

University of Southern Queensland  
Faculty of Engineering and Surveying

**Project Topics for Prospective Postgraduate Research Students**

**Agricultural, Civil and Environmental Engineering**

<b>Project Description</b>	<b>Staff Member(s)</b>	<b>Email</b>
<p><b>Title:</b> Lean construction – understanding potential through contracting strategies</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Lean management is a common-sense proposition for achieving more with less with benefits to all parties through waste minimisation and generation of value. Inspired by success in the manufacturing industry, construction has awakened to the challenge of learning from the manufacturing industry whilst adapting to the needs of the construction industry.</p> <p>In traditional contracting, ‘value’ is generally believed to be achieved through competitive tendering though saddled with adversarial contractual relationships between different parties from time to time. Such problems seem to climax in complex projects with diminishing value to stakeholders. Consequently, a new contractual relationship has evolved wherein parties enter into pain-share and gain-share arrangements in ‘alliance contracting’. Yet, initial investigations reveal that the potential of lean-philosophy has not been realised in either traditional or alliance contracting. As such, the purpose of this study is to investigate how its potential could be realised through contracting strategies.</p>	Dr Vasantha Abeysekera	<a href="mailto:Vasantha.abeysekera@usq.edu.au">Vasantha.abeysekera@usq.edu.au</a>
<p><b>Title:</b> Strategies for managing capital works arising from natural disaster from a lean perspective</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The recent disasters in Queensland, Australia have affected many Australians lives, and caused considerable damage to property and infrastructure. The recovery and repair process is already underway with significant challenges on how best to commission and implement associated capital works. This study investigates this problem in depth from a construction project management perspective with the intention of developing a generic project management framework for rapid deployment of resources and completion of projects from a lean perspective where waste is eliminated and value is enhanced.</p>	Dr Vasantha Abeysekera	<a href="mailto:Vasantha.Abeysekera@usq.edu.au">Vasantha.Abeysekera@usq.edu.au</a>

<p><b>Title:</b> Behaviour of innovative fibre composite structures for structural applications</p> <p><b>Available for Major/s:</b> Civil Engineering/Structural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>During the past two decades, there has been considerable activity in research and development of fibre composites in Australia and internationally, for application of civil infrastructure. Areas of activity have includes innovative bridge systems, replacement of large section hardwood girders, development of marine structures. The R&amp;D work at USQ has involved not only the initial concept development but also the construction and deployment of full-scale prototypes. Through close involvement with major asset owners including state road and rail authorities and city councils, these technologies have evolved from initial technology demonstrators to become viable technical alternatives to traditional structural solutions. USQ’s Research breakthroughs have received international acclaim and it is now widely recognised as Australia's leading composites research and development group.</p> <p>It is important to understand the behaviour of fibre composite structures for different applications, so that the design could be optimised and cost could be reduced. This research project will be carried out within the Centre of Excellence in Engineered Fibre Composites (CEEFC), with potential industry partner involvement. CEEFC is one of the Research Centres at USQ, which plays a leading role in the research and development of fibre composites in engineering infrastructure. This research will include experimental and analytical investigations of innovative composite structures. The outcome of this study can enhance the understanding of the materials behaviour and develop appropriate design methodology with such structures that would greatly benefit the fibre composite industry.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>To conduct this research, very good knowledge of undergraduate/postgraduate courses related to Structural Engineering, mechanics of structures and Structural Analysis is required. The research will consist of experimental and analytical studies. Experience in conducting laboratory testing (materials and structures) and familiarity with finite element modelling (including usage of appropriate software) will be advantages.</p>	<p>Assoc Prof Thiru Aravinthan</p>	<p><a href="mailto:aravinthant@usq.edu.au">aravinthant@usq.edu.au</a></p>
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<p><b>Title:</b> Behaviour of structural rehabilitation using external post-tensioning</p> <p><b>Available for Major/s:</b> Civil Engineering/Structural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Strengthening of existing structures such as bridges, buildings and other infrastructure has become an important issue for the civil and structural engineers. External post-tensioning is considered as one of the most appropriate techniques for strengthening and rehabilitation of the existing structures. While the external post tensioning could be effectively used for the flexural strengthening of existing structures, recent studies shows the efficiency of the strengthening using external post tensioning is significantly reduced by the existing cracks. The effect of the existing cracks in an externally post tensioned reinforced concrete structure is a complex function depends on a number of parameters including the nature of the crack, concrete strength, amount of reinforcement and prestressing force.</p> <p>It is important to understand the behaviour of structural rehabilitation using external post-tensioning, so that the rehabilitation could be optimised and cost could be reduced. This research project will include experimental and analytical investigation of structures strengthened by external post tensioning. A comparison of existing design models and prediction equations will also be made. The outcome of this study can enhance the understanding of the behaviour of externally post-tensioned structures and develop appropriate design methodology for structural rehabilitation.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>To conduct this research, very good knowledge of undergraduate/postgraduate courses related to Structural Engineering, mechanics of structures and Structural Analysis is required. The research will consist of experimental and analytical studies. Experience in conducting laboratory testing (materials and structures) and familiarity with finite element modelling (including usage of appropriate software) will be advantages</p>	<p>Assoc Prof Thiru Aravinthan</p>	<p><a href="mailto:aravinthant@usq.edu.au">aravinthant@usq.edu.au</a></p>
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<p><b>Title:</b> Nutrient removal of wastewater using microalgae for potential biofuel recovery</p> <p><b>Available for Major/s:</b> Civil/ Environmental/ Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Nutrient removal from wastewaters has been traditionally achieved by activated sludge. But, in recent years, microalgae have been exploited for simultaneous nutrient removal from wastewaters and fatty acid production for use as bio-fuel. There are limited studies available on algae production using piggery, dairy and municipal wastewater, however, the optimization of lipid production is yet to be done. Besides, the growth rates of algae in different wastewaters and potential lipid production have not been fully established. This project looks into the optimization of algal growth for maximum extraction of oils by giving environmental stress to the desired algal species in different wastewaters. It involves construction of lab-scale batch reactors, followed by continuous photo bioreactors with innovative membrane technology for algal growth and subsequent harvesting for extracting oil.</p>	<p>Dr Vasantha Aravinthan</p>	<p><a href="mailto:aravintv@usq.edu.au">aravintv@usq.edu.au</a></p>
<p><b>Title:</b> Study of domestic water end use using smart metering system</p> <p><b>Available for Major/s:</b> Civil/ Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The prolonged drought we are experiencing currently poses great challenges to water authorities to provide potable water for the communities in a sustainable manner. Toowoomba City Council is implementing several demand management programs aiming to reduce the demand on potable water supplies. These measures include resorting to higher levels of water restrictions, offering rebate for those switching on to water saving appliances and installation of rainwater tanks etc. However, in order to achieve maximum savings in residential water consumption, the knowledge of where the potable water is used most is essential for planning and modelling purposes. This will also enable the council to take informed decisions targeting the demand management programs to those water events that consume high volume of potable water. This project involves establishing a water end use analysis using the data from smart metering system.</p>	<p>Dr Vasantha Aravinthan</p>	<p><a href="mailto:aravintv@usq.edu.au">aravintv@usq.edu.au</a></p>

<p><b>Title:</b> Control strategies for public transport operation in regional cities</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Many larger regional cities throughout the world are struggling to develop strategies which will allow the cost effective development of public transport facilities which are attractive to users in regard to both accessibility and cost. The acquisition of new, dedicated right-of-ways in existing areas is usually difficult, expensive and socially disruptive and so authorities often seek to develop public transport services which can utilise the existing road or rail infrastructure (e.g. provision of bus services). However the operation of such services is frequently hampered by the limitations of the existing networks and users perceive little advantage and less flexibility in public transport use than using private vehicles. Although some strategies have been developed which give some priority to public transport (e.g. dedicated bus lanes on major roads), the competition between public and private transport for use of the network frequently limits the effectiveness of the public transport operation.</p> <p>The proposed work will seek to investigate new ways of controlling both the public and private transport use of existing networks to provide competitive public transport services. It is envisaged that such control might be brought about by user pricing strategies as well as physical vehicle controls, and achieving this throughout both major and minor segments of the network to ensure an integrated overall approach.</p>	<p>Prof Ron Ayers Dr Soma Somasundaraswaran</p>	<p><a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a> <a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a></p>
<p><b>Title:</b> Road maintenance needs assessment for low traffic roads</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Most road networks consist of a few major roads carrying the majority of the traffic volume, and a larger number of minor roads carrying low traffic volumes. Rehabilitation and maintenance expenditure is predominantly directed to the major roads in order to provide the greatest value for money. Maintenance assessment for minor roads is often given only cursory consideration due to the sparse funds available for this aspect of a road authority's works.</p> <p>Within any road authority's road network there is likely to be a large diversity in the design standards and uses of the minor roads. Whilst traffic factors are the major determinants of performance for major roads, the factors affecting minor road performance are many and varied. It is therefore difficult for a road authority to optimise maintenance planning and expenditure for its minor road network, particularly as lack of funding is usually a concern.</p> <p>The proposed work will seek to investigate the problems involved in effectively planning road maintenance work for low traffic roads. The study will seek to develop effective and economic methods for a road authority to assess and program its minor roads' maintenance task.</p>	<p>Prof Ron Ayers Dr Soma Somasundaraswaran</p>	<p><a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a> <a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a></p>

<p><b>Title:</b> Pavement material stabilisation for low rainfall areas</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Subbase and basecourse pavement layers for minor roads are usually composed of naturally occurring gravels or crushed rock. Crushed rock is generally a more expensive option than naturally occurring materials due to the need for drilling, blasting and crushing. Naturally occurring gravels have been widely used in the past but in many areas supplies of suitable materials is now dwindling. An alternative pavement material is the use of a non-standard natural material which can be improved to specification levels by stabilisation with an added material.</p> <p>Commonly used stabilisers are lime and cement but the use of either of these materials in the stabilisation process means that a reasonable supply of fair quality water is needed. This can be a problem in arid areas where water may have to be hauled long distances, resulting in a prohibitively high cost of the stabilisation work.</p> <p>The proposed work will investigate the possibility of new forms of stabilisation, or alternate stabilisation techniques, which may be able to be used with a minimal amount of water, or lower quality water than that needed for cement or lime stabilisation. It is envisaged that the work will require substantial laboratory investigation to verify the feasibility of the new materials and or techniques.</p>	<p>Prof Ron Ayers Dr Soma Somasundaraswaran</p>	<p><a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a> <a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a></p>
<p><b>Title:</b> Fracture toughness of lattice materials</p> <p><b>Available for Major/s:</b> Mechanical/Civil/Materials PhD</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Honeycombs are lattice materials that are used extensively in aerospace and marine industries along with infrastructure and sports goods industries, because of their high stiffness and strength to weight ratios. Apart from the stiffness and strength, the fracture toughness of lattices is equally important as it can cause catastrophic failures, especially for brittle lattice materials. In this work, the fracture toughness of brittle lattice materials will be experimentally measured. In parallel, theoretical and numerical methods (finite element approach) will be used/developed for predicting the lattice fracture toughness.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>A good mechanics/material science background is required.</p>	<p>Dr Sourish Banerjee</p>	<p><a href="mailto:Sourish.Banerjee@usq.edu.au">Sourish.Banerjee@usq.edu.au</a></p>

<p><b>Title:</b> Bio-inspired tough hybrid graphene-based polymer composite</p> <p><b>Available for Major/s:</b> Mechanical/Civil/Materials PhD</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The addition of small amount of graphene nanoplatelet reinforcement in polymer significantly increases the stiffness and strength of polymeric nanocomposites. If the matrix is brittle, for example, epoxy resin, toughness does not improve significantly with reinforcement. Inspired by biological materials, the aim of this work is to produce a hybrid graphene based epoxy with an improved toughness and damage tolerance. Theoretical and numerical methods will be employed to understand the fracture mechanisms of hybrid composite and develop the predictive capability.</p>	<p>Dr Sourish Banerjee</p>	<p><a href="mailto:Sourish.Banerjee@usq.edu.au">Sourish.Banerjee@usq.edu.au</a></p>
<p><b>Title:</b> Combining the concepts of ‘Precision Agriculture’ and ‘Precision Livestock Farming’ to promote pasture utilisation and production return by grazing ruminants</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The overall aim of this research would be to use grazing animals as the indicator of pasture quality. This will be achieved by measuring animal movement as well as soil and plant composition of the pasture in order to determine the variability across the paddock. Results will be a more efficient usage of the pasture via the appropriate application of spatial operations. The specific objectives of this research are:</p> <ul style="list-style-type: none"> <li>• To monitor the animal movement on a pasture to determine areas of preferred grazing.</li> <li>• To establish differences in soil and plant composition between the preferred and avoided pasture areas and, thus, establish reasons for the animal’s avoidance of certain areas</li> <li>• To utilise the gathered information to reach a more efficient usage of the pasture by applying spatial operations.</li> <li>• To repeat these trials on the same pasture after the application of spatial operations in order to monitor changes in animal movement behaviour, soil and plant composition.</li> </ul> <p>The proposed project will advance the current understanding by analysing the soil and plant compositions in the grazed and ‘non-grazed’ areas to understand the preferential movement of the herd. This information shall then be utilised for spatial operations aiming to increase the pasture productivity and to develop more sustainable pastures and management systems.</p> <p>The research will be conducted externally as on-farm research. Other facilities, such as laboratories for soil or plant sampling, are available on the university campus in Toowoomba.</p>	<p>Dr Thomas Banhazi</p> <p>Dr Troy Jensen</p>	<p><a href="mailto:Thomas.banhazi@usq.edu.au">Thomas.banhazi@usq.edu.au</a></p> <p><a href="mailto:troy.jensen@usq.edu.au">troy.jensen@usq.edu.au</a></p>

<p><b>Title:</b> Use of a mobile phone as a precision agricultural tool in developing countries.</p> <p><b>Available for Major/s:</b> Agricultural/ Civil/ Computer systems / GIS/ Electrical/ Environmental/ Instrumentation and Control/ Mechanical/ Mechatronic/ Power/ Software/ Surveying</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The implementation of precision farming in the developing world through imposition of modern precision farming technologies is unlikely to work. There are two areas of development that is considered critical to promote adoption of precision farming in developing countries. Firstly, it is about bringing awareness about the value of on-farm and spatial knowledge already possessed by the small subsistence farmers of the developing nations. Secondly, it focuses on the development of technological aid that is practical and affordable to the farmers and yet complements with the existing mainstream technological advancement of the developing countries. Here the suggestion is towards further development of mobile phones to accommodate easy to use spatial information features that would have application in developing countries.</p>	<p>Dr Badri Basnet</p> <p>Dr Troy Jensen</p>	<p><a href="mailto:badri.basnet@usq.edu.au">badri.basnet@usq.edu.au</a></p> <p><a href="mailto:troy.jensen@usq.edu.au">troy.jensen@usq.edu.au</a></p>
<p><b>Title:</b> Root zone interactions as influenced by the application of lime and lime/gypsum combinations to sodic soils with mildly to highly alkaline pH</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Sodicity is caused by an abundance of excess exchangeable sodium on the clay face and affects 60 percent of soils worldwide (Tanji 1990). Consequently, these soils often become subject to dispersion upon wetting, resulting in an adverse soil environment for agricultural production. Estimated losses in Australian production due to sodicity are AUD\$1025 million (Hajkowicz and Young 2005). Calcium is known to stabilise the soil through exchange with sodium that causes clay repulsive forces to be overcome. Gypsum is the most common calcium based ameliorant used, but faces issues associated with efficiency and rate of dissolution. Lime is higher in calcium than gypsum, but considerably less soluble under standard conditions. There is a dearth of information pertaining to lime and rootzone interactions with regard to sodicity. Recent research highlights the possibility of using legumes to dissolve inherent soilborne carbonates via changes in dissolved carbon dioxide through increase soil solution partial pressure (Mubarak and Nortcliff 2010), while other research shows the possibility for a synergy between lime and gypsum where gypsum aids in the dissolution of lime through proton exchange (Valzano <i>et al.</i> 2001). However, many sodic soils are alkaline and do not lend themselves to dissolution of lime, or promote precipitation of calcium. This project will investigate the rootzone effects of legumes on applied lime and lime/gypsum combinations in sodic soils.</p>	<p>Dr John McLean Bennett</p> <p>Dr Ehsan Tavakkoli</p> <p>Prof Steven Raine</p>	<p><a href="mailto:john.bennett@usq.edu.au">john.bennett@usq.edu.au</a></p> <p><a href="mailto:Ehsan.tavakkoli@usq.edu.au">Ehsan.tavakkoli@usq.edu.au</a></p> <p><a href="mailto:steven.raine@usq.edu.au">steven.raine@usq.edu.au</a></p>

