on deep water production</li> </ul>	
<b>Description of Work:</b>	
<p>Tides have been identified as the prominent factor in sea ice dynamics over the continental shelf in the Weddell Sea. Presently, few sea ice models include tidal dynamics and few tidal models include sea ice, making tidal effects on sea ice difficult to investigate. For this project, the student will investigate tidal effects on sea ice using a coupled sea ice/ocean model. Model output will also be used to determine changes in deep water production, which typically accompany changes in the sea ice cover. This project has obvious implications for climate work not only in the Antarctic and Arctic, but also globally from the connection between deep water production and the global thermohaline circulation.</p>	

<b>Project:</b>	<b><i>Transport and Mixing in the Straits of the Indonesian Seas</i></b>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Robin Robertson ( <a href="mailto:r.robertson@adfa.edu.au">r.robertson@adfa.edu.au</a> )
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>• Learn to use a prominent ocean circulation model</li> <li>• Perform fine scale simulations of the transport and mixing in the key straits of the Indonesian Seas</li> </ul>	

**Description of Work:**

Pacific Water is transformed in localized regions through mixing as it passes through the Indonesian Seas. Due to its localized nature, coarser scale models estimate the mixing poorly, particularly for narrow straits. Finer resolution simulations provide more accurate estimates; however, the entire Indonesian Sea region is too large for the optimal resolution. It is proposed that the student perform a series of fine scale tidal simulations, including mean currents, for key straits in this region: Lombok, Ombai, Makassar, and Timor. These simulations will identify localities of mixing and provide improved estimates of the flows through the straits. Besides being useful for shipping and naval operations, this work has important climate implications, both regionally and globally.

<b>Project:</b>	<i>Using hyperspectral remotely sensed data for monitoring coastal water quality</i>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ), Dr Zhi Huang, Geoscience Australia, and Dr Xiuping Jia
<b>Co-Supervisor</b>	
<b>Description of Work:</b>	
<p>Airborne Hyperspectral Remotely Sensed data has very high spatial and spectral resolutions. It is therefore most suitable for fine-scale and detailed investigation of coastal water quality. The hyperspectral reflectance is jointly influenced by a range of physical and biochemical conditions in the near-surface water. These water quality factors include chlorophyll, phytoplankton, dissolved organic materials, suspended sediments, dissolved oxygen, and surface temperature, etc. The hyperspectral data can thus be used to accurately estimate the concentrations of these water quality parameters and to monitor their seasonal and annual changes.</p> <p>The proposed project would involve intensive field campaigns collecting hyperspectral data and water quality data at selected seasons. This would be followed by solid data analysis to quantify the relationship of various water quality factors to the reflectance at specific wavebands, which is highly significant and challenging. The collaboration with OUC is critical for the collection and analysis of these data. We would provide expertise in the areas of data processing, modelling and result interpretation.</p>	

<b>Project:</b>	<i>What ocean do Lagrangian observing platforms (e.g., Argo and drifting buoys) observe?</i>
<b>Program Code:</b>	1082
<b>Supervisor:</b>	Dr Xiao Hua Wang ( <a href="mailto:hua.wang@adfa.edu.au">hua.wang@adfa.edu.au</a> ) and Dr Gary Brassington, Bureau of Meteorology
<b>Co-Supervisor</b>	
<b>Description of Work:</b>	
<p>In the mid- and high-latitudes the ocean circulation is composed largely of eddies and fronts. In isolation an ocean eddy is relatively stable being in quasi-geostrophic balance and retaining a closed material surface around its core water mass. It is only through the disruption or destruction of this balance through eddy- interactions that an exchange in mass with its environment takes place. Only at these times is it possible for a Lagrangian observing platform to enter or exit the eddy circulation. This poses many interesting questions such as how frequently do these platforms observe eddies and what are the implications for constructing climatologies of the ocean and ocean forecasting. This research would make use of state of the art high resolution ocean models, analysis of altimetry and the in situ Argo and drifting buoy observations available at the Bureau of Meteorology and the global ocean observing system.</p>	

## PHYSICS (ADVANCED MATERIALS)

<b>Project:</b>	<b><i>Coherent transients in inorganic crystals by frequency-switching of diode lasers</i></b>
<b>Program Code:</b>	1871, 1892
<b>Supervisor:</b>	Prof Hans Riesen ( <a href="mailto:h.riesen@adfa.edu.au">h.riesen@adfa.edu.au</a> )
<p><b>Objectives:</b> Coherent transient experiments, including optical free induction decay, photon echoes and optical nutation, facilitate an understanding of subtlest details of electronic structures in the solid state. The project aims to investigate the application of coherent transients in chemically interesting systems, such as coordination compounds, by laser-frequency switching of semiconductor (diode) lasers.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Establish the facile induction of coherent transients by laser frequency switching of diode lasers by utilizing archetypal materials such as ruby, emerald and the like.</li> <li>• Transfer the technology to more challenging systems such as coordination compounds.</li> <li>• Studying the effects of external electric and magnetic fields on the coherent transients.</li> <li>• Gain a full theoretical understanding of the observed transients.</li> </ul>	