<p><b>Title:</b> Effect of irrigation by coal seam gas produced water on soil infiltration capacity under a sequential rain–irrigation system</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Growing attention to domestic energy production in Australia has resulted in the rapid development of a Coal Seam Gas (CSG) industry. The industry recovers natural gas (methane) from water-saturated coal seams. One key element crucial to the success of the CSG industry is the safe management of the saline and sodic water produced by CSG extraction. Currently irrigation of agro-forestry systems by CSG water is a key option for beneficial use. This project will address the current deficit of scientific knowledge in relation to the sustainable beneficial use of associated CSG water via irrigation. It is well recognized that the salinity of irrigation water and the sodium adsorption ratio (SAR), have an interactive effect on soil physical properties. However, most water quality criteria are based on short-term laboratory experiments with continuous water flow in packed soil columns. Information is lacking on suitable water quality criteria when waters of elevated SAR are irrigated under climatic conditions where rain events occur during the season. This project will be designed to test infiltration and hydraulic conductivity of the near surface horizons of soils from the sites that are irrigated with simulated CSG waters with differing EC and SAR levels and subjected to alternating rainfall.</p>	<p>Dr John McLean Bennett</p> <p>Mr Dan Rattray</p> <p>Prof Steven Raine</p>	<p><a href="mailto:John.Bennett@usq.edu.au">John.Bennett@usq.edu.au</a></p> <p><a href="mailto:steven.raine@usq.edu.au">steven.raine@usq.edu.au</a></p>
<p><b>Title:</b> Abiotic stress to plant growth in alkaline soils</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>High pH soils (&gt;8) occupy about 25% of the land area in Australia and about one third of the world soils are also alkaline. Problems commonly associated with alkaline soils include poor soil structure, low water infiltration capacity, nutrient deficiency and toxicity of Al, Fe and carbonate species. Studies on alkaline soil chemistry are very limited, particularly the investigations on different ionic species occurring at different pH values in the range of 8 to 11. This project aims to undertake a critical evaluation of different abiotic stresses to plant growth in relation to pH in the alkaline range in soils to classify these soils in relation to plant productivity and soil management. As well, while detailed studies on the reclamation of acid soils have been undertaken, reclamation of alkalinity is unknown in soil management. The project will investigate the reclaiming alkalinity techniques using chemicals, organic amendments, micro- biological methods or using plants that secrete acids in root exudates for the management of alkaline soils and their productivity.</p>	<p>Dr John McLean Bennett</p> <p>Prof Steven Raine</p>	<p><a href="mailto:John.Bennett@usq.edu.au">John.Bennett@usq.edu.au</a></p> <p><a href="mailto:steven.raine@usq.edu.au">steven.raine@usq.edu.au</a></p>

<p><b>Title:</b> Realising the potential of gypsum enhanced composted organic waste for land application</p> <p><b>Available for Major/s:</b> Agricultural/Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>World fertiliser demand has led to a search for alternative nutrient sources, with a particular interest being shown in composting of industrial and municipal organic wastes. While composted organic wastes have indeed shown merit as a nutrient source, they often contain high amounts of sodium that can lead to sodification of soil upon compost application and incorporation. This is of particular concern for sodic soils, where the application of composted organic waste that is high in sodium will exacerbate sodic conditions and result in nutrient losses through volatilisation and runoff. Applications of gypsum to soil prior or post compost application may alleviate the issue of sodicity, but this requires the application of two amendments. Furthermore, evidence suggests that the solubility of gypsum can be too high to adequately address sodicity when used in irrigated systems. Preliminary research in response to this has shown using short soil columns that there may be merit in incorporating gypsum into the compost as a source of calcium during the composting cycle for two reasons: 1) to address the inherent sodium from the organic waste source; and 2) to exchange calcium onto organic exchange sites within the composted organic waste thereby creating a slow release source of calcium. While the results of this research show that the soil structural condition was improved by gypsum enhanced compost to condition similar to, or better than, a corresponding application of gypsum alone, the true potential for a slow release calcium source was not realised. Also, the effects of enhancing compost with calcium on nutrient availability and composition were not investigated. Composting relies on microbial activity and organic acids to breakdown the organic waste material, thus making insoluble nutrients available. The effects of adding a calcium amendment into the composting cycle on microbial species, abundance and function is largely unknown.</p> <p>Hence there are opportunities to investigate:</p> <p>The potential of composted material organic exchange sites to enable a slow release source of calcium for soil</p> <ul style="list-style-type: none"> <li>• The effects of gypsum addition to compost on microbial species, abundance, and function</li> <li>• Changes in composted material nutrient availability as influenced by gypsum enhancement and the ensuing nutrient movement and solute accumulation</li> </ul>	<p>Dr John McLean Bennett</p> <p>Dr Vasantha Aravinthan</p>	<p><a href="mailto:john.bennett@usq.edu">john.bennett@usq.edu</a></p> <p><a href="mailto:aravintv@usq.edu.au">aravintv@usq.edu.au</a></p>
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<p><b>Title:</b> Irrigation water quality and soil structure</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>About 35% of total land area in Australia is affected by different categories of salt-affected soils. Apart from natural salinity, a significant proportion of the cultivated land has become saline due to irrigation, particularly when groundwater or recycled waste waters were used. Recent reports draw attention to elevated concentrations of potassium (K) and/or magnesium (Mg) in some soils which arise naturally and also as a result of increasing irrigation with waste or effluent or recycled water in Australia. There is also a tendency in industries to use K or Mg salts instead of Na during recycling processes to prevent the increase in Na concentration in effluents. Long term application of such wastewaters may lead to build up of exchangeable K and Mg in soils which both can also cause effects similar to sodium, but has been neglected because of low amounts usually present in salt-affected soils. Therefore, there is a need to derive and define a new ratio of these cations in place of SAR, which will indicate the effects of Na, K, Mg and Ca on soil structural stability. This will be achieved using a formula analogous to the SAR but which selectively incorporates the dispersive effects of Na and K on the one hand with the flocculating effects of Ca and Mg on the other. This project aims to designs experiments for development of such a formula in relation to the cation ratio of soil structural stability and in comparison to SAR in soil solutions in their relationship to clay dispersion and soil hydraulic conductivity.</p>	<p>Dr John McLean Bennett Prof Steven Raine</p>	<p><a href="mailto:John.Bennett@usq.edu.au">John.Bennett@usq.edu.au</a> <a href="mailto:steven.raine@usq.edu.au">steven.raine@usq.edu.au</a></p>
<p><b>Title:</b> Urban flood forecasting by integration of spatial rainfall and Rational Method analyses</p> <p><b>Available for Major/s:</b> Civil, Spatial Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Flooding within urban catchments can occur quickly in response to rainfall, so the time available to retrieve hydrological data, conduct a flood forecasting analysis and issue a warning is often limited. Sophisticated methods of analysis are available, for example based on 1D or 2D flood hydraulic models, but these techniques are data intensive, relatively slow and complex. There is a need for simple and rapid methods of flood forecasting that can provide predictions of flood rise and timing to within acceptable levels of accuracy. Hydrological approaches based on the Rational Method show promise, providing that the computations are based on appropriate estimates of the areal rainfall within the catchment. This project will investigate methods to integrate spatial rainfall data, that may be in the form of distributed point rainfalls and/or weather radar mapping, and simple flood discharge techniques such as the Rational Method.</p>	<p>Dr Ian Brodie</p>	<p><a href="mailto:ian.brodie@usq.edu.au">ian.brodie@usq.edu.au</a></p>

<p><b>Title:</b> Effectiveness of stormwater runnon for discharge and pollution reduction</p> <p><b>Available for Major/s:</b> Civil, Spatial Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Runoff in urban areas during storms, predominately generated from impervious surfaces such as roads, can cause increased erosion, instability and water quality degradation within downstream waterways. The hydrological response of urbanisation is a rapid increase in stormwater discharge and pollution. Water Sensitive Urban Design (WSUD) provides a range of potential solutions to reduce the environmental impact of urban runoff. A WSUD technique that is emerging is the installation of level spreaders with vegetated filter strips (LS-VFS) located at stormwater outlets to redistribute runoff so it is less concentrated. This spreading of runoff over a vegetated area (typically a grassed surface within urban parkland) can be considered to be ‘stormwater runnon’ process.</p> <p>Minimal research has been done on the effectiveness of stormwater runnon in mitigating stormwater discharge and pollution. Depending on the Candidate, there are opportunities to research topics on:</p> <ul style="list-style-type: none"> <li>• Predictive models to estimate the efficacy of stormwater runnon systems</li> <li>• Field testing of key processes including infiltration and pollutant capture</li> <li>• Enhancements to current LS-VFS designs</li> <li>• Exploring other benefits of stormwater runnon including the passive irrigation of green open space</li> </ul>	Dr Ian Brodie	<a href="mailto:ian.brodie@usq.edu.au">ian.brodie@usq.edu.au</a>
<p><b>Title:</b> Innovative mechanical weed control using water jet</p> <p><b>Available for Major/s:</b> Agricultural / Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Weed control in the agriculture can be very costly to both the farmers and the environment. The aim of the project is to develop an innovative mechanical system using high pressure water jet to devitalise weed at harvest as part of an integrated weed management strategy for long-term control of weeds and herbicide resistance. Although water jets are currently being used in the manufacturing industry and the food processing sector as cutting tools, the potential of using water jets for weed control in agricultural fields is a new concept and has not received much research worldwide, and thus this topic offers extremely good potential for a promising PhD student for further research and innovation. The project will involve the following work: (1) Conduct on-farm and lab experimentations to determine the relationship between pressure requirement (impact force) and weed seed germination rate; (2) Identify possible designs concepts (3) Analyse concepts and develop a most effective (optimized) prototype, possibly using tools such as Computational fluid dynamics (CFD) software (4) Conduct a comprehensive assessment in terms of farm economics and environmental benefits.</p>	Dr Guangnan Chen	<a href="mailto:chengn@usq.edu.au">chengn@usq.edu.au</a>

<p><b>Title:</b> Environmental friendly composites made from natural renewable materials: Preparation, properties and their applications in civil engineering structures</p> <p><b>Available for Major/s:</b> Civil/Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Bio-resins are an emerging industrial technology derived from natural renewable components such as Plant-based Oils. Bio-resins can be obtained from the epoxidation of Vegetable Oils, which creates suitable laminating resins known as Epoxidized Vegetable Oils (EVO). This initial process can be followed by a 2<sup>nd</sup> chemical functionalization known as the acrylation process of the epoxidized oils, which generates the acrylated-type of bio-resins (AEVO). The current international interest on bio-resins stems largely from increasing regulation and public concern for a pollution-free environment and the need for sustainable alternatives to reduce the dependence on fossil fuels. The synthesized bio-resins can be used as the matrix of 100 % bio-composites with the application of Natural Fibbers such as Flax, Hemp, Bamboo or Jute fibres between others, used as natural reinforcement to the bio-composites. At the Centre of Excellence in Engineered Fibre Composites (CEEFC – USQ university, Australia) we have been working in the last 5 years on the development and characterization of bio-composites. The research work proposed for this PhD Project involves the use of natural and renewable resources such as Plant-based oils and renewable waste materials (such as Cashew Nutshell liquid) for the preparation of bio-resins and bio-composites. In this research project these new bio-composites will be evaluated for their thermo-mechanical properties and for their structural performance in civil engineering applications.</p> <p>All the experimental work of preparing the bio-resins and bio-composites, including testing, will be carried out in the laboratories of the CEEFC Centre (Building P 9) located here in the USQ university.</p>	<p>Dr Francisco Cardona</p>	<p><a href="mailto:francisco.cardona@usq.edu.au">francisco.cardona@usq.edu.au</a></p>
<p><b>Title:</b> Development of novel fibre and polymer reinforced engineered concrete composites</p> <p><b>Available for Major/s:</b> Civil/Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Concretes are heterogeneous materials, made up of aggregates and sand of different grain sizes dispersed in a brittle mineral cement binder of porous calcium silicate hydrates (CSH). The low tensile strength and poor fracture resistance of cement-based materials are serious shortcomings that not only impose constraints in structural design but also affect the long-term durability of concrete structures. One of the solutions has been the development of high performance concrete formulations (UHPC), which are mainly based on a drastic reduction of the water to cement ratio (w/c) with super-plasticizer additions to maintain a good workability, and the improvement of aggregates size and close packing with reactive fillers. But, whatever is the concrete mix design, the mechanical properties are limited</p>	<p>Dr Francisco Cardona</p>	<p><a href="mailto:francisco.cardona@usq.edu.au">francisco.cardona@usq.edu.au</a></p>

<p>because of the intrinsic brittleness of the hydrated cement phase. To address the challenge to develop new and improved high performance concrete in this Postgraduate Research Project is proposed to investigate the simultaneous effect of added hybrid fibers and of water-soluble polymers to the cementitious matrix of concrete. This Project will consider both micro-steel fibers and plastic fibers such as Polypropylene (PP) and polyvinyl alcohol (PVA) fibers to reinforce the cement paste. The reinforcing effect of the fibers will be combined together with the toughening effect of water-soluble polymers (such as Polyethylene glycol (PEG) and Polyvinylpyrrolidone (PVP) between others) to achieve the attractive attributes for reinforcing cementitious materials. Hybrid fiber reinforcement combines the advantages of both the fibers, i.e., the stiff short fibers of steel are combined with flexible plastic microfibers, and their interface adhesion to the cement matrix is enhanced by the presence of the water-soluble polymers. A significant improvement on the ductility, durability, carbonation resistance and the strength of the cement pastes and concrete are expected as a result of the combine effect of fibers and polymers.</p> <p><b>Suitability:</b> For ON-CAMPUS students only.</p>		
<p><b>Title:</b> Developing mathematical and physical models for Contaminated Land and Ground Water Remediation (CLGWR)</p> <p><b>Available for Major/s:</b> Environmental/ Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>As modern developments frequently overlie former industrial zones, decontamination of land and underlying groundwater is a common task for Geo-Environmental Engineers. Safe construction cannot take place above such zones until they are successfully decontaminated, usually at significant cost. Effective treatment whilst maintaining cost to a minimum represents a significant engineering challenge.</p> <p>Numerical modelling methods exist (eg. finite element analysis and computational fluid dynamics incorporating chemistry). These can be optimised according to the results from simple physical section models incorporating sand, gravel and non-permeable layers (silicone), in addition to data from full scale operations.</p> <p>Based on a number of geo-environmental numerical models as a starting point, the student will simulate and compare with real data, the process of ground decontamination via flushing. Refinement of these models, optimised and calibrated with real data, is essential for increased cost effectiveness of and management of CLGWR technology and processes. The student will be expected to become involved in some full scale decontamination operations, via a commercial operation or consultancy firm of their choice.</p>	<p>Dr Ian Craig Dr Jim Shiau</p>	<p><a href="mailto:ian.craig@usq.edu.au">ian.craig@usq.edu.au</a> <a href="mailto:jim.shiau@usq.edu.au">jim.shiau@usq.edu.au</a></p>

<p><b>Title:</b> Evaluation of coal dust monitoring procedures</p> <p><b>Available for Major/s:</b> Environmental/ Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Coal Dust Monitoring is being carried out by Toowoomba Regional Council in response to complaints by Toowoomba residents. The alleged source of the coal dust nuisance/health hazard is from trucks which travel through town on their way to the Port of Brisbane for export. Frequently, the trucks are inadequately covered (tarpred) to reduce dust pollution during travel.</p> <p>A number of different coal dust monitoring methods are available, and each has varying cost and advantages. A review of these methods is required, with a view to cost/efficacy optimisation. An Australian standard does exist which covers minimum procedures that should be followed. Any laboratory method used should ideally be able to distinguish between coal dust and other sources of carbon eg. diesel soot.</p> <p>This student/s will have the chance to become involved with the TRC Coal Dust Monitoring program, and assist TRC engineers and Dr Ian Craig with monitoring and analysis procedures.</p>	<p>Dr Ian Craig</p>	<p><a href="mailto:ian.craig@usq.edu.au">ian.craig@usq.edu.au</a></p>
<p><b>Title:</b> Simulation of travelling gun irrigation performance under non-quiescent conditions</p> <p><b>Available for Major/s:</b> Agricultural/ Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Travelling gun (big gun) irrigation machines are a prevalent irrigation method across the dairy and sugar cane production systems of northern Australia, and to a lesser extent in horticultural production systems across Australia.</p> <p>The on-going development, validation, and calibration of our existing computer simulation model, for application to a wider variety of travelling gun configurations under non-quiescent conditions is essential for the on-going performance improvement of these irrigation systems in the irrigation industry.</p> <p>This project seeks to improve the applicability of our existing simulation techniques for travelling gun irrigation machines when operating under windy conditions.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>There will be a necessity to travel to, and work independently in remote locations to obtain field data, and an Open class driver's licence would be deemed as essential. Experience with field data logging systems and pressurised water supplies would be beneficial. Ability to program and use a variety of simulation packages in a modern computing environment is essential.</p>	<p>Dr Joseph Foley</p> <p>Prof Rod Smith</p>	<p><a href="mailto:joseph.foley@usq.edu.au">joseph.foley@usq.edu.au</a></p> <p><a href="mailto:rod.smith@usq.edu.au">rod.smith@usq.edu.au</a></p>