<b>Project:</b>	<b><i>Crystal-fields and magnetic exchange in ternary rare earth intermetallic compounds</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Professor Seán Cadogan ( <a href="mailto:s.cadogan@adfa.edu.au">s.cadogan@adfa.edu.au</a> )
<p><b>Objectives:</b> Ternary rare-earth intermetallic compounds are important from both theoretical and applied points of view. These compounds usually contain a transition element and a metalloid element, in addition to the rare-earth, and this combination allows us to study the role played by the <i>f-d-p</i> electrons in determining the magnetic structure of a compound. We can also probe the fundamental magnetic exchange and crystal-field interactions across a series of related compounds.</p> <p>The crystal structures of ternary compounds can be quite complex, involving more than one rare-earth site, and in some cases the different rare-earth sites show quite independent magnetic behaviour from one another, which is somewhat unusual in metallic systems. In this project we will investigate the magnetic exchange and magneto-crystalline anisotropy mechanisms in ternary rare-earth intermetallics in terms of fundamental building blocks whose local point symmetries form the basis for the behaviour of the more complex ternary structures.</p> <p>This work is mainly theoretical/computational and will involve the development of computer programs to carry out crystal-field and exchange calculations for a variety of ternary structures.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Analysis of the structural information on various series of ternary intermetallics;</li> <li>• Development of computer programs to carry out crystal-field and magnetic exchange calculations;</li> <li>• Determination of the underlying fundamental crystallographic symmetries of complex ternary structures;</li> <li>• Explanation of the magnetic and structural behaviour of complex ternaries in terms of local exchange and crystal-field interactions.</li> </ul>	

<b>Project:</b>	<b><i>Determining the magnetic structures of rare earth compounds</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Professor Seán Cadogan ( <a href="mailto:s.cadogan@adfa.edu.au">s.cadogan@adfa.edu.au</a> )
<p><b>Objectives:</b>  Rare earth intermetallic compounds are important from both theoretical and applied points of view. The magnetic structures adopted in these compounds allow us to probe the fundamental magnetic exchange and crystal-field interactions across a series of related compounds. Such compounds are also the basis for the World's strongest permanent magnets and they underpin the coming generation of magnetic refrigeration materials. The aim of our research is to investigate the interplay between the crystallography and the aforementioned fundamental interactions as these lie at the heart of the intrinsic magnetic behaviour of rare-earth compounds.</p> <p>In this project we will prepare a number of series of intermetallic compounds containing rare-earth elements and study their crystallography and magnetism using a variety of experimental techniques (x-ray and neutron diffraction, Mössbauer Spectroscopy, Magnetometry etc). We will determine the magnetic structures of these compounds and we will investigate the changes in magnetic structure that often occur when one cools the sample. Such changes are usually the result of competition between different terms in the crystal-field interaction and this project offers the scope for computer modelling of the intrinsic magnetic behaviour of a rare-earth compound.</p> <p><b>Description of Work:</b></p> <ul style="list-style-type: none"> <li>• Preparation of compounds by argon-arc melting and annealing, with characterisation by standard techniques such as x-ray diffraction;</li> <li>• Carry out basic measurements of a compound's magnetic properties using magnetometry and ac-susceptibility;</li> <li>• Determine the magnetic structures and their temperature evolutions by neutron diffraction and Mössbauer Spectroscopy;</li> <li>• Explanation of the magnetic structural behaviour in terms of exchange and crystal-fields.</li> </ul>	

<b>Project:</b>	<b><i><sup>57</sup>Fe Mössbauer studies of meteorites</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Professor Seán Cadogan ( <a href="mailto:s.cadogan@adfa.edu.au">s.cadogan@adfa.edu.au</a> )
<p><b>Objectives:</b>  The classification of meteorites usually involves three major categories which are distinguished on the basis of the amounts of metallic Fe-Ni and Fe-bearing silicates they contain. <i>Irons</i> are mainly Fe-Ni metal, <i>Stones</i> are mainly silicates with a small amount of metal and <i>Stony Irons</i> have roughly equal amounts of metal and silicates. Stony meteorites can be further subdivided into chondrites and achondrites. About 85% of observed meteorite falls are chondrites that most likely originated in asteroid-like objects which were never large enough to undergo melting in the early stages in the formation of the Solar System.</p> <p>We have a set of meteorite samples that were collected in two hot desert regions: the Nullarbor Desert in Australia and the Sahara Desert in North Africa. Meteorites falling in such dry regions tend not to weather away too quickly.</p> <p>In this project we will carry our <sup>57</sup>Fe Mössbauer spectroscopy on a number of meteorites to identify the oxidation states and crystal chemistry of the Fe-bearing meteoritic phases. When a meteorite reaches Earth, all the iron is present as either Fe<sup>0</sup> or Fe<sup>2+</sup>, with effectively no Fe<sup>3+</sup>. Therefore, any Fe<sup>3+</sup> present in a recovered meteorite can only have been formed on Earth and reflects the interaction of the meteorite with the climatic conditions present at the crash-site. Such information is important to the study of terrestrial climate and involves question such as whether or</p>	

not meteorites record a signal of the terrestrial climate at the time of their fall. This information can also be used to determine the 'Terrestrial Age' of the meteorite i.e. how long has the meteorite been on Earth. We will also study the nanoparticles of Fe-oxides and hydroxides present in a meteorite and investigate their magnetic behaviour at low temperatures.

**Description of Work:**

- Preparation of meteorites for <sup>57</sup>Fe Mössbauer Spectroscopy measurements;
- Carry out basic measurements of a meteorite's magnetic properties using ac-susceptibility;
- Obtain <sup>57</sup>Fe Mössbauer spectra over the temperature range 4–300 K;
- Analysis of the <sup>57</sup>Fe Mössbauer spectra, identification and quantification of the Fe-bearing phases present in the meteorite;
- Study the magnetic ordering of the nanoparticle Fe-oxides/hydroxides at low temperature.

<b>Project:</b>	<b><i>Fundamental magnetism and magnetocaloric effects in rare earth alloys and compounds</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr Wayne Hutchison ( <a href="mailto:w.hutchison@adfa.edu.au">w.hutchison@adfa.edu.au</a> )
<b>Objectives:</b> Rare earth intermetallic alloys such as RNiAl <sub>4</sub> (R = rare earth) have fundamentally interesting magnetic properties, including metamagnetism. Additionally, it has been discovered recently that the magnetic transitions in these alloys show large magnetocaloric effects, and could be the basis for refrigeration schemes. Rare earth compounds such as HoF <sub>3</sub> , an enhanced nuclear paramagnet also show potential for use in very low temperature refrigeration. This project will involve further fundamental study of such compounds in order to identify potential refrigerants and develop possible schemes for using such alloys.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Synthesis of alloys and compounds with characterisation by standard techniques such as x-ray diffraction;</li> <li>• Carry out measurements to characterise magnet materials using a number of appropriate techniques including heat capacity, magnetisation and susceptibility, neutron diffraction, and low temperature (millikelvin) nuclear orientation;</li> <li>• Select the most suitable materials for refrigeration in various temperature regimes. Develop and test prototype refrigeration schemes.</li> </ul>	

<b>Project:</b>	<b><i>Light-driven water flips in crystalline solids: science and applications in optical data storage</i></b>
<b>Program Code:</b>	1871, 1892
<b>Supervisor:</b>	Prof Hans Riesen
<b>Objectives:</b> The project aims to exploit our recent discovery of a thousandfold increase in the efficiency of non-photochemical spectral hole-burning upon partial deuteration of Cr <sup>3+</sup> doped NaMgAl(oxalate) <sub>3</sub> ·9H <sub>2</sub> O with the effect vanishing on complete deuteration. This observation is a significant discovery in hole-burning spectroscopy of inorganic systems in the solid state. The mechanism is based on photo induced 180° flips of the partially deuterated water molecules of crystallization. Importantly, the non-photochemical holes are stable up to 120 K and hence suitable for applications at liquid nitrogen temperatures.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Water flips induced by d-d and f-f transitions of one or more of the transition</li> </ul>	



metal and lanthanide ions in inorganic hydrates will be explored by hole-burning spectroscopy. Because of their low electron-phonon coupling, f-f transitions are prime candidates for higher temperature hole-burning materials.

- The dependence of spectral hole-burning properties, such as quantum efficiency and spontaneous hole-filling on: structural details, the temperature, the potential barrier height, rotational tunnelling splittings, external electric and magnetic fields and the degree of deuteration, will be investigated in a range of selected compounds.
- The potential of the selected materials as the active media in portable frequency standards, in laser stabilization schemes and in optical data storage and signal processing devices will be explored.