<p><b>Title:</b> Measurement of evaporation during sprinkler irrigation</p> <p><b>Available for Major/s:</b> Agricultural/ Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Sprinkler irrigation is thought by many in the irrigation industry to be highly efficient yet many cotton growers cite inefficiency caused by high evaporation losses as a prime reason for not adopting centre pivot or lateral move machines. Evaporation from the sprinkler droplets during flight, and from the wetted canopy and soil surface are the major if not sole cause of inefficiency in sprinkler irrigation. However, opinions among irrigation researchers on the magnitude of evaporation losses vary across an enormous range, eg, 0.5 to 45%. One reason for this is the inability to measure evaporation and evaporation losses during sprinkler irrigation directly. Researchers have had to employ inference from measurements of other components of the water balance, using catch cans or lysimeters, where the accuracy of the techniques used can result in massive errors in the estimates of evaporation.</p> <p>Recent work at USQ has shown that the evaporation during sprinkler irrigation can be measured directly and accurately by use of eddy correlation (ECV) equipment mounted above the height of the sprinklers. Internationally, ECV has been used extensively above a wide range of crops and land uses to measure water use and evaporation but the use by NCEA above sprinklers during irrigation is unique. The system was tested above a sprinkler irrigated cotton crop grown at USQ during the 2010/11 season. This work suggests that the losses are smaller than often presumed, that direct evaporation from the sprinkler droplets in flight is very small, and that the dominant component of the evaporation during sprinkling is from the wetted canopy of the crop which also provides important cooling of the canopy.</p> <p>This USQ work has proven the technique but it now remains to be applied in the field to real irrigation systems to evaluate management implications and assess variability across different regions, irrigation systems and crop stages, in extensive and highly advective irrigated cropping scenarios.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>There will be a necessity to travel to, and work independently in remote locations to obtain field data, and an Open class driver's licence would be deemed as essential. Experience with field data logging systems and pressurised water supplies would be beneficial.</p>	<p>Dr Joseph Foley</p> <p>Md Jasim Uddin</p> <p>Prof Rod Smith</p> <p>Assoc Prof Nigel Hancock</p>	<p><a href="mailto:joseph.foley@usq.edu.au">joseph.foley@usq.edu.au</a></p> <p><a href="mailto:rod.smith@usq.edu.au">rod.smith@usq.edu.au</a></p> <p><a href="mailto:nigel.hancock@usq.edu.au">nigel.hancock@usq.edu.au</a></p>
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<p><b>Title:</b> Finding optimal reinforcement distribution using topology optimisation</p> <p><b>Available for Major/s:</b> Civil Engineering (available for both PhD and Master's level)</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In reinforced materials, such as reinforced concrete, finding the optimum reinforcement design is of critical importance. Topology optimisation methods can be used to find the optimal distribution of one material in a multi-material domain and thus can potentially be used to conceptualise the optimum layout of reinforcements in reinforced materials.</p> <p>This project investigates possible applications and limitations of topology optimisation techniques in reinforcement optimization. There are a number of complications which need to be addressed including non-linear behaviour of materials, material failure, and bonding between the materials.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>Solid understanding of finite element method          Computer programming skills          Good understanding of non-linear finite element method (PhD)</p>	<p>Dr Kazem Ghabraie</p>	<p><a href="mailto:kazem.ghabraie@usq.edu.au">kazem.ghabraie@usq.edu.au</a></p>
<p><b>Title:</b> Optimum design of structural frames subject to lateral loadings</p> <p><b>Available for Major/s:</b> Civil Engineering (available for both PhD and Master's level)</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Structural optimisation can be divided into three levels. Sizing optimisation seeks the optimal dimensions of members with fixed shapes. Shape optimisation finds the best shapes of boundaries of members. Topology optimisation seeks the best topology, connectivity, or layout of a system. In past two decades, considerable development has been achieved in topology optimisation area. Topology optimisation techniques are now used in a wide range of problems including structural design, synthesis of compliant mechanisms, material design, etc.</p> <p>In this project topology optimisation techniques will be applied to find the optimum design of structural frames subject to lateral loadings. Given the load, geometry, mechanical, and material constraints, an initial guess design is considered. This initial design is analysed using finite element method. Based on responses, the topology of the design is updated and a new design is proposed which is analysed and updated in the next iteration. This iterative procedure continues until a convergent solution is achieved.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>Solid understanding of finite element method          Computer programming skills</p>	<p>Dr Kazem Ghabraie</p>	<p><a href="mailto:kazem.ghabraie@usq.edu.au">kazem.ghabraie@usq.edu.au</a></p>

<p><b>Title:</b> Development of optimum passive energy dissipaters for mitigation of dynamic energy in structures</p> <p><b>Available for Major/s:</b> Civil/Mechanical Engineering (available for both PhD and Master’s level)</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In recent years many energy dissipating devices have been developed and implemented to enhance structural safety and serviceability against dynamic loads. The energy dissipation systems can be broadly categorised into passive, active, semi-active, and hybrid dissipation systems. Passive energy dissipaters generally mitigate the excitation using yielding of metals, frictional sliding, viscoelastic deformation of fluids, etc. Metallic yielding devices are particularly popular due to their low fabrication and maintenance cost, ease of installation, and high reliability. These devices are usually installed into the bracing systems or beam-column joints. When the input load reaches a certain level, the dissipating device will undergo plastic deformation consuming the input energy and preventing the main structure from fatal damage. This research aims to optimise the design of metallic yielding energy dissipaters to maximise their energy absorption.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>Solid understanding of non-linear finite element method Computer programming skills</p>	<p>Dr Kazem Ghabraie</p>	<p><a href="mailto:kazem.ghabraie@usq.edu.au">kazem.ghabraie@usq.edu.au</a></p>
<p><b>Title:</b> Sensor for remote detection of water advance for automation of surface irrigation</p> <p><b>Available for Major/s:</b> Agricultural Engineering/ Mechanical Engineering/ Electrical/Electronic Engineering/ Computer system Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Surface irrigation is the most common form of irrigation across the globe and is practiced on over 50% of the total irrigated area in Australia. Commonly termed “flood irrigation” this type of application is often inefficient potentially wasting hundreds of GL of Australia’s limited water supply each year. However, these systems can be highly efficient when designed and managed effectively.</p> <p>The National Centre for Engineering in Agriculture (NCEA) based at USQ plays a leading role in developing hardware and software tools to assist in improving the efficiency of irrigation. The centre is currently undertaking a project to develop an automated real-time control system for furrow irrigation as practiced by the cotton and grains industries. Commercial application of this system is reliant on the development of an effective method to remotely sense the wetting front as it moves down the field.</p> <p>The aim of this project is to investigate new techniques for remote sensing of the water front on the soil surface within the furrow. Existing sensors are installed within the field and hence are an inconvenience for other farm operations. Work to date has</p>	<p>Dr Malcolm Gillies</p>	<p><a href="mailto:malcolm.gillies@usq.edu.au">malcolm.gillies@usq.edu.au</a></p>

<p>suggested potential options such as machine vision detection of the water from webcam footage, analysis of infrared images or detection of the plant response to the presence of water. This project will involve development and testing of a prototype system(s) for deployment in the field.</p>		
<p><b>Title:</b> Precision agriculture opportunities in the Australian sugar industry</p> <p><b>Available for Major/s:</b> Agricultural/ Electrical/ Environmental/ Instrumentation and Control/ Mechanical/ Mechatronic</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>There are several specific areas of interest relevant to this topic. These include:</p> <p><b>1. Technologies for targeted management in sugar cane</b></p> <p>Technologies for targeted management (e.g. VRT, ground based sensing etc.) have not been used in the Australia sugar industry. Anecdotal evidence suggests that even applying a uniform rate of a particular product (e.g. granular fertiliser – particularly in tropical locations) does in fact result in a variable application. This topic would scope and evaluate the current state of play and assess and evaluate relevant technologies and quantify their impact on production and returns to sugarcane farmers.</p> <p><b>2. Opportunities in harvester research</b></p> <p>Mechanical harvesting of sugarcane has been a major success story for the Australian sugar industry. However, the Australian sugarcane industry has suffered a plateau in productivity (Wilson and Leslie 1997) and there is considerable evidence that mechanisation is a component of this plateau in performance. A recent review of opportunities to improve the performance of sugarcane harvesters by Davis et al. (2010) highlighted the harvesting issues confronting industry and the rationale for future industry funded harvesting R&amp;D. Based on this review, there are four main objectives in this project.</p> <ul style="list-style-type: none"> <li>• Build industry capacity in harvesting best practice and new harvesting technologies</li> <li>• Package existing knowledge on harvesting best practice and provide a mechanism for ongoing review</li> <li>• Implement a program of collaborative harvesting systems R,D and E with a focus on monitoring tools and protocols; performance assessment; machine design and harvesting best management practise (BMP)</li> </ul>	<p>Dr Troy Jensen</p>	<p><a href="mailto:troy.jensen@usq.edu.au">troy.jensen@usq.edu.au</a></p>

<p><b>Title:</b> Improvements in the handling and processing of pecan and macadamia nuts.</p> <p><b>Available for Major/s:</b> Agricultural/ Electrical/ Environmental/ Instrumentation and Control/ Mechanical/Mechatronic</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>There are several specific areas of interest relevant to this topic. These include:</p> <ol style="list-style-type: none"> <li><b>1. Drop analysis of pecan and macadamia nuts in the production chain.</b></li> </ol> <p>The quality of the shelled nut is being lost due to bruising and damage that has occurred due to impact with hard surfaces in the production system. The challenge of this project is to monitor the situation to determine where this is occurring and modify the system to remediate this problem.</p> <ol style="list-style-type: none"> <li><b>2. Evaluating the drivers of brown centring in macadamia nuts</b></li> </ol> <p>Brown centring in macadamia nuts is caused by inappropriate drying conditions. The objective of this research would be to determine what the correct drying parameters are for macadamia nuts and implement these changes in a commercial operation.</p> <ol style="list-style-type: none"> <li><b>3. Pecan harvester assessment</b></li> </ol> <p>Considerable time and effort is expended on-farm in the harvesting operations of pecan nuts. Nut, leaf litter, twigs and larger pieces of branches are all processed by the harvester. The efficiency of the harvester to separate the nuts from non-nut determines how much superfluous material remains with the nuts prior to entering the drying facility. Depending on the quality of the sample, additional effort may be expended screening the residual material prior to it being sent off to the processor.</p> <p>By improving the nut retrieval process by optimising the cleaning fan performance, it is hoped that a much cleaner and more repeatable sample can be produced by the harvester, minimising the post-harvest handling of non-nut material resulting in lowered labour and operating costs.</p>	<p>Dr Troy Jensen</p>	<p><a href="mailto:troy.jensen@usq.edu.au">troy.jensen@usq.edu.au</a></p>
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<p><b>Title:</b> Determining crop tolerance to salinity stress using electromagnetic induction sensor (EM38)</p> <p><b>Available for Major/s:</b> Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Salinity tolerances of crops have seldom been determined by field experiments because of the variability of saline soils. In the traditional field plot experiments the crop is grown on a uniform or near uniform site. The spatial variability of saline soils makes it difficult to select a uniformly saline site for field plots. Much of the data on salinity tolerance has been obtained from plants growing in controlled experiments in sand cultures in greenhouses or using lysimeters. These sand cultures are often salinised by circulating the concentration of saline solution required to provide the level of salinity desired. The salinity tolerances determined in these sand cultures or lysimeters differ from the salinity tolerances a farmer encounters in the field. The electromagnetic induction meter permits rapid collection of soil salinity information in the field. The project aims to determine the salinity tolerance of crops by mapping of soil salinity on a partially saline field with an EM38 meter and yield is mapped using a yield monitor on a combine, both techniques use GPS. Then, a relationship between salinity and yield can be determined. Also, given that EM38 readings are influenced by soil temperature, moisture and texture, the project aim to develop a calibration system to isolate the contribution of these parameters.</p>	<p>Dr Troy Jensen</p> <p>Mr Dan Rattray</p> <p>Prof Steven Raine</p>	<p><a href="mailto:troy.jensen@usq.edu.au">troy.jensen@usq.edu.au</a></p> <p><a href="mailto:steven.raine@usq.edu.au">steven.raine@usq.edu.au</a></p>
<p><b>Title:</b> Structural behaviour of composite hybrid beams made from recycled plastics and FRP rebars</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Recycling waste polymeric materials such as plastic bags, plastic bottles and using these materials as the major constituent component of any construction materials will have a very positive impact on both environment and energy conservation. In this project, service and ultimate behaviour of recycled low-density polyurethane (LPDE) beams made from recycled plastics and reinforced with FRP (such as fibre glass) rebars are investigated. These hybrid beams can be used as impact protection systems in many engineering applications. Few examples of possible uses of them as impact protection systems are in bridge piers, fort jetties, car parks and road side construction projects.</p> <p>Finite element method based numerical models will be developed to predict non-linear structural behaviour and energy absorption capability of these hybrid beams. Developed models will be verified using recent experiments results from a large experimental program. Verified numerical models will be used to predict the behaviour of different size beam configurations for relevant applications.</p>	<p>Assoc Prof Karu Karunasena</p>	<p><a href="mailto:Karu.Karunasena@usq.edu.au">Karu.Karunasena@usq.edu.au</a></p>

<p><b>Title:</b> Rehabilitation of old timber structures using external fibre composite reinforcements</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>There are many timber bridges around world needing rehabilitation of their old deteriorating timbers girders. In order to repair old timber structures, a suitable rehabilitation technique is required. A rehabilitation method that is getting attention in civil engineering applications recently involves bonding sheets (or bars) of fibre reinforced polymer (FRP) to the tensile face and sides of the affected beam member to improve its bending and shear strength and deflection characteristics. Fibre-reinforced polymer (also known as fibre-reinforced plastic) has been in use as a structural material since 1940s but only recently civil engineers started focusing more attention on this material due to its useful properties such as high strength, corrosion resistance and long term durability.</p> <p>This project involves the investigation of structural behaviour of FRP reinforced beams. Suitable analytical and numerical models will be developed to predict the bending, shear, deflection and buckling behaviour FRP rehabilitated beams with due consideration given to non-linear material behaviour of timber and linear behaviour of most FRPs. The model will be validated using available experimental results. An extensive numerical parametric analysis based on the finite element method will be carried out to show the influence of key parameters such as FRP area, FRP type and FRP layup sequence on the structural behaviour of rehabilitated beams.</p>	<p>Assoc Prof Karu Karunasena</p>	<p><a href="mailto:Karu.Karunasena@usq.edu.au">Karu.Karunasena@usq.edu.au</a></p>
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<p><b>Title:</b> Structural behaviour of composite hybrid beams/slabs made from lightweight sandwich panels based on wood veneer, fibreglass and phenolic core</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>A composite sandwich structure fabricated by attaching two thin but stiff skins to a lightweight but high strength thick core can serve as a building block for constructing laminated structural sandwich composites for building and other structural applications in civil engineering field. The main advantage of using the composite sandwich concept is that the resulting structure has high bending stiffness and high strength to weight ratio. At USQ, a new generation composite sandwich panel made up of glass fibre reinforced polymer skins and lightweight but high strength phenolic core material has been developed specifically for civil engineering applications and their mechanical behaviour has been investigated thoroughly. Although, this panel is much lighter than steel or concrete, it would be desirable if even lighter panel suitable for structural applications can be developed.</p> <p>At the University of Auckland's Centre for Advanced Composite Materials (CACM), a variety of novel naturally sourced materials have been developed. Recently, a wood veneer-based light weight sandwich panel has been developed for high-end non-structural interior applications. This panel consists of a corrugated and/or honeycomb made core made from thin plywood veneer and natural fibre-reinforced thermoplastic. The skins are also from made from the same material. Due to the corrugated or honeycomb structure of the core, this sandwich is much lighter than plywood veneer. The mechanical properties of this sandwich material have been thoroughly studied.</p> <p>In a collaborative project with USQ and CACM, it is proposed to study the structural behaviour of new hybrid sandwich beams/slabs made by combining the two innovative panels developed at their respective places. Different cross-sectional designs involving flatwise and edgewise arrangements will be considered in numerical model analyses. Bending, buckling and vibration behaviour of the beams/slabs will be investigated using a standard finite element software package such as Strand7. Attention will also be focussed on the effect of debonding of the core from the skin as well as debonding at the glue line between panels on the structural behaviour, as this is a potential problem in sandwich panels.</p>	<p>Assoc Prof Karu Karunasena</p>	<p><a href="mailto:Karu.Karunasena@usq.edu.au">Karu.Karunasena@usq.edu.au</a></p>
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<p><b>Title:</b> Structural performance of expanded polystyrene sandwich panels</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The use of sandwich panels in structural wall systems, slabs and roofs is popular due to their lightweight, cost effectiveness and thermal insulation capability. Aim of this research is to study the structural behaviour of Expanded Polystyrene (EPS) sandwich panels. They are made of expanded polystyrene core and steel wire meshes on either side of the core and cement mortar as the outer layer on both sides of the panel. Normally a thicker panel with stiffer face and higher core density is more advantageous as it will give more flexural and shear rigidity. . However panels have to be lightweight too. Panels with fixed core density and different mortar thicknesses can be tested for elastic modulus and shear modulus. Using the experimental results for both large and small panels, the results could be produced in a more generalised form by eliminating the size effect. By analysing the test results, optimum panel design with optimum core and panel thickness for stiffness and minimum density can be found. These panels would be ideal for structural applications especially in developing countries.</p>	<p>Dr Weena Lokuge</p>	<p><a href="mailto:weena.lokuge@usq.edu.au">weena.lokuge@usq.edu.au</a></p>
<p><b>Title:</b> Behaviour of geopolymer concrete with recycled concrete aggregate</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>With increased attention on environmental concerns such as global warming, sustainable development and recycling, alternatives for conventional concrete such as geopolymer concrete have been researched around the world. Geopolymer concrete is proven to have good engineering properties with a reduced carbon footprint. Geopolymers not only reduce the greenhouse gas emission but also use a large amount of industrial wastes such as fly ash and slag. If normal aggregate in geopolymer concrete can be replaced by recycled concrete aggregate, it will lead to potential environmental and economic benefits as the recycled concrete from construction and demolition sites will end up in landfill sites otherwise. This research proposes to investigate the behaviour of fly ash based geopolymer concrete. It is documented that geopolymer concrete normally exhibits higher shrinkage values. Furthermore Australian standard for Concrete structures, AS3600 does not cover the design parameters for geopolymer concrete. So it is a timely concern to investigate the impact of recycled concrete aggregate on the properties of geopolymer concrete. An experimental program will be organised to observe the mechanical properties and structural performances of geopolymer concrete with normal aggregates and recycled aggregates.</p>	<p>Dr Weena Lokuge</p>	<p><a href="mailto:weena.lokuge@usq.edu.au">weena.lokuge@usq.edu.au</a></p>

<p><b>Title:</b> Use of polymer concrete in structural applications</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Polymer concrete (PC) has gained increased popularity in the construction industry in applications where high strength, speedy curing and durability are of paramount important. It was first developed in 1950s and became popular since 1970s and today it is applied in many precast elements in buildings, bridge panels, machine bases etc. Compared to cement based concrete, PC is stronger, more durable and most importantly greener sustainable material. However, it is more expensive than cement based concrete. It is important to find ways to minimise the cost associated with PC so that this highly desirable material can be used extensively in the construction sector. At the same time the mechanical properties and structural performance of members made of this material is not nationally accepted at the moment. The use of fly ash as the filler (which would otherwise be ending up in landfill), recycled plastic waste as the polymer binder and recycled concrete aggregate can further reduce the cost of PC.</p> <p>It is reported in the past that the use of unsaturated polyester resins from recycled polyethylene terephthalate (PET) plastic waste or orthophtalic polyester in making PC will reduce the associated cost. PC will be made of polymer binder, fly ash and aggregate. Design of experiments will be used to identify about 10 mix proportions and will be tested for mechanical properties. An experimental program will be conducted to investigate the complete stress-strain behaviour of the same PC mix designs which will later be used to develop a constitutive model for the same. There will be a set of control tests as well using normal polyester as the resin. After analysing the results, beams with different steel ratios will be test for flexural strengths and shear strengths. Therefore material and member behaviour of polymer concrete can be investigated.</p>	<p>Dr Weena Lokuge</p>	<p><a href="mailto:weena.lokuge@usq.edu.au">weena.lokuge@usq.edu.au</a></p>
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<p><b>Title:</b> Simplified Design Methodologies for Optimum Composite Sandwich Structures</p> <p><b>Available for Major/s:</b> Civil Engineering; Structural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The construction and building design industry often takes the approach of using simplified design formulae and calculation methods to assess and characterise the strength and failure behaviour of various engineering structures. Unfortunately, there is an overall lack of an established knowledge base on how to design, assess and characterise the strength and failure behaviour of fibre composite sandwich structures. Accordingly, there is an industry need to develop new calculation methods that accurately capture the mechanical response of composite sandwich structures, while being relatively straightforward to implement in standard and existing calculation methodologies. Design charts and failure mode maps are also essential for designing optimum sandwich structures that exhibit different types of failure modes. This project aims to provide an understanding with the necessary tools to develop new and simplified design methodologies for optimum fibre composite sandwich structures in civil engineering applications. The effects of the individual material properties and geometric configurations on the failure mechanisms and the overall behaviour of sandwich structures will be studied in detail and will be presented in easy-to-follow design charts. The results of this project can also be extended in optimum design of sandwich structures for application in various fields of engineering. The objectives of this project are:</p> <ol style="list-style-type: none"> <li>1. To investigate the overall behaviour of fibre composite sandwich structures under key parameters experimentally, theoretically and numerically.</li> <li>2. To develop new and simplified analytical models and design charts to predict the behaviour and failure mechanisms of composite sandwich structures with different geometries and material systems.</li> <li>3. To verify the new and simplified analytical models with experimental investigation</li> </ol> <p>The results of the project will provide the research community with a more in-depth understanding of the behaviour of fibre composites sandwich structures, thus filling the knowledge gap that currently exists in civil infrastructure. The simplified design and analysis methods developed in this study will provide engineers with necessary tools to begin exploring structural systems involving composite sandwich structures.</p> <p><b>Expectations/Additional Requirements:</b> Knowledge on engineering mechanics, structural design and experimentation</p>	<p>Dr Allan Manalo</p>	<p><a href="mailto:manalo@usq.edu.au">manalo@usq.edu.au</a></p>
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<p><b>Title:</b> Performance evaluation of prefabricated composites building systems</p> <p><b>Available for Major/s:</b> Civil Engineering, Structural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Fibre composites have numerous potential advantages in prefabricated system of construction such as better quality control, improved health and safety of workers, and faster build times. Using fibre composites, prefabricated housing components are easy, fast and economic to install as it requires minimal handling and reduced energy in transportation. Consequently, an increasing range of housing products made from composite materials are now available like roof, wall, floor, and subfloor covering. Despite its many advantages, the acceptance of composite houses has been low due to lack of standards and design. Currently, the design of structural components does not take into account the orthotropic material properties of fibre composites leading to a higher cost housing system than using conventional construction materials. As there is limited knowledge on the performance behaviour of these construction systems, new techniques involving fibre composites into factory based ‘system building’ have noticeably failed to meet expectations. Up to date, there is inadequate scientific research undertaken to substantiate the benefit of using fibre composites in prefabricated system of construction. This project aims to provide an understanding, through simulated testing and analytical investigation, of the structural performance of current and emerging prefabricated composite components in order to develop performance-based design criteria which will be useful to the housing and construction industry. Among the possible research topics are:</p> <ol style="list-style-type: none"> <li>1. Structural behaviour of prefabricated composite wall systems.</li> <li>2. Behaviour of jointing/connection systems for prefabricated building components</li> <li>3. Investigation of the behaviour of fibre composites in structural flooring systems</li> <li>4. Behaviour of lightweight fibre composite roofing system</li> <li>5. Structural behaviour of full-scale prefabricated composite houses</li> </ol> <p>The results of this study will provide designers and engineers with sufficient foundational guidance and necessary tools to further explore the use of fibre composites into industrialised building systems. It will also serve as a guide for best practice to easily assess the quality of prefabricated housing components. Such an approach could expedite the implementation of fibre composite houses through a more functional and economical design.</p> <p><b>Expectations/Additional Requirements:</b> Knowledge on engineering mechanics, structural design and experimentation</p>	<p>Dr Allan Manalo</p>	<p><a href="mailto:manalo@usq.edu.au">manalo@usq.edu.au</a></p>
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<p><b>Title:</b> Green composites for housing and construction</p> <p><b>Available for Major/s:</b> Civil Engineering, Structural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Most construction practices and materials used within the building industry leave a large ecological footprint. In fact, construction and demolition of buildings materials contributes 30-40% of solid waste in Australia. Consequently, there is an increasing interest in research and development on producing new generation of composites from natural fibres and other renewable resources to replace the less eco-friendly structural and non-structural materials used in housing and construction. The many advantages of natural fibre composites include environmentally friendly (renewable resource, recyclable, biodegradable), low energy consumption, low cost, light weight and good specific mechanical properties. Therefore, a project that supports the development and adaptation of cleaner, greener and more renewable materials while providing the construction and building industries with an alternative and environmentally sustainable materials should be conducted.</p> <p>This project aims to develop eco-friendly technologies from plant-based composites and to evaluate their mechanical properties. The overall aim is to study the basic characteristics of housing/building products from sustainable materials and predict their structural behaviour (load-deflection characteristics, natural frequencies etc.). The results of this study will provide the basic material properties for natural fibre composite beams and panels suitable for structural applications. Combined with numerical simulations, this research will give a clear indication of the suitability of green composites in housing and construction. Under this project, among the possible research studies that can be conducted are:</p> <ol style="list-style-type: none"> <li>1. Bamboo fibre composites for structural applications.</li> <li>2. Hybrid glass and bamboo fibre composites sandwich structures</li> <li>3. Thermal and sound insulation sandwich panels from natural fibres</li> </ol> <p>This study will provide information to make valued assessment in using natural fibres for high-performance composites in the Australian building industry. Furthermore, the results of this study will create major market access for plant-based composite products to generate new industry and employment for the Australian agro-based communities.</p> <p><b>Expectations/Additional Requirements:</b> Knowledge on engineering mechanics, structural design and experimentation</p>	<p>Dr Allan Manalo</p>	<p><a href="mailto:manalo@usq.edu.au">manalo@usq.edu.au</a></p>
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<p><b>Title:</b> Identification of social and environmental benefits of water trading</p> <p><b>Available for Major/s:</b> Water Resources/ Resource Economics/ Environmental Science; Land and Water Management</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Water trade it encourages water to move the most highly value among competing users and uses. Water markets premise that trading provides economic benefits to buyers and sellers, and to society as a whole, including environment. However, there have been concerns that changes associated with water trading might have adverse economic, social and environmental impacts. Until now considerable attentions have been paid in understanding the farm-level financial impact of water trading. However less attention has been pain in understanding the social and environmental impact. Water trading out of the region could have adverse impact on the land values and local industry, although it may have positive impact on environment. This graduate research project aims to identify both positive and negative impact of water trading on communities and environment.</p>	<p>Dr Shahbaz Mushtaq</p> <p>Dr Ian Brodie</p>	<p><a href="mailto:Shahbaz.Mushtaq@usq.edu.au">Shahbaz.Mushtaq@usq.edu.au</a></p> <p><a href="mailto:Ian.Brodie@usq.edu.au">Ian.Brodie@usq.edu.au</a></p>
<p><b>Title:</b> Assessing the performance of Variable Rate Irrigation equipment applied to a pivot irrigation system for dairy fodder production</p> <p><b>Available for Major/s:</b> Agricultural Engineering/ Instrumentation and Control/ Agronomy, Soil and Water</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>This project is related to the performance of hardware, software, and sensors to vary the rate of irrigation application in response to in-field soil variability, topography and crop performance. This Dairy Industry project is to determine the feasibility (agronomically, technically and economically) of using variable rate irrigation in fodder production.</p> <p>Automated VRI systems rely on prescription maps, which are developed over time by the operator/irrigator, which infers trial and error over a number of seasons. Initial inputs are generally based on low resolution soil maps, NDVI or other third party spatial data sets which only have a tenuous relationship with on-site irrigation performance and crop yield.</p> <p>This project will use the computer model Variwise, which integrates APSIM to analyse the feasibility of applying different VRI strategies to fodder production over a range of climate and production scenarios. Once strategies are selected, the role of this project is to assess the applicability to the farmer's operational requirements and crop performance.</p> <p>Therefore the project has a number of elements: assess the performance of the irrigation system (including VRI), compilation of spatial data sets, selection of irrigation strategies based on modelling outcomes, and ground-truthing the application of strategies based on operational requirements.</p>	<p>Dr Allen D. McHugh</p>	<p><a href="mailto:mchugha@usq.edu.au">mchugha@usq.edu.au</a></p>

<p><b>Title:</b> Application of shakedown concept in the design of road pavements</p> <p><b>Available for Major/s:</b> Geotechnical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Most pavement design methods currently used around the world are largely empirical. For example, in the current design practice of road pavements, it is assumed that “failure” occurs when the vertical <i>elastic</i> compressive strain at the top of the subgrade reaches a critical value so that a relationship between the magnitude of the strains and the number of repetitions to cause rutting failure can be empirically established.</p> <p>However, failures of pavements associated with moving repeated traffic loads are typically caused by gradual deterioration rather than sudden collapse. This type of failure behaviour is mostly due to the accumulation of plastic strains under repeated loadings. They are different from the geotechnical engineering solution of the stability problems of soil masses under simple loading programs.</p> <p>An excellent review of the current practice of pavement engineering has been given by Brown (1996) in the 33rd Rankine Lecture to the British Geotechnical Society. He emphasizes that practice is lagging behind knowledge of the behaviour of road materials obtained from laboratory experiments and that theoretical models need to be improved.</p> <p>This project thus aims at developing a novel elasto-plastic design approach of road pavements based on shakedown theorems which consider the effect of repeated moving traffic loads.</p> <p><b>Significance and Innovation</b></p> <p>For flexible pavements, the most common causes of failure are rutting or cracking of the wear surface. To avoid this type of damage, which is usually very expensive to repair, road designers must be able to estimate the maximum cyclic load capacity of a pavement accurately and reliably. The shakedown method proposed here will provide a rational basis for resolving this question, as it can be used to predict the maximum level of repeated loading that a pavement can sustain without suffering excessive permanent deformation. The method will enable road engineers to perform parametric studies that investigate issues such as the optimal properties of the pavement material, the optimal layer sequences, and the optimal layer thicknesses.</p> <p><b>Approach</b></p> <p>There are two basic approaches that can be used to obtain shakedown limits. The first one employs conventional elastoplastic finite element analysis to trace the complete deformation path, and requires each load cycle to be broken up into a discrete number of steps.</p> <p>After each increment is applied and the load cycle reaches its maximum amplitude, the sign of loading is reversed and the structure is unloaded in an incremental fashion. This process is repeated for a large number of load cycles and plots of the load--</p>	<p>Dr Jim Shiau</p>	<p><a href="mailto:jim.shiau@usq.edu.au">jim.shiau@usq.edu.au</a></p>
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deformation response and cumulative plastic dissipation are produced (Cochetti and Maier 2000). Shakedown occurs if the deformations and residual stresses no longer change from one cycle to the next, and is also signalled by constant plastic dissipation with time and contained plastic flow. If these conditions do not arise, the structure eventually undergoes incremental collapse and it is necessary to repeat the whole process with smaller load amplitude. Due to the large number of load steps required, and the need for a trial--and--error strategy to locate the shakedown limit, this type of approach is both time consuming and costly. If it is used to perform parametric studies, where the material and geometric properties are varied in an effort to isolate an optimal configuration, the costs can be prohibitive.

The second approach, which is more elegant than the first, makes use of the shakedown theorems to obtain upper and lower bounds on the shakedown load directly. These analyses employ similar methods to the limit theorems, which are widely used for predicting static collapse loads. Though

the latter are powerful techniques for performing stability analysis of structures under static loading (Sloan 1988 and 1989), they are of limited use for predicting the behaviour of structures subjected to repeated loading where other forms of collapse may occur. The shakedown theorems for an elastic--perfectly plastic continuum have been given by Melan (1938) and Koiter (1956) and may be stated as:

**Melan’s static shakedown theorem (lower bound).** “If any time--independent distribution of

residual stresses can be found which, together with the elastic stresses due to the load, constitutes

a system of stresses within the elastic limit, then the system will shakedown”. In other words, the elastic stresses associated with the maximum load, together with any distribution of residual

stress, which nowhere violates the yield condition, will give a lower bound to the shakedown limit.

**Koiter’s kinematic shakedown theorem (upper bound).**

“Shakedown will not take place if any kinematically admissible cycle of plastic strain can be found in which the work done by the elastically imposed stresses exceeds the internal plastic work”. To provide solutions that are useful in practice, Melan’s static shakedown theorem should be used in tandem with Koiter’s kinematic shakedown theorem so that lower and upper bounds on the shakedown load are obtained. These ‘direct methods’ clearly have great advantages over incremental elastoplastic finite element analysis as they avoid tracing the complete loading history.

This project is concerned with applying finite element formulations of Melan’s and Koiter’s theorems to the design of pavements under repeated loadings.

**Procedures**

The followings show the step-by-step procedures to achieve the

<p>goal towards my PhD study at USQ:</p> <ol style="list-style-type: none"> <li>1. Review of current pavement design methods.</li> <li>2. Review of shakedown theorems.</li> <li>3. Design and construction of a Track Model for the investigation of road pavements under repeated surface loads.</li> <li>4. Application of lower bound shakedown analysis to the design of road pavement.</li> <li>5. Application of upper bound shakedown analysis to the design of road pavement.</li> <li>6. Production of design charts based shakedown methods.</li> </ol>		
<p><b>Title:</b> Developing physical and numerical models for geotechnical teaching and research</p> <p><b>Available for Major/s:</b> Geotechnical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In a geotechnical teaching curriculum, the basic concepts of Geomechanics are usually first introduced, accompanied with some standardized soil tests for measuring the index properties, permeability, consolidation, and shear strength of soil. More advanced geotechnical and foundation engineering courses are then presented by introducing more complex boundary value solution techniques and numerical methods to different forms of geotechnical structures. The transition from basic Geomechanics into the analysis and design of geotechnical structures can be challenging for students and at this stage the role of physical models becomes important as part of the student's learning process.</p> <p>Large centrifuges are often used in research laboratories to study the self-weight stress induced failure of geotechnical structures. While most academics recognize the importance of geotechnical teaching by using the centrifuge technology to demonstrate the behaviour of geotechnical problems, the cost of servicing this teaching aid is prohibitive in many universities. In this proposal, we present the concepts involved in designing inexpensive laboratory equipment which can be used to perform demonstrations and research experiments on the ultimate behaviour of various geotechnical structures under external loadings. Such equipment can be efficiently used to complement the theoretical approach and serve to visualize phenomena of geo-structural failures.</p> <p>To date, a number of large centrifuges have been established in research laboratories around the world to study the self-weight stress induced failure of geotechnical structures. While most researchers recognize the importance of geotechnical teaching by using the centrifuge technology to demonstrate the behaviour in geotechnical problems, the cost of servicing this teaching aid is prohibitive in many universities.</p> <p>The main objective of this research is to present the concepts involved in designing inexpensive laboratory equipment which can be used to perform demonstrations and research experiments on the ultimate behaviour of various geotechnical structures under external loadings. Such equipment may include models for ultimate bearing capacity of a footing near a slope, active and</p>	<p>Dr Jim Shiau</p>	<p><a href="mailto:jim.shiau@usq.edu.au">jim.shiau@usq.edu.au</a></p>

<p>passive earth pressures on retaining walls, stability of geotextile-reinforced soil, uplift and lateral resistance of soil anchors and buried pipelines, and the behaviour of pile foundations under lateral loadings. This research will show that such equipment can be efficiently used to complement the theoretical approach and serve to visualize phenomena of geo-structural failures in two- and three- dimensional space.</p>		
<p><b>Title:</b> Analysis of route choice during peak periods in urban arterial networks</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Total travel in most urban areas has grown ten-fold over the last 60 years. The highest proportion of vehicles in this growth is private cars. Drivers of these vehicles are daily using urban arterial networks and increasingly concerned about traffic congestion, delay and the cost of motoring in these congested conditions.</p> <p>Urban drivers experience congestion mainly in peak periods and many of them try to find alternatives to reach their destination such as changing route, leaving early or using a different mode of transport. The first two alternatives help drivers to optimize their trips during peak period, particularly in a private vehicle dependent society like Australia. A recent investigation revealed that the first two options influence driver behavior, and the use of road space, as well as the time of the peak hour periods, and these have been changed from the established norms.</p> <p>This study will investigate the propagation of traffic flow, route choice and transmission of the peak periods in congested urban arterial networks. In particular the changing pattern of traffic congestion, changes in traffic flows and departure patterns will be modeled using an aggregate approach. This study would help to identify an appropriate form of traffic flow pattern in an urban network during its peak periods. Mathematical and computer models will be used to evaluate the effect of the application of remedial measures that advise the urban drivers to restrict traffic actions throughout the urban road network.</p>	<p>Dr Soma Somasundaraswaran</p> <p>Prof Ron Ayers</p>	<p><a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a></p> <p><a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a></p>
<p><b>Title:</b> Analysis of traffic characteristics in interrupted flow under mixed flow condition</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The effective usage of arterial networks in urban areas is of great importance in our daily life as it influences delay, travel times, costs, and environmental concerns. In recent years, the increasing amount of vehicular traffic has led to frequent traffic jams on urban arterials. Several control strategies have been implemented to use the existing networks more efficiently such as coordinated and adaptive signal control, variable speed and message signs, and route guidance. Most of these control strategies are based on traffic stream models both at macroscopic and microscopic level. Stream description models and travel</p>	<p>Dr Soma Somasundaraswaran</p> <p>Prof Ron Ayers</p>	<p><a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a></p> <p><a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a></p>

<p>time estimation models also contribute to these strategies. However all these models are sensitive to the degree of mixed flow (i.e., the proportion of heavy vehicles and other vehicle classifications) in traffic stream. There is a need to investigate the traffic stream to identify areas where flow mixing will bring a qualitative jump in the level of service and understanding of traffic flow characteristics.</p> <p>This study will examine the effect of mixed traffic on traffic flow models. Results from this study will help to develop more efficient traffic operational decisions in mixed flow condition along arterials.</p>		
<p><b>Title:</b> Comparison of young driver crash involvements with varying licensing practices</p> <p><b>Available for Major/s:</b> Civil Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Internationally, young drivers are vastly overrepresented in road crash fatalities and injuries and this proportion in middle and low income countries is often greater than in high income countries. One of the reasons for this difference in crash involvement is related to licensing practices in individual countries. Developed countries are improving the situation using well planned graduated licensing programs that include extended period of supervised training, controlled driving with peers, and probation periods to delay full-privilege licensing. International co-operation in sharing most appropriate practices is also playing a vital role for combating young driver's risk.</p> <p>This project will focus on the high level of risk associated with young drivers in a country (e.g., a Middle East country) by investigating the delivery of local road safety strategies and programs. The initial tasks of this project will consider the following objectives: to evaluate the different strategies and plans delivering road safety including licensing practices; and to assess the key processes and effectiveness of the local authorities.</p> <p>The main aim of this project is to estimate the effectiveness of the road safety initiatives in the presence of number of potential explanatory variables in a particular country. Appropriate modelling will be used to identify the potential variables from strategies and available data in various countries. The result will be used to identify and recommend policy changes, countermeasures and actions to receive better output from road safety investments.</p>	<p>Dr Soma Somasundaraswaran Prof Ron Ayers</p>	<p><a href="mailto:kathirgs@usq.edu.au">kathirgs@usq.edu.au</a> <a href="mailto:ayers@usq.edu.au">ayers@usq.edu.au</a></p>

<p><b>Title:</b> Advanced life cycle management of engineering assets</p> <p><b>Available for Major/s:</b> Civil, Environmental, Mechanical, Electrical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The effective and efficient management of engineering assets is becoming increasingly important as we focus more on the total asset life cycle and move to a more sustainable engineering focus.</p> <p>Local governments, for example, have extensive networks of roads, storm water drains, water supply and sewerage pipelines, mechanical and electrical equipment and other assets. Private companies, state governments and utility providers also manage extensive assets for providing services or facilitating production.</p> <p>The task is to manage these assets so that they optimise a range of factors, including whole of life value for money, ability to deliver adequate level of service at required demand, functional serviceability, life cycle performance, service life, and stakeholder requirements.</p> <p>There are also a range of developments in this area, such as advanced monitoring of asset condition, sustainable life cycle approaches to asset management, use of sustainability rating systems, risk management, use of modern materials such as engineered fibre composites, use of recycled materials and innovative design approaches.</p> <p>There are therefore a large range of possible research projects in this broad topic area. Some of these research topics might include:</p> <ul style="list-style-type: none"> <li>• Asset maintenance and management policies and systems</li> <li>• Asset management planning</li> <li>• Optimising asset performance and serviceability</li> <li>• Sustainable approaches to asset management</li> <li>• Design and management for safety in construction, use and maintenance</li> <li>• Modelling stakeholder requirements</li> <li>• Use of modern materials in asset development and maintenance</li> <li>• Designing and operating for sustainability</li> <li>• Risk management</li> <li>• Asset condition monitoring</li> <li>• Intelligent predictive modelling of asset failure</li> <li>• Rehabilitation and replacement studies</li> <li>• Special issues with asset development and management in developing countries (for example, low volume roads)</li> <li>• Optimised facilities management</li> </ul>	<p>Dr David Thorpe</p>	<p><a href="mailto:david.thorpe@usq.edu.au">david.thorpe@usq.edu.au</a></p>
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<p><b>Title:</b> Take-up of advanced engineering materials and processes by the small and medium enterprise sector</p> <p><b>Available for Major/s:</b> Civil, Environmental, Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Advanced engineering materials and processes promise to revolutionise engineering building, construction and manufacture.</p> <p>For example, engineered fibre composites can replace a number of structural engineering and building materials, because of their high strength to weight ratio, light weight and ease of installation.</p> <p>However, the take-up of many technological advances in engineering materials and processes by small and medium enterprise companies (SMEs), including start-up manufacturers, is not always rapid. It is possible that a number of factors, such as relatively high cost, financial risk for these firms in using an unproven technology, a design knowledge that is still developing, an unproven life cycle, long-term sustainability issues, risk considerations, and the impact of change on operational processes could impact on this decision.</p> <p>The key factors likely to impact on the take-up of such materials and processes by the SME sector are, however, not fully understood and therefore require investigation.</p> <p>Therefore, it is proposed that research be undertaken to identify and evaluate the factors impacting on the take-up of advanced engineering materials and processes, such as engineered fibre composite materials, by the SME sector.</p> <p>Initially, it would be expected that the project would identify what factors might influence the adoption of advanced materials and processes by the SME sector, and what factors might prevent this adoption. It would then be expected that the main factors in this process would be investigated in detail.</p> <p>A further research project would be to use this information to develop and implement practical strategies to facilitate and implement technology transfer from research by the University sector to the SME industry sector.</p>	<p>Dr David Thorpe</p>	<p><a href="mailto:david.thorpe@usq.edu.au">david.thorpe@usq.edu.au</a></p>
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<p><b>Title:</b> Sustainable road development and management</p> <p><b>Available for Major/s:</b> Civil, Environmental Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Roads are essential for the functioning of modern society, and play a key role in the carriage and distribution of goods, services and people. There are however concerns about their role in a sustainable world.</p> <p>Modern roads need to be planned, designed, constructed, maintained and disposed of sustainably. Issues in such sustainable road development and management include planning and design for sustainable transportation, management of storm water and runoff, design and construction for minimal impact on the natural environment, use of sustainable and recycled materials, whole of life asset management, and the use of sustainable construction and maintenance processes. Thus the close attention to drainage systems, sound environmental management, water sensitive urban design, use of advanced environmentally friendly materials, and environmentally responsible project management are important considerations in the sustainable development and management of roads.</p> <p>Key roads should also have continued functionality during and immediately after major natural disasters. Therefore, the design and construction of such roads and their associated structures should take into account their viability as transportation links in all but the most extreme of operating conditions.</p> <p>A number of research topics are possible with this topic. Examples include the development and construction of roads in environmentally sensitive areas, development and management of strategic roads and roads of national importance, the sustainable use of roads, and evaluation of the issues in road planning, design, construction, or operation from a sustainability perspective, with possible application to a particular road network.</p>	<p>Dr David Thorpe</p>	<p><a href="mailto:david.thorpe@usq.edu.au">david.thorpe@usq.edu.au</a></p>
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<p><b>Title:</b> The effects of seeds graining process on the tribological characteristics of components in agriculture machines</p> <p><b>Available for Major/s:</b> Agricultural Engineering/ Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In this work, the effect of third body presence such as dust and seeds powder on the tribological behaviour of agriculture machines should be investigated. There are many components exposed to relative motion under applied load, i.e. adhesive tribological loading. The presence of third body in the rubbing area transforms the adhesive wear into three body abrasion which in turn accelerates the wear process. Such phenomenon is not desired. Therefore, a study should be conducted to prevent or reduce the effect of the third bodies on the tribological performance of those components. There are several methods which can assist to enhance the tribological performance of the agriculture components, i.e. preventing the presence of the third bodies, reduce the effect of those bodies, replace the components with better counterparts, .....etc.</p>	<p>Dr Belal F. Yousif</p>	<p><a href="mailto:Belal.Yousif@usq.edu.au">Belal.Yousif@usq.edu.au</a></p>
<p><b>Title:</b> Development of a natural fibre reinforced sandwich panel against earthquake</p> <p><b>Available for Major/s:</b> Civil / Mechanical Engineering.</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Fibre composite (FRP) sandwich panels have been used in different applications such as aerospace, automobile and building constructions. FRP composite sandwich panel has a high structural strength to weight ratio, and high energy absorption which made is perfect for earthquake resistant design.</p> <p>However, the high cost of FRP has made it very difficult to promote the design and construction of this type of structure among the developing countries. The main objective of this research is to develop a new hybrid sandwich panel incorporating a bio-based material derived from renewable resources and therefore to reduce the cost. This research work will be mainly based on a series of laboratory experiments and numerical studies. The expected outcome from this research is a new sustainable hybrid sandwich panel which has a better structural performance to against earthquake and low cost.</p>	<p>Dr Yan Zhuge</p>	<p><a href="mailto:zhuge@usq.edu.au">zhuge@usq.edu.au</a></p>

<p><b>Title:</b> Seismic retrofitting of existing masonry structures using fibre reinforced polymer (FRP)</p> <p><b>Available for Major/s:</b> Civil/ Mechanical Engineering.</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Masonry is one of the most commonly used materials throughout the world for the construction of low rise buildings. Even though the history of past earthquakes has shown that masonry buildings suffer the maximum damage and also account for the maximum loss of life, they continue to be popular. It was evident from the past earthquake that most unreinforced masonry structures were seriously damaged. Therefore it is an important issue to retrofit and strengthen existing masonry structures to resist the potential earthquake damages.</p> <p>The basic concept of seismic retrofitting is to upgrade the structural strength and improve the inelastic deformation capacity of the structure. In the last two decades, several seismic retrofitting techniques for masonry structures have been developed and practiced and fibre reinforced polymer (FRP) material has been increasingly used due to their high strength/stiffness to mass ratio and easy application. Although much research has been carried out on FRP strengthening of unreinforced masonry (URM) structures, most of them have been experimental studies to investigate the effectiveness of retrofitting techniques rather than the development of a rational design model. This proposed research will be focused on the development of a design model for FRP retrofitted masonry structures. A series of experimental testing will be conducted to investigate the failure mechanism of the structures, followed by the development of the numerical model using finite element method. A design formula will be developed at the final stage of the project.</p>	<p>Dr Yan Zhuge</p>	<p><a href="mailto:zhuge@usq.edu.au">zhuge@usq.edu.au</a></p>
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**Electrical, Electronic and Computer Engineering**

Project Description	Staff Member(s)	Email
<p><b>Title:</b> Micro-grid regulation with smart dispersed VAR control.</p> <p><b>Available for Major/s:</b> Power Engineering/Electrical</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The use of the full 4 quadrant operation of micro-grid connected PV and Wind inverters potentially allows for enhanced system stability, protection and improved voltage regulation. At this stage regulations do not permit this operation and detailed simulation and experimental validation are essential before larger scale usage is allowed.</p> <p>A number of intelligent inverters may need to work as a group to meet this objective. The network requirements, sequence logic and resulting impact on stability and protective devices will require analysis.</p>	<p>Dr Les Bowtell</p>	<p><a href="mailto:bowtell@usq.edu.au">bowtell@usq.edu.au</a></p>
<p><b>Title:</b> Computer networks and quality of experience</p> <p><b>Available for Major/s:</b> Computer Systems Engineering, Electrical and Electronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Experience related performance measures are important for operational, commercial as well as usability reasons. Quality of Experience (QoE) is widely discussed as a measure of user perceived performance; however, no universal definition for QoE is available. Recent work has suggested using specific performance measures that are more descriptive than traditional QoE. These account for objective and subjective measures and focus on applications and tasks specific performance. The parameters include Quality of (an) Application (QoA) and Quality of Use (QoU). These are further divided into objective and subjective measures, i.e. objective QoA, subjective QoA, objective QoU and subjective QoU. Subjective QoA reassembles QoE widely discussed in technical literature; QoU provides a measure for quality of experience in a more general, non-technical sense. It is proposed that these individual performance parameters provide a better picture of performance and allow stakeholders to make more specific decisions.</p> <p>The research project proposes the analysis and evaluation of the various QoE measures. The project will combine qualitative methods and quantitative methods and ground the investigation in traditional teletraffic and network engineering.</p>	<p>Dr Alexander Kist</p>	<p><a href="mailto:kist@usq.edu.au">kist@usq.edu.au</a></p>

<p><b>Title:</b> Energy efficient network optimisation</p> <p><b>Available for Major/s:</b> Computer Systems Engineering/ Electrical and Electronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In light of the global focus on greenhouse gas emissions, energy consumption of communication networks has become an important research area. Computer and communication networks are major consumers of energy and have become critical infrastructure. Networks are generally dimensioned for peak loads. For extended periods, resources consume power, but are lightly or unused. The research project proposes and analyses communication networks that can dynamically change the number of active devices according to traffic and resilience requirements. It will combines teletraffic engineering, routing and network equipment in a novel way to achieve major energy savings in networks. Outcomes will include original mathematical models to quantify gains, mechanisms to change systems dynamically and a comprehensive measurement study to verify energy savings and network robustness. The project will enables major energy savings in communication networks, reducing energy cost as well as greenhouse gas emissions.</p>	<p>Dr Alexander Kist</p>	<p><a href="mailto:kist@usq.edu.au">kist@usq.edu.au</a></p>
<p><b>Title:</b> Adaptive rate allocation for ADSL and wireless</p> <p><b>Available for Major/s:</b> Electrical/ Electronic Engineering/ Computer Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Asymmetric Digital Subscriber Line (ADSL) connects a large proportion of internet users worldwide. In the case of ADSL over copper telephone lines, the sub channels carry a variable bit allocation based on the measured signal to noise ratio (SNR). This bit rate per sub channel is set according to the SNR using a bit-loading algorithm, and is subject to the maximum power constraint of the channel. For guaranteed delivery channels such as TCP, this scheme works well. However where there may be some tolerance for bit errors, particularly in video on demand, the scheme of bit allocation is suboptimal. In other words, a lower SNR sub channel could be utilized to carry a greater bit-loading, with no impact on the user's perception of the delivered content. The aim of this project is to investigate such adaptive bit-loading. It is novel in that the physical layer channel needs to co-operate with the higher-layers of the protocol stack in order to negotiate an acceptable bit error rate (BER).</p>	<p>Assoc Prof John Leis</p>	<p><a href="mailto:leis@usq.edu.au">leis@usq.edu.au</a></p>

<p><b>Title:</b> Laser-spectroscopic and laser-acoustic approaches to methane gas detection</p> <p><b>Available for Major/s:</b> Electrical, Electronic Engineering/ Mechanical/Mechatronic Engineering/ Computer Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Measuring gas concentrations in mining, transportation and other industries is vitally important to ensure safety. Moreover, the measurements need to be intrinsically safe - that is, no electrical connection to the sensing environment. Thus, laser light coupled with fibre-optic transmission is one avenue which presents itself. The aim of this project is to investigate novel, in-situ and electrically isolated measurement techniques for explosive gas detection in hostile environments. Problems include the sensitivity, selectivity, calibration of the instrument. A primary aim is the development of acoustic signal processing techniques which are suitable for laser-modulated photo acoustic gas sensing. The focus could be one or more of: signal processing design, the fundamental physics of the optoacoustic method, the mechanical design of the resonator, and novel measurement algorithms such as frequency-sweep and adaptive phase-lock.</p>	<p>Assoc Prof John Leis</p> <p>Prof David Buttsworth</p>	<p><a href="mailto:leis@usq.edu.au">leis@usq.edu.au</a></p> <p><a href="mailto:david.buttsworth@usq.edu.au">david.buttsworth@usq.edu.au</a></p>
<p><b>Title:</b> Real-time control system research based on unreliable network links</p> <p><b>Available for Major/s:</b> Electrical, electronic/ Computer Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>A Networked Control System (NCS) is a control system wherein the control loops are closed through a real-time network. The defining feature of an NCS is that control and feedback signals are exchanged among the system's components in the form of information packages through a network.</p> <p>The insertion of the communication network in a control system makes the analysis and design of an NCS more complicate, since it imposes additional time delays and even packet drop in control loops. That brings a lot of challenges in control and network engineering research. These challenges include NCS related new control techniques, reliability and security of communications, bandwidth allocation, development of data communication protocols, corresponding fault detection and fault tolerant strategies, real-time information collection and efficient processing of sensors data. Depending on the application, time-delays and/or packet drop could severely degrade the system performance. This project is to develop and design and analysis method for NCS systematically.</p> <p>The applications of NCS covers a broad range of industries such as: space and terrestrial exploration, GIS based environment monitoring, access in hazardous environments, factory automation, remote diagnostics and troubleshooting, experimental facilities, domestic robots, aircraft, automobiles, manufacturing plant monitoring, nursing homes and tele-operations.</p>	<p>Assoc Prof Paul Wen</p> <p>Assoc Prof Armando Apan</p>	<p><a href="mailto:pengwen@usq.edu.au">pengwen@usq.edu.au</a></p> <p><a href="mailto:armando.apan@usq.edu.au">armando.apan@usq.edu.au</a></p>

<p><b>Title:</b> The monitoring and automatic control of depth of anaesthesia during operation</p> <p><b>Available for Major/s:</b> Electrical, electronic/ Computer Engineering/ Mechatronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Nowadays, physiological monitoring is imperative for the safety of medical operations. During surgery, doctors heavily depend on monitors to detect as quickly as possible the change of patients' conditions. The difficulty in monitoring and automatic control of depth of anaesthesia is the inherent patient variability due to differences in demographic and drug tolerance. These discrepancies are translated into the pharmacokinetics-pharmacodynamics PKPD(s) dose-response model uncertainty that may affect the stability of the closed loop system. This research aims at developing mathematical models and design predictive controllers using Internal Model Control, Model Based Predictive Control, robust control and fuzzy control techniques.</p> <p>The objective of this project is to develop patient dose-response models and to provide an adequate drug administration regimen for the anaesthesia to avoid under or over dosing of the patients. The controllers are designed to compensate for patients inherent drug response variability, to achieve the best output disturbance rejection, and to maintain optimal set point response.</p>	<p>Assoc Prof Paul Wen</p> <p>Dr Tony Ahfock</p>	<p><a href="mailto:pengwen@usq.edu.au">pengwen@usq.edu.au</a></p> <p><a href="mailto:tony.ahfock@usq.edu.au">tony.ahfock@usq.edu.au</a></p>
<p><b>Title:</b> Cooperative MIMO wireless communications for 4G cellular networks</p> <p><b>Available for Major/s:</b> Telecommunications Engineering/ Electronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Due to physical limitations, wireless agents may not be able to support multiple antenna so as to reap the transmit diversity gained in multiple-input and multiple-output (MIMO) systems. Cooperative wireless communications allow single-antenna mobile terminals to reap some of the benefits of MIMO systems. The essential idea underlying cooperative wireless communications is that single-antenna mobiles in a multi-user scenario can share their antennas in a manner that creates a virtual MIMO environment. Cooperative devices are growing in value with respect to wireless communications and networks. They substantially enhance system performance by decreasing power consumption and packet loss rate, and increasing system capacity and network resilience. Cooperative wireless communications has wide application in next generation (4G) mobile networks.</p> <p>This PhD project involves studying into the theory and practices of cooperative MIMO communications systems. Novel designs of cooperative MIMO systems are expected out of this project, which are able to demonstrate considerable performance gains.</p>	<p>Dr Wei Xiang</p>	<p><a href="mailto:wei.xiang@usq.edu.au">wei.xiang@usq.edu.au</a></p>

<p><b>Title:</b> Fountain codes-based approach for multimedia contents delivery over IP networks: a revolutionary application-layer forward error correction paradigm</p> <p><b>Available for Major/s:</b> Telecommunications Engineering/ Electronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The proposed PhD project <i>aims</i> to address a significant research problem of multimedia content delivery over IP networks based upon a conceptually new application-layer forward error correction technology termed fountain codes. With the rollout of the National Broadband Network (NBN) in Australia, telecommunication operators are presented with the opportunity to provide high-definition (HD) and 3-D digital video services to consumer televisions using IP-based networks (IPTV services). The significance of this technology lies in that it will contribute to the release of precious bandwidths occupied by current analogue and digital TV channels, which could otherwise be utilised by other wireless services.</p> <p>However, new technology faces new technical challenges: one of the most prominent problems for deploying high-quality IPTV services is insufficient video quality manifested as noticeable artefacts in the video caused by packet loss. IP-based networks were initially designed following the principles of an economical best-effort network, which is difficult to support stringent QoS requirements boasted by conventional dedicated TV broadcasting systems. Consequently, this calls for advanced application-layer error control technology to guarantee video quality. This project aims to address this significant problem based upon a conceptually new technique called fountain codes which is also known as rateless codes.</p>	<p>Dr Wei Xiang</p>	<p><a href="mailto:wei.xiang@usq.edu.au">wei.xiang@usq.edu.au</a></p>
<p><b>Title:</b> Quality of service support in wireless multimedia sensor networks</p> <p><b>Available for Major/s:</b> Computer Science and Engineering, Telecommunications</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>There has been a recent emergence of multimedia streaming applications over wireless sensor networks such as multimedia surveillance, storage of potentially relevant activities from networked cameras, traffic conditions and collision avoidance. Recent advances of multimedia source coding and inexpensive hardware have made multimedia transmission over WSN possible. However, wireless sensor networks (WSNs) have very limited capabilities (low bandwidth, poor link characteristics and limited power supply) in supporting these video and audio applications. Real-time multimedia applications often have stringent requirements on Quality of Service (QoS) such as bandwidth, delay, jitter and loss ratio. The aim of this project is to investigate current mechanisms to support QoS in wireless multimedia sensor networks; design and develop energy efficient and fault tolerant QoS schemes and protocols (e.g. admission control and scheduling) which will provide QoS guarantees under various dynamic wireless network scenarios including in harsh underground environments.</p>	<p>Dr Hong Zhou</p>	<p><a href="mailto:hong.zhou@usq.edu.au">hong.zhou@usq.edu.a u</a></p>

<p><b>Title:</b> Scheduling algorithms for QoS guarantees in IEEE 802.16 broadband wireless access networks</p> <p><b>Available for Major/s:</b> Computer Science and Engineering, Telecommunications</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In recent years, there have been increasing demands for delivering a wide range of real-time multimedia applications (i.e. voice over IP, video conferencing, and video-on-demand) in wireless networks. IEEE 802.16 broadband wireless access (BWA) systems (also named WiMAX) provide fixed-wireless access for individual homes and business offices through the base station instead of cable and DSL in wired networks. This creates great flexibility and convenience as well as challenges for the design and analysis of such networks. Multimedia communications require certain level of Quality of Services (QoS) guarantees and individual applications also have very diverse QoS requirements. The wireless networks are required to support real-time multimedia applications with different QoS guarantees.</p> <p>Scheduling algorithms play a key role in satisfying these QoS requirements. IEEE 802.6 media access control specifies QoS signalling mechanisms such as bandwidth requests and bandwidth allocation. However, IEEE802.16 left the QoS based packet scheduling algorithms undefined. In recent years, several scheduling algorithms for broadband wireless networks were published. However, there is inadequate research specially focused on IEEE802.16. In this project, we will propose solution which is practical and compatible for IEEE 802.16 QoS signalling mechanism; examine the access delay of real-time traffic in IEEE 802.16 systems for various algorithms; demonstrate the proposed architecture and algorithm can support diverse real-time multimedia traffic with different QoS guarantees.</p>	<p>Dr Hong Zhou</p>	<p><a href="mailto:hong.zhou@usq.edu.au">hong.zhou@usq.edu.au</a></p>
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<p><b>Title:</b> Optimal node deployment of large scale wireless sensor networks</p> <p><b>Available for Major/s:</b> Computer Science and Engineering, Telecommunications</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Node deployment is very important to a successful implementation of a large scale wireless sensor network (WSN). The number, position and node type determine the properties of a WSN system such as power consumption, reliability and overall cost. The deployment generally can be divided into two categories: uniform and non uniform distribution. In terms of functionality, nodes can be classified into three categories: sensing node, relay node and sensing/relay node.</p> <p>The aim of this research to develop the optimal deployment strategy which can minimize the deployment and operation cost for a given Quality of Service constraints. The issue can be more challenging and demanding in hostile underground mining environment where sensor nodes may fail or be blocked due to lack of power or physical damage where some redundancy must be considered. The new design developed in this research must balance the requirements of the cost and QoS requirements and also take into account the fault tolerance and scalable dynamic routing protocols.</p>	<p>Dr Hong Zhou</p>	<p><a href="mailto:hong.zhou@usq.edu.au">hong.zhou@usq.edu.au</a></p>
<p><b>Title:</b> Multimedia Real-Time Communications Protocols for Underground Wireless Sensor Networks</p> <p><b>Available for Major/s:</b> Computer Science and Engineering, Telecommunications</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Wireless Sensor Networks is very popular in underground mine applications. As the name indicates WSN can be regarded as a combination of two set of functionalities. That is, the collection of sensing information and the transportation of information through a wireless network.</p> <p>To enhance the safety and increase the productivity in the operation of underground mines, it is very important to continuously monitor the miners and environmental conditions such as temperature, carbon monoxide levels and methane levels. When underground mine accident occur, the two way real-time multimedia communications with the miners will become critical for rescue efforts.</p> <p>Real-time applications have stringent requirements on Quality of Service (QoS) which the critical data will experience. The aim of this project is to design and develop QoS provisioning schemes which will guarantee the quality of the service in different scenarios. The innovative schemes developed include scalable dynamic admission control mechanism, scheduling algorithms and QoS routing protocols.</p>	<p>Dr Hong Zhou</p>	<p><a href="mailto:hong.zhou@usq.edu.au">hong.zhou@usq.edu.au</a></p>

**Engineering Education**

Project Description	Staff Member(s)	Email
<p><b>Title:</b> Technological impacts on the learning experience</p> <p><b>Available for Major/s:</b> Engineering (Education)</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Internet-based technologies are widely used to support student learning for on-campus students as well as students that are far away from campus. Modern distance education; however, largely depends on Information and Communication Technologies (ICT) to provide inclusive and engaging learning environments. Factors such as design and delivery of course material, attributes and experiences of learners and technical performance all have an impact on the quality of the learning experience. These factors have an effect on how students interact with learning activities. Even in industrially developed, geographically large countries such as the United States or Australia, Internet access speed and quality differs considerably between metro and rural/remote areas; marking a digital divide. The term digital divide is often used to describe inequality of Internet access technology along geographical but also social lines. Recent results (Kist 2011) indicate that Quality of Design and Delivery is a more dominant factor for Quality of Experience of Learners than Quality of Service (QoS). This research will follow on from these results and investigate how the learning experience relates to technical performance of learning and teaching systems and what impact design and delivery of the course material have. It will contrast these results with the improved Internet access the Australian National Broadband Network (NBN) will provide and investigate what impact the NBN has on the digital divide in the context of distance education.</p>	Dr Alexander Kist	<a href="mailto:kist@usq.edu.au">kist@usq.edu.au</a>

## Mechanical and Mechatronic Engineering

Project Description	Staff Member(s)	Email
<p><b>Title:</b> Applications of machine vision and mechatronics</p> <p><b>Available for Major/s:</b> Electrical/ Software/ Mechatronics Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Within the National Centre for Engineering in Agriculture many interesting problems emerge. These have in the past ranged from the use of structured light to determine the 'quality' of cattle, the use of machine vision to identify species, the use of microspectral techniques to identify weeds, with the accompanying electromechanical systems to put them to practical use.</p> <p>Students with potential aptitudes in such areas can be launched into appropriate programmes of research. If possible, they should bring an application area of their own, which need not be specifically agricultural.</p>	Prof John Billingsley	<a href="mailto:billings@usq.edu.au">billings@usq.edu.au</a>
<p><b>Title:</b> Ejector pump design analysis and optimisation</p> <p><b>Available for Major/s:</b> Mechanical, Mechatronic, Instrumentation</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Renewable energy technologies for refrigeration and air conditioning applications are of increasing interest. The ejector pump concept has significant potential for use in refrigeration and air conditioning applications that are driven by low grade sources such as solar energy but the efficiency of ejector pumps is relatively poor. Ejector pumps are driven using a high energy stream that is accelerated through a nozzle to a supersonic speed which then draws in the low pressure fluid and through a high speed mixing and deceleration process, the low pressure stream is pumped up to a higher pressure. Successful optimisation and off-design operation of ejector pumps is hampered by a lack of understanding of the physical processes occurring in the ejector. Opportunities to make important contributions in the design and optimisation of ejector pump systems currently exist in a number of areas which individually, or in suitable combination, can form topics for research masters and PhD programs. These areas include:</p> <ol style="list-style-type: none"> <li>(1) Flow visualisation and analysis. Optimisation of the mixing and compression processes can be improved through a detailed understanding of flow structures present in the ejector. Methods currently under development include schlieren visualisation and particle image velocimetry. Improved implementation of these methods is needed to precisely determine the unsteady density and velocity fields in the high speed mixing and compression process.</li> <li>(2) Temperature field assessment. Precise characterisation of the distribution of flow temperatures should be</li> </ol>	Prof David Buttsworth	<a href="mailto:david.buttsworth@usq.edu.au">david.buttsworth@usq.edu.au</a>

<p>possible using tunable diode laser absorption spectroscopy and these measurements will enhance our understanding of the critical ejector flow processes.</p> <p>(3) Thermodynamic state characterisation. Flow from the supersonic nozzle can be in a supersaturated state but because of the high speeds, condensation does not occur immediately at the supersonic nozzle exit. Fundamental measurements and simulations of the nozzle flow are needed to determine if we can correctly model the inviscid flow field.</p> <p>(4) Characterisation of unsteady compression effects. The compression process in the ejector takes place through a series of shock waves which can oscillate within the duct as they interact with turbulence in the mixing and boundary layer regions. Shock waves are a dominant feature of the ejector. Characterising shock wave behaviour for on- and off-design operation is expected to provide insight into the mechanics of ejector performance.</p> <p>(5) Computational simulation. The flow within the ejector is complex and subject to substantial uncertainties in the thermodynamic state and the influence of heat transfer and turbulence effects. A number of well-developed CFD tools are currently available to assist this ejector research and improvements to computational simulation capabilities is expected to be made in conjunction with the new measurements outlined above.</p> <p>(6) Investigation of alternative ejector configurations. Ejector configurations normally adopted are axisymmetric – a central nozzle within a duct of circular cross-section. Alternative arrangements are possible and these might be adopted for reasons of improved performance, manufacturability, or suitability in particular applications. Analysis, simulation, and experimentation with alternative configurations in needed.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>Research students are expected to have demonstrated capabilities in the laboratory environment and will become proficient in the application of Matlab and other computational tools to the simulation and analysis of ejector flow measurements.</p>		
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<p><b>Title:</b> Development of Structural Health Monitoring Systems (SHM) for advanced composite structures</p> <p><b>Available for Major/s:</b> Mechanical/ Civil/ Materials/ Chemical</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The detection of structural damage such as cracks and delamination in beams remains an important problem in structural health monitoring and is an active area of research. There are various methods for structural damage detection like non-destructive testing methods such as strain field analysis, modal analysis; acoustic and ultrasonic methods are some of the emerging structural health monitoring methods that are technically mature enough to be used as structure integrated damage monitoring system. Using the recent advancements in active and passive sensor systems such as fibre optic sensors and the advanced modelling and analytical tools this project can be tailored to many projects on the development of SHM systems for various structures/components depending on their applications.</p>	<p>Dr Jayantha Epaarachchi Prof Alan Lau</p>	<p><a href="mailto:eparracj@usq.edu.au">eparracj@usq.edu.au</a> <a href="mailto:Kin-tak.Lau@usq.edu.au">Kin-tak.Lau@usq.edu.au</a></p>
<p><b>Title:</b> Development of smart composite structures</p> <p><b>Available for Majors:</b> Mechanical/Civil/Materials/Chemical</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Advanced composite structures has been widely using in a variety of engineering applications including aerospace, automobile, petro-chemical and civil infrastructures for a few decades. At present there is a great demand for intelligent/smart composite structures in these fields which are possible to maintain more effective and efficient manner. The development of advanced composites are becoming more feasible with the recent development of active and passive sensor systems and other materials such as shape memory alloy. However, the development of smart structures depends on the nature of the application. This project is not limited to a single component/structure and can be tailored for many projects depending on the application.</p>	<p>Dr Jayantha Epaarachchi Prof Alan Lau</p>	<p><a href="mailto:eparracj@usq.edu.au">eparracj@usq.edu.au</a> <a href="mailto:Kin-tak.Lau@usq.edu.au">Kin-tak.Lau@usq.edu.au</a></p>
<p><b>Title:</b> Power generation using solar-gas hybrid technologies</p> <p><b>Available for Major/s:</b> Mechanical/ Power Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Concentrating Solar Power – Parabolic Trough (CSP-PT) installations consist of linear parabolic mirrors which concentrate solar energy to heat tubes of oil or salt to high temperatures, typically to several hundred degrees centigrade. The thermal energy produced can be stored to enable continuous 24-hour operation of the turbine generator, but this option is generally expensive. As an alternative considering the vast natural and coal-seam gas footprint in Australia, an approx 20% boost from natural gas can be deployed, which enables the plant to operate continuously. The purpose of this research is to investigate if the CSP-PT +20% gas boost technology would present the best option (as a feasibility study and conceptual design) for Australia and potentially other parts of the world to address the growing global energy demand.</p>	<p>Mr Steven Goh Dr Ian Craig</p>	<p><a href="mailto:steven.goh@usq.edu.au">steven.goh@usq.edu.au</a> <a href="mailto:ian.craig@usq.edu.au">ian.craig@usq.edu.au</a></p>

<p><b>Title:</b> Development of a biodegradable composite artificial reef system</p> <p><b>Available for Major/s:</b> Mechanical / Civil Engineering / Materials Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The main aim of this project is to develop a biodegradable fibre composite artificial reef (CAR) system using natural fibres for sea water cleanup and other purposes.</p> <p>This project will use natural fibres mixed with PLA, PBA or other biodegradable polymer to fabricate a new type of composite artificial reef (CAR). The project methodology includes studying the type of natural fibre which is good for this purpose (good natural degradability in sea water without generating any harmful effect to micro-organisms (sea), say using seaweed fibre), designing the architecture of the reef for CAR through experimental, theoretical and computational approaches, their effectiveness in trapping rubbish (actual size of the rubbish should be known and studied), manufacturing process, mixture process and composition of fibre and polymer, the growth rate of coral may also issue to be studied, site tests are required to study the effectiveness of the designed CAR.</p>	<p>Dr Mainul Islam</p>	<p><a href="mailto:mainul.islam@usq.edu.au">mainul.islam@usq.edu.au</a></p>
<p><b>Title:</b> Development of fibre composite road tanker</p> <p><b>Available for Major/s:</b> Mechanical Engineering / Civil Engineering / Materials Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The main aim of this project is to establish research for the development of application systems for fibre composite materials in the transport industry for corrosive liquid road tankers.</p> <p>Currently the transport industry is utilising tankers that are expensive to purchase and have high maintenance costs from a very early life span. This project will aim to resolve which materials best suit the required production system that will result in longest life span capability in respect of corrosive liquids.</p> <p>The intention of this project is the study and application of fibre composites directly in relation to corrosive chemicals as used extensively in the agri-business market throughout Australia. Examination of fibre composites used in production of liquid road tankers reveals that there is no current method in place to determine life-span or long-term effects of corrosive chemicals on tanker linings. The intended project will analyse current data and determine through experiments which composite materials and systems of application will deliver best result in corrosive resistance and develop a prediction model on the long-term effects of such liquids on differing materials.</p>	<p>Dr Mainul Islam</p>	<p><a href="mailto:mainul.islam@usq.edu.au">mainul.islam@usq.edu.au</a></p>

<p><b>Title:</b> Fabrication and properties of syntactic foams and foam core sandwich composites</p> <p><b>Available for Major/s:</b> Mechanical Engineering / Civil Engineering / Materials Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Syntactic foams are in general ternary materials made of pre-formed hollow microspheres, binder and voids. Syntactic foams can be used as various structural components including sandwich composites and in areas where low densities are required e.g. undersea/marine equipment for deep ocean current-metering, anti-submarine warfare and others. Their other uses include products in aerospace, automotive and building industries. However, the densities of syntactic foams in the past have been relatively high compared to the traditional expandable foams, limiting their applications.</p> <p>A wide variety of materials can be used for syntactic foams. The filler microspheres may be glass, polymeric, carbon, ceramic or metallic materials. Thus, a wide range of different types of syntactic foams can be made by selecting different materials and consolidating techniques for binder and hollow microspheres. Various types of sandwich composites can also be made by selecting different constituent materials for core and skins. For the selection of constituent materials, factors such as properties and cost may be considered.</p> <p>Main objectives of this project are to (a) develop novel syntactic foams using hollow microspheres and suitable binders, (b) investigate relationships between various manufacturing parameters, (c) investigate mixing behaviour of fillers and binders, (d) characterise mechanical behaviour of the developed syntactic foams, and (e) develop and investigate properties of novel sandwich composites made of developed syntactic foams and suitable skins.</p>	<p>Dr Mainul Islam</p>	<p><a href="mailto:mainul.islam@usq.edu.au">mainul.islam@usq.edu.au</a></p>
<p><b>Title:</b> Autonomous Mobile Robot Development</p> <p><b>Available for Major/s:</b> Computer systems/ Electrical/ Mechatronic/ Mechanical/Software</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The roles of autonomous robots are numerous, with many of their functions overlapping in their applications. Postgraduates interested in this area are open to tackle problems such as Navigation, Obstacle Avoidance, Path Planning, Sensor Fusion, Mechanical Robustness, Image Processing, Machine Vision, Control, Learning and Artificial Intelligence. At present, mobile robots are mainly remote controlled. These research topics aim to remove such an operator and allow the mobile robot to perform basic and even complex tasks independently.</p>	<p>Dr Tobias Low</p>	<p><a href="mailto:Tobias.Low@usq.edu.au">Tobias.Low@usq.edu.au</a></p>

<p><b>Title:</b> Obstacle Detection using Vision for Mobile Robots.</p> <p><b>Available for Major/s:</b> Computer systems/Electrical/Mechatronic/Software</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Traditionally, autonomous mobile robots utilise active-based sensors such as laser and sonar system for obstacle detection and avoidance. However, many mobile robots are incorporating vision systems for more complex tasks in image recognition and localisation. Visual information obtained from a camera image, and moreover multiple camera images can theoretically provide (under certain conditions) complete 3D structure of a scene. This ultimately makes active sensors redundant, an observation also evident in biological animals.</p> <p>This project looks to develop a visual-based obstacle detection technique for the task for autonomous mobile robot navigation. Students will mainly gain experience developing and implementing computer-vision algorithms, alongside developing control aspects of a wheel-based mobile robot platform.</p>	Dr Tobias Low	<a href="mailto:Tobias.Low@usq.edu.au">Tobias.Low@usq.edu.au</a>
<p><b>Title:</b> Mobile Robot Poultry Guard/Monitor Project – Navigation System Design</p> <p><b>Available for Major/s:</b> Agricultural/Computer systems/Electrical/Environmental/Instrumentation and Control/Mechatronic/Mechanical</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The monitoring of animal welfare in their environments, in particular, poultry, is becoming a large concern within society. Farmers typically have to monitor broilers (poultry) and their environments by traditional means such as scan sampling, a technique of observing and recording animal behaviour at pre-selected time intervals. The information gathered from monitoring can be used to assess animal welfare and its environment so that it can be improved on. However, these manual processes are time-consuming and look to only monitor the broiler’s environment at certain times. As such, this project looks to develop an automated process for the monitoring of broilers that remove the need for the manual processes in obtaining environmental and behavioural information.</p> <p>As a component of the overall Robot Poultry Monitor (RPM) project, this topic focuses on the development of a navigation system for a mobile robot operating in broiler sheds. Students will gain experience in developing a navigational technique for use in a mobile robot for the exploration of a broiler shed. Difficulties involved in the development include, but are not limited to:</p> <ol style="list-style-type: none"> <li>1. Dynamic and lazy obstacles that the robot must identify and minimise the potential damage.</li> <li>2. Reactive, real-time requirements.</li> <li>3. Low cost and low power system.</li> <li>4. Robust and able to recover from unseen circumstances.</li> <li>5. Difficult and non-uniform terrain.</li> </ol>	<p>Dr Tobias Low</p> <p>Assoc Prof Thomas Banhazi</p> <p>Prof Nigel Hancock</p> <p>Dr Cheryl McCarthy</p>	<p><a href="mailto:Tobias.Low@usq.edu.au">Tobias.Low@usq.edu.au</a></p> <p><a href="mailto:Thomas.Banhazi@usq.edu.au">Thomas.Banhazi@usq.edu.au</a></p> <p><a href="mailto:nigel.hancock@usq.edu.au">nigel.hancock@usq.edu.au</a></p> <p><a href="mailto:cheryl.mccarthy@usq.edu.au">cheryl.mccarthy@usq.edu.au</a></p>

<p><b>Title:</b> Control issues for a novel variable compression ratio mechanism for internal combustion engines</p> <p><b>Available for Major/s:</b> Mechanical/Mechatronic Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Patent application has been made for a novel variable compression ratio mechanism for internal combustion engines. Modelling has identified significant engine efficiency improvement when the variable compression ratio mechanism is employed together with variable valve timing facilitating an Atkinson Cycle configuration for low load operation. The variable compression ratio feature allows the engine to also produce the maximum power available from the engine displacement through a full induction stroke. The device is a modified, variable-length connecting rod that uses hydraulic chambers each side of a floating bush at the big-end of the connecting rod. During the cycle of all 4-stroke engines, compressive and tensile loads exist on the connecting rod at various times. These loads allow incremental rod length change if the flow of oil between the two oil chambers can be controlled. The first prototype created in previous work successfully demonstrated the capability of the device in a motored engine under moderate engine pressure loads and engine speeds. The goal for further work is to explore optimisation of the mechanism that achieves the rod length change, together with the control device and its actuation device in conjunction with the engine control system. The work will need to consider component reliability, manufacturing complexity and the ability for the mechanism to integrate into a conventional engine configuration. Modelling, prototyping and experimentation will be integral components of this work.</p> <p><b>Expectations/Additional Requirements, if any:</b></p> <p>Applicant should have experience with or the ability to master the use of Matlab for various forms of simulation. Solid modelling software (ProEngineer) and multi-physical analysis software (Ansys) have been used extensively in past work on this project and familiarity with or the ability to learn these applications would be necessary. Knowledge of modern engine control systems would be advantageous. A natural ability with mechanical devices and a hand-on approach to research are essential.</p>	<p>Dr Ray Malpress</p>	<p><a href="mailto:ray.malpress@usq.edu.au">ray.malpress@usq.edu.au</a></p>
<p><b>Title:</b> Machine vision-based weed spot spraying</p> <p><b>Available for Major/s:</b> Mechatronic/ Electrical/ Computer systems</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>This project aims to develop machine vision-based precision spray technologies for the sugar, cotton and/or grains industries in response to increasing pressures on herbicide use. Currently there exists no commercial technology that can reliably distinguish green weeds from green crop based on visual features (e.g. spectral response, shape and texture) and success in this area represents a major technical breakthrough. The research will involve the development of new technologies for detecting weeds in a crop. Skills in programming and image analysis are desirable for this project.</p>	<p>Ms Cheryl McCarthy</p>	<p><a href="mailto:cheryl.mccarthy@usq.edu.au">cheryl.mccarthy@usq.edu.au</a></p>

<p><b>Title:</b> Porous media for radiation blockage and particle filtration in large size applications</p> <p><b>Originator: Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Porous materials are widely used for sifting solid particles from fluids, filtering bacteria, membrane systems and separation of various fluids and gases. They are also used in heat transfer applications such as cooling towers, liquid rocket engines and building protection industries. Recent studies show that they can be very effective to protect objects against radiant heat fluxes. In this project, computational and experimental approaches will be used to determine, monitor and improve the performance of porous material at large size applications which require radiation blockage and mass filtration simultaneously. The project includes the following key steps;</p> <ol style="list-style-type: none"> <li>1. Establishing the correlation between porosities and particle sizes (high temperature wind tunnel),</li> <li>2. Finding the relationship between porosities and blockage of passing radiant heat fluxes (ANSYS and pyrometer),</li> <li>3. Obtaining the relationship between porosities, material properties and radiant heat fluxes from porous material at elevated temperature (ANSYS , pyrometer and radiometer),</li> <li>4. Determining thermal stresses of porous material at high radiant heat flux environment (ANSYS, MATLAB and tensile test machine),</li> <li>5. Finding the relationship between porosities and drag forces (FLUENT and wind tunnel),</li> <li>6. Design of the optimal configuration for a particular high temperature application (MATLAB, AUTOCAD, ANSYS),</li> <li>7. Prototype manufacturing (workshop).</li> </ol> <p>The results of this work particularly will improve high temperature applications of porous material such as design of cooling towers, jet engines, automobile industry, fuel transportation systems, burner designs, and building protection against bushfires.</p>	<p>Dr. Ahmad Sharifian</p>	<p><a href="mailto:sharifia@usq.edu.au">sharifia@usq.edu.au</a></p>
<p><b>Title:</b> Design of high performance short towers for solar tower plants</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The production and use of fossil fuels contributes to environmental pollution and is unsustainable. A Solar Tower Plant (or Solar Chimney Plant) is a renewable energy producing power plant that comprises the chimney effect, the greenhouse effect and the wind turbine technology. Air is contained in a large greenhouse structure around the base of a tall tower or chimney. Sun heats up the air and reduces its density. The warm and light air rises up in the tower and the airflow drives turbines and produces electricity. The output power of a Solar Tower</p>	<p>Dr. Ahmad Sharifian</p>	<p><a href="mailto:sharifia@usq.edu.au">sharifia@usq.edu.au</a></p>

<p>depends on the height of the tower and the collector area under a specified metrological condition. Solar Tower Plants offer several advantages, such as no requirement to high tech material (as they require mainly concrete and glass) and no requirement to cooling water. The main disadvantage of Solar Tower plants is their requirement to tall towers.</p> <p>The aim of this study is to model and optimize the system and determine the possibility of shorten the height of the tower in order to reduce initial construction cost. Several computer simulation codes (ANSYS, FLUENT and MATLAB) will be developed that will describe the main components, their performance, and their interactions. The accuracy of the code and the results will be verified by experimental studies using a small-scale model in the labour.</p>		
<p><b>Title:</b> High performance CNTs' web for CNT based products: Modelling and processing CNT's macro-structures</p> <p><b>Available for Major:</b> Materials Science/ Mechanical Engineering/ Advanced Fibrous Materials/ Nanotechnology</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Research studies on Carbon Nanotubes (CNT) have revealed the unique atomic structure, very high aspect ratio, and extraordinary mechanical and electromechanical properties of these materials. Various applications have been discussed for nano-mechanics, advanced electronics, bio-technology, etc, using the CNT unique performance. However the absence of reliable methods for controlling the assembly of large numbers of CNTs limits the productivity required for wide-spread practical applications. In fact, the solid-state processes used to date for converting CNTs into macro-structures typically produce products with significantly lower properties (i.e. tensile strength, electrical and thermal conductivities) than those of individual CNTs.</p> <p>This project aims to model of the assembly of CNT fibres into macroscopic structures. In the model, the inter-nanotube interaction based on van der Waals forces will be considered with the regard to the effect of the bonds on the interfacial interaction. The development in polymer physics that describe polymer movement in concentrated solutions will be used as a basis for understanding factors that influence on CNT migration in the web. This will establish the potential to develop a predictive framework to describe the movement of CNT bundles within the web surface through a judicious specification of their structures. This will lead to a better understanding of the structure property relationships of these structures and yields CNT's application in many different areas.</p> <p>The research allows for extending USQ's recognised research potential in the CNTs, CNT based nanotechnology. The research achievement will advance knowledge of Advanced Fibrous Materials and bring enormous benefits to industry.</p>	<p>Dr. C.-D Tran</p> <p>Prof. T. Tran-Cong</p> <p>Dr. S. Lucas (CSIRO)</p>	<p><a href="mailto:Canh-Dung.Tran@usq.edu.au">Canh-Dung.Tran@usq.edu.au</a></p> <p><a href="mailto:thanh.tran-cong@usq.edu.au">thanh.tran-cong@usq.edu.au</a></p>

<p><b>Title:</b> Carbon Nano Tube (CNT) reinforced polymer composite materials</p> <p><b>Available for Major:</b> Materials Science/ Mechanical Engineering/ Advanced Fibrous Materials/ Textile and fibre technology /Nanotechnology &amp; Polymer chemistry</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Carbon nanotube's unique properties of high tensile strength and Young's modulus, high aspect ratio, and good electrical and thermal conductivities have made possible novel applications, for example, in nanomechanics, advanced electronics and ballistics. The CNTs in fibre reinforced composites with their very small diameters (4–10 nm) and high aspect ratios (1000–10000) have received increased attention as reinforcements for polymer composites. Significant effort has focused on fabricating macroscopic structures to make use of the CNT's unique properties, in particular by producing blended polymer/CNT composites with improved physical and mechanical properties. Furthermore, it has been theorized that CNTs can enhance the mechanical properties of polymer composites at relatively low loadings of nanotubes due to the high aspect ratio and excellent physical properties. In the most recent polymer/CNT composite studies, CNTs have been used as discontinuous reinforcement for polymer matrices, for example, they have been fabricated into films and yarns, using a variety of techniques. However, the most difficult and complex problem in these approaches is the alignment and dispersion capability of CNTs because of their easy agglomeration in polymer liquids. These issues essentially define the basic challenges for applied CNT composite research.</p> <p>This research theme aims (i) to study the relationship between CNTs' properties and CNTs' structure and the properties of composite materials, specially their mechanical behaviours; (ii) to devise the treatments for aligning and handling the CNTs' interaction in the composite media in order to improve the properties of composite materials and (iii) to develop modelling of CNT based polymer composite materials.</p> <p>The research allows for extending USQ's recognised research potential in the CNTs and CNT based nanotechnology. The research achievement will advance knowledge and bring enormous benefits to industry.</p>	<p>Dr. C.-D Tran</p> <p>Prof. T. Tran-Cong</p> <p>Dr. T. Truong (DSTO)</p>	<p><a href="mailto:Canh-Dung.Tran@usq.edu.au">Canh-Dung.Tran@usq.edu.au</a></p> <p><a href="mailto:thanh.tran-cong@usq.edu.au">thanh.tran-cong@usq.edu.au</a></p>
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<p><b>Title:</b> Analysis of performance issues with internal combustion engines</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>With continuing questions about the long-term reserves of fossil fuels and the environmental impacts of their use, it is important to try to utilise this resource in the best way possible. Automobiles are a major contributor to the consumption of fossil fuels and because of the unique requirements of the transport industry (relatively high power with relatively low weight), the overall efficiency of internal combustion engines is significantly lower than for fixed power stations, so continuing research is required.</p> <p>There is potential for a number of students to research the latest technological developments in this industry by undertaking modelling work using Computational Fluid Dynamics (CFD) and/or experiments. Some of the work currently being undertaken involves usage of new engine operating techniques (HCCI: Homogeneous Charge Compression Ignition), alternative fuels (such as natural gas) and conventional fuels with additives (such as hydrogen and natural gas).</p>	<p>Dr Andrew Wandel Assoc Prof Talal Yusaf</p>	<p><a href="mailto:andrew.wandel@usq.edu.au">andrew.wandel@usq.edu.au</a> <a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>
<p><b>Title:</b> Analysis of performance issues with internal combustion engines</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>With continuing questions about the long-term reserves of fossil fuels and the environmental impacts of their use, it is important to try to utilise this resource in the best way possible. Automobiles are a major contributor to the consumption of fossil fuels and because of the unique requirements of the transport industry (relatively high power with relatively low weight), the overall efficiency of internal combustion engines is significantly lower than for fixed power stations, so continuing research is required.</p> <p>There is potential for a number of students to research the latest technological developments in this industry by undertaking modelling work using Computational Fluid Dynamics (CFD) and/or experiments. Some of the work currently being undertaken involves usage of new engine operating techniques (HCCI: Homogeneous Charge Compression Ignition), alternative fuels (such as natural gas) and conventional fuels with additives (such as hydrogen and natural gas).</p>	<p>Dr Andrew Wandel Assoc Prof Talal Yusaf</p>	<p><a href="mailto:andrew.wandel@usq.edu.au">andrew.wandel@usq.edu.au</a> <a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>

<p><b>Title:</b> Geopolymer --- a green alternative to ordinary cement and concrete</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Cement/concrete is the second largest volume materials (after water) used globally. Annually, world consumption of cement is 3 billion ton. Because the cement manufacturing process involves high temperature calcinations, the industry is the third largest industrial consumer of energy. It contributes about 10% of the world's CO<sub>2</sub> emission. Geopolymer uses fly-ash and slag to react with alkaline liquids at temperatures below 50°C and produce a cement-like binder paste. When it hardens, it behaves as cement or concrete if it is mixed with aggregates. Geopolymer can be a revolutionary material as the green alternative to cement. In addition it uses industrial by-products as raw materials (fly-ash from power station and slag from smelter).</p>	Assoc Prof Hao Wang	<a href="mailto:hao.wang@usq.edu.au">hao.wang@usq.edu.au</a>
<p><b>Title:</b> Natural fibre composites and natural polymers</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Composite materials suppliers, manufacturers and end-users have a significant un-met demand in environmentally friendly technologies, particularly materials from renewable sources. Research has shown that there is significant potential for natural fibre composites to replace glass fibre composites, wood and other non-structural and semi-structural materials. This research theme aims to develop composite materials based on renewable naturally-sourced fibres and resins, and to improve the design methodologies, manufacturing processes and the performance of the natural fibre composites. It extends USQ's recognised research strength on fibre glass composites and uses natural fibres, such as flax, hemp and jute, to replace the synthetic fibres as reinforcement in composites.</p>	Assoc Prof Hao Wang	<a href="mailto:hao.wang@usq.edu.au">hao.wang@usq.edu.au</a>
<p><b>Title:</b> Statistical analysis of experimental data for tribological applications</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>There are various parameters that influence the tribological performance of materials including load, speeds, sliding distance, contact conditions. The current literature lacks information on the method of analyses of the experimental data. In this project, the student is requested to investigate the experimental data of the tribological performance of different types of materials using the existing statistical techniques. The aim is to reduce the number of experiments and to identify the critical parameters to be used in design. In the second stage, the student is required to develop a suitable method of analysing experimental data, implement the developed method for other materials for verification purposes.</p>	Dr Belal Yousif Dr Sourish Banerjee	<a href="mailto:BelalF.Yousif@usq.edu.au">BelalF.Yousif@usq.edu.au</a> <a href="mailto:Sourish.Banerjee@usq.edu.au">Sourish.Banerjee@usq.edu.au</a>

<p><b>Title:</b> Bio-lubricant for IC engines</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In this project, the student is requested to investigate the possibility of using available bio-oil for lubricant for internal combustion engines. Tribological setup should be used to test the oil and to study the performance of the oil at different conditions, i.e. load, speed, environmental temperature. The effects of additives should be considered as well. Modelling of the film thickness should be developed.</p>	<p>Dr Belal Yousif Assoc Prof Talal Yusaf</p>	<p><a href="mailto:BelalF.Yousif@usq.edu.au">BelalF.Yousif@usq.edu.au</a> <a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>
<p><b>Title:</b> Natural fibres polymeric composites for bearing applications</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>In this project, the student is requested to investigate the possibility of using natural fibres as reinforcement for polymeric composites to be implemented for bearing applications. Tribological setup should be used to test the developed materials. Several parameters should be considered to optimize the performance of the materials. Numerical modelling of the bearing should be developed for predicting the performance and for design optimization.</p>	<p>Dr Belal Yousif Dr Sourish Banerjee</p>	<p><a href="mailto:BelalF.Yousif@usq.edu.au">BelalF.Yousif@usq.edu.au</a> <a href="mailto:Sourish.Banerjee@usq.edu.au">Sourish.Banerjee@usq.edu.au</a></p>
<p><b>Title:</b> Biogas production using waste water</p> <p><b>Available for Major:</b> Agricultural/Mechanical/ Chemical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The aim of this project is to utilize the waste energy stored in waste water ponds such as Abattoir, oil plant, effluent etc and convert it to useful energy. The energy will then be converted to mechanical/electrical energy using mechanical devices such as gas turbine or/and IC engine</p>	<p>Assoc Prof Talal Yusaf</p>	<p><a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>
<p><b>Title:</b> Ultrasound Technology for Disinfection as a Pre-treatment for Reverse Osmosis (RO)</p> <p><b>Available for Major:</b> Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>This project is an attempt to investigate the efficiency of ultrasound technology for controlling biofouling in RO membrane system. Prior to using ultrasound technology for this purpose, the optimum operation conditions of ultrasound treatment were identified theoretically and experimentally. The optimum ultrasound treatment was then applied to treat the feed water of RO system. The performance of ultrasound as a biofouling controller was evaluated through visualizing the accumulated biofilm on the membrane and measuring the permeate flux of untreated and treated feed. The outcomes of this study showed that ultrasound treatment can be used as an efficient anti-biofouling technique.</p>	<p>Assoc Prof Talal Yusaf</p>	<p><a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>

<p><b>Title:</b> Applicability and Implementation of Hydrogen Gas for Internal Combustion Engines</p> <p><b>Available for Major:</b> Mechanical/ Chemical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b>                  The project aims to produce Hydrogen and use it as additive fuel in ICE engine</p> <ol style="list-style-type: none"> <li>1. To implement the usage of hydrogen gas for internal engines.</li> <li>2. To develop a complete system for the above mentioned application.</li> <li>3. To develop a correct hydrogen delivery system to an internal combustion engine.</li> </ol>	Assoc Prof Talal Yusaf	<a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a>
<p><b>Title:</b> Mechanical treatment for microorganism disruption</p> <p><b>Available for Major/s:</b> Mechanical/ Chemical/ Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b>                  Mechanical treatment for microorganism disruption, a three suggested method to identify the real cause of cell wall disruption using ultrasound, these three methods are shear stress, strain energy and shock wave. The background is chemical and mechanical engineering. Knowledge on biology is positive.</p>	Assoc Prof Talal Yusaf	<a href="mailto:yusaf@usq.edu.au">yusaf@usq.edu.au</a>
<p><b>Title:</b> Revising of greenhouse gas emission factors for agriculture</p> <p><b>Available for Major:</b> Mechanical/ Agricultural Engineering</p> <p><b>Project Description/Direction(s)/Information:</b>                  Diesel engines that commonly used in highly mechanised irrigated agriculture and tractors contribute a significant proportion of the total green house gas emissions generated (GHG) on farm. Stringent GHG emission control legislations internationally imposed for off-road diesel engines are applied on tractors as part of off-road mobile sources. National GHG emission estimates of combusting conventional diesel fuel in agriculture in many countries and Australia are based on the (what IPCC) IPCC guidelines emissions factors, and in turn, those emissions factors are taken from studies conducted in 1975 (need reference). The deficiency of these emission factors include, i) no consideration of the transient effects of engine performance and duty on emissions, ii) measurements were based on a relatively small sample of tractors and iii) studies were based on older tractor models with engine technology no longer in use. Inaccurate emissions factors lead to inaccurate estimates thereby inefficient legislation. This proposal studies GHG emission factors for diesel engine in agricultural tractors taking in consideration the transient effect of the rail life cycle on the engine performance and engine technology used in agriculture.</p>	Assoc Prof Talal Yusaf	<a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a>

<p><b>Title:</b> Alternative Fuel from Microalgae for Diesel Engine</p> <p><b>Available for Major:</b> Agricultural/Mechanical Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The project aims to produce alternative fuel for diesel engine especially for agricultural applications. It has been reported that microalgae will be the best alternative fuel for the future for many reasons: it is environmentally friendly biodegradable, the biomass productivity is many time folds the biomass from other crops and it will not affect the human food production. The project consists of the following parts, 1, Growing microalgae in small and large scale. 2, Harvesting microalgae biomass from the medium. 3, Extracting the oil from the biomass. 4, Some analysis for microalgae biodiesel. 5, Testing the engine performance and emissions at different operation conditions using microalgae biodiesel in different blend ratio with diesel.</p>	<p>Assoc Prof Talal Yusaf</p>	<p><a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a></p>
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## Surveying and Spatial Science

Project Description	Staff Member(s)	Email
<p><b>Title:</b> Remote sensing and GIS application to environmental management, ecology, and natural resources</p> <p><b>Available for Major/s:</b> GIS/ Remote Sensing/ Geomatic Engineering/ Environmental Science/ Ecology/ Forestry</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>A postgraduate research project can be developed between Dr. Apan and the prospective applicant on a topic that involves the use of remote sensing (satellite imagery) and/or geographic information system (GIS) to environmental science, ecology, forestry, etc. Some of the broad areas include:</p> <ul style="list-style-type: none"> <li>• Remote sensing and GIS to observe terrestrial ecosystems (e.g. productivity, biodiversity, etc.) and their responses to environmental / climate change</li> <li>• Vegetation, forestry and habitat mapping/modelling using GIS and remote sensing</li> <li>• Drought effects, modelling, impact assessment, etc., using geospatial technologies</li> <li>• Biodiversity assessment using geospatial technologies</li> <li>• Land use/cover change analysis using GIS and imagery</li> <li>• Soil erosion and desertification studies involving the use of imagery and GIS</li> <li>• Flood risk mapping, impact assessment, etc. using geospatial technologies</li> </ul> <p>A specific topic can be tailored according to the interest and expertise of the postgraduate applicant.</p>	<p>Assoc Prof Armando Apan</p>	<p><a href="mailto:apana@usq.edu.au">apana@usq.edu.au</a></p> <p><a href="http://www.usq.edu.au/users/apana">http://www.usq.edu.au/users/apana</a></p>
<p><b>Title:</b> Remote sensing and GIS application to agriculture</p> <p><b>Available for Major/s:</b> GIS/ Remote Sensing/ Geomatic Engineering/ Agriculture/ Environmental Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>A postgraduate research project can be developed between Dr. Apan and the prospective applicant on a topic that involves the use of remote sensing (satellite imagery) and/or geographic information system (GIS) to agriculture. Some of the broad areas include:</p> <ul style="list-style-type: none"> <li>• Remote sensing of crop stress (due to disease, water, nutrition, soil, etc.)</li> <li>• Crop yield estimation and monitoring using remote sensing and GIS</li> <li>• Drought monitoring using remote sensing and GIS</li> <li>• Flood risk mapping modelling using remote sensing and GIS</li> <li>• Plantation mapping and monitoring</li> <li>• Spatial technologies for precision agriculture</li> <li>• Soil erosion and desertification studies involving the use of imagery and GIS</li> </ul> <p>A specific topic can be tailored according to the interest and expertise of the postgraduate applicant.</p>	<p>Assoc Prof Armando Apan</p>	<p><a href="mailto:apana@usq.edu.au">apana@usq.edu.au</a></p> <p><a href="http://www.usq.edu.au/users/apana">http://www.usq.edu.au/users/apana</a></p>

<p><b>Title:</b> UAV Topics</p> <p><b>Available for Major/s:</b> Spatial Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The commercial availability of unmanned aerial vehicles has reduced the cost of acquiring imagery for research purposes. USQ has recently acquired a UAV with accompanying sensors</p> <ul style="list-style-type: none"> <li>○ Four sensors             <ul style="list-style-type: none"> <li>▪ Six band multispectral sensor</li> <li>▪ Lidar</li> <li>▪ Thermal sensor</li> <li>▪ Panchromatic camera</li> </ul> </li> <li>○ High accuracy position and orientation sensors             <ul style="list-style-type: none"> <li>▪ Dual frequency GPS</li> <li>▪ Inertial movement sensor</li> </ul> </li> </ul> <p>The ability to deploy these types of sensors inexpensively allows for great flexibility in generating data for:</p> <ul style="list-style-type: none"> <li>● Studies in crop and vegetation monitoring</li> <li>● Studies on the effect of pixel size and sensor on remotely sensed reflectance measurements</li> <li>● Studies on bird habitat physical properties</li> <li>○ Birds are particularly sensitive to the vertical structure of tree canopies with regards to habitat.             <ul style="list-style-type: none"> <li>● Studies on the effect of Lidar point density on vegetation characterisation.</li> </ul> </li> <li>○ USQs terrestrial laser scanner can be employed in creating ground truth data sets.</li> </ul>	Dr Glenn Campbell	<a href="mailto:glenn.campbell@usq.edu.au">glenn.campbell@usq.edu.au</a>
<p><b>Title:</b> Regional atmospheric correction glint removal algorithm for inland water remote sensing</p> <p><b>Available for Major/s:</b> Spatial Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Poor quality atmospheric correction of images has a significant effect on the performance of remote sensing algorithms for the retrieval of water quality parameters such as algae content, suspended sediment and coloured dissolved organic matter. The atmospheric correction of inland case-II waters is particularly difficult because of their optically complex nature. Standard approaches like the MERIS standard normalised surface reflectance product and the BEAM Case-2 Regional Processor (Eutrophic Lakes) were developed in temperate European environments and have been shown to fail in Australian conditions. The geometric relationship between the sun and sensor means that summer images of inland water bodies in northern Australia and other tropical regions are often contaminated by glint. The lack of a regionally appropriate inland waters atmospheric correction process that does not require specialist knowledge to be implemented limits the operational use of remote sensing by environmental engineers or technicians. The development and validation of a robust ‘black box’ correction tool would be of great use to the remote sensing community.</p> <p><b>Expectations/Additional Requirements:</b> Prior experience in software development would be an advantage.</p>	Dr Glenn Campbell	<a href="mailto:glenn.campbell@usq.edu.au">glenn.campbell@usq.edu.au</a>

<p><b>Title:</b> Improving semi-analytical water reflectance models for use in the remote sensing of inland water quality.</p> <p><b>Available for Major/s:</b> Spatial Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The relationship between the optical properties of the colour producing agents (algae, suspended sediment and coloured dissolved organic matter) in the water and the remotely sensed reflectance is complex. All semi-analytical models of this relationship utilise a factor that accounts for the anisotropy in the in-water light field when relating the light field independent inherent optical properties (IOPs) of the water quality parameters to the light field dependent, apparent optical property, reflectance. This anisotropic factor is often estimated empirically. As it is related to the inherent optical properties of the water quality parameters, it means that a very large computational overhead is imposed every time a new environment is targeted. A more analytical relationship between the IOP values and the anisotropy factor would reduce this overhead. Furthermore, the problem of inverting the water reflectance spectrum to retrieve water quality parameter concentrations for inland water is ill-posed. That is, the solution is ambiguous because multiple combinations of water quality parameter concentrations can lead to the same or very similar reflectance spectra. When random measurement noise is superimposed on this already ill-posed problem then the retrieval uncertainties are exacerbated. It would be of benefit to be able to predict the areas of greatest uncertainty directly from the IOP measurements and use the result to flag those inverted pixels as being of uncertain quality.</p>	Dr Glenn Campbell	<a href="mailto:glenn.campbell@usq.edu.au">glenn.campbell@usq.edu.au</a>
<p><b>Title:</b> Sport biomechanics: Foot arch support and body balancing</p> <p><b>Available for Major/s:</b> Spatial Science/ Mechanical and Mechatronic Engineering/ Computer vision</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The research involves the study of foot arch support and body balancing. The study explores the quality of body balancing based on the type of foot arch support (insole). Foot arch of test subjects are captured by high-speed video imaging techniques and the gait performance evaluated to determine the type of foot arch support needed based on current insole design specifications. Insoles are designed and built. Next, the subjects are requested to perform stationary running to determine the body and limb movement using different foot arch supports. Pressure sensor, electronic sensor and photogrammetric imaging technique will be utilised in the data capture to determine the quality of body balancing. Candidate(s) should have good knowledge of MathLab, statistics and photogrammetry or computer vision techniques for this research. Candidate(s) will be jointly supervised by researchers from USQ and the School of Physiotherapy and Exercise Science at Griffith University, Gold Coast). The research is aimed at Masters and PhD level.</p>	Dr Albert Chong Assoc Prof Talal Yusaf Assoc Prof Kevin McDougall Richard Newsham West (Griffith University, Gold Coast).	<a href="mailto:chonga@usq.edu.au">chonga@usq.edu.au</a> <a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a> <a href="mailto:Kevin.mcdougall@usq.edu.au">Kevin.mcdougall@usq.edu.au</a>

<p><b>Title:</b> Sport biomechanics: Leg muscle performance</p> <p><b>Available for Major/s:</b> Spatial Science/ Mechanical and Mechatronic Engineering/Computer vision</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The research involves the study of leg muscle with reference to human gait and running or in relation to human physical mobility impairment. The investigation may include but not limited to the study of the relationship between skin-surface based muscle shape change and heel or forefoot loading during such activities. The study determines the quality of muscle performance based on skin surface 3D modelling. This can be achieved by the development of new methods in the skin surface 3D modelling using conventional and high-speed cameras and integration with other image capture sensor such as X-ray, CT scan and ultra-sounding. Pressure sensing and EMG capability are available if they are required to improve or evaluate the quality of the results. Candidate(s) should have the basic knowledge on MathLab, finite element modelling and photogrammetry or computer vision for this research. Joint supervision involves academic staff at the School of Physiotherapy and Exercise Science (Griffith University, Gold Coast). The research is aimed at Masters and PhD level.</p>	<p>Dr Albert Chong                  Assoc Prof Talal Yusaf                  Assoc Prof Kevin McDougall                  Richard Newsham West (Griffith