<b>Project:</b>	<b><i>Magnetic resonance and silicon based quantum computing</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr Wayne Hutchison ( <a href="mailto:w.hutchison@adfa.edu.au">w.hutchison@adfa.edu.au</a> )
<b>Objectives:</b>	
The general aim of this project is the use of magnetic resonance, directly, to measurements on spin systems which have application as spin based quantum computers (QC). The technique is also applied to investigations of the principal materials and fabrication processes. The emphasis is on electron spin resonance (ESR) studies of the phosphorus in silicon (Si:P) system. But will also have scope to include low temperature nuclear magnetic resonance applied to radioactive probes.	
<b>Description of Work:</b>	
<ul style="list-style-type: none"> <li>• Use of continuous wave and pulsed electron spin resonance techniques to study spin dynamics and materials issues in silicon doped with n - type impurities such as phosphorus;</li> <li>• The studies will involve both bulk doped and ion implanted samples, as well as the fabrication of devices on a submicron scale;</li> <li>• Low temperature (millikelvin) nuclear orientation and nuclear magnetic resonance will be applied to beta-ray emitting <math>^{32}\text{P}</math> in these systems to study and manipulate nuclear spin polarisation.</li> </ul>	

<b>Project:</b>	<b><i>Predicting wear and pre-empting knee prosthesis failure: a multidisciplinary study</i></b>
<b>Program Code:</b>	1892
<b>Supervisor:</b>	Dr Laura Gladkis ( <a href="mailto:l.gladkis@adfa.edu.au">l.gladkis@adfa.edu.au</a> ), A/Prof Heiko Timmers, and Prof Paul Smith, ANU School of Medicine)
<b>Description of Work:</b>	
Total Knee Replacements are increasingly being performed on younger, and more active, people for whom the rate of revision due to wear is more than double that of traditional populations. The proposed study will utilize a state-of-the-art mechanical knee simulator to examine the effects of prosthesis malalignment and high demand activity on wear. Wear dynamics will be assessed using a novel system of highly sensitive radioisotope labelling. Bioactivity of the wear debris will be evaluated via a novel assay system. The resultant knowledge will potentially increase the longevity of total knee prostheses and reverse the trend of increasing revision rates.	

<b>Project:</b>	<b><i>Samarium activated storage phosphors for personal radiation monitoring and medical imaging.</i></b>
<b>Program Code:</b>	1871, 1892
<b>Supervisor:</b>	Prof Hans Riesen
<b>Objectives:</b>	
The project aims to exploit our recent discovery of a novel class of X-ray storage phosphors. In particular, nanocrystalline $\text{BaFCl:Sm}^{3+}$ is an efficient photoluminescent	

storage phosphor with a mechanism that is based on the reduction of  $\text{Sm}^{3+}$  to  $\text{Sm}^{2+}$  upon exposure to ionising radiation. The objectives of this project are to enhance the sensitivity of the phosphor by optimising the preparation methods and testing of the phosphor for personal radiation monitoring and medical imaging. The importance of the former has been highlighted by the recent events in Fukushima, Japan. The phosphor may allow a reduction of X-ray dose in medical imaging, a highly desirable outcome.

**Description of Work:**

- A range of different preparation routes will be investigated in order to optimise the sensitivity of the storage phosphor
- The dependence of the sensitivity as a function of particle size, samarium concentration and co-doping by other metal ions will be investigated.
- The phosphors will be investigated by advanced laser spectroscopy, synchrotron based powder X-ray diffraction and X-ray absorption and electron microscopy.
- The potential of the phosphor in personal radiation monitoring, clinical dosimetry and medical imaging will be explored. This includes building reader units, employing LEDs and lasers, for dosimetry and medical imaging.

**STATISTICS**

<b>Project:</b>	<b><i>Analysis of recovery/recapture data for Short-tailed Shearwaters Puffinus tenuirostris</i></b>
<b>Program Code:</b>	<i>1881</i>
<b>Supervisor:</b>	<i>Dr Leesa Sidhu (<a href="mailto:L.Sidhu@adfa.edu.au">L.Sidhu@adfa.edu.au</a>)</i>
<b>Description of project:</b> Short-tailed Shearwaters have been studied continuously on Fisher Island, Tasmania since 1946, making this one of the longest continuous studies of any wildlife population in the world. Although life-history data have been collected sporadically over this time period, a detailed mark-recapture-recovery analysis has not yet been conducted. This study will produce age- and time-varying survival estimates for Short-tailed Shearwaters, and examine the effect of individual covariates such as egg size on first year survival.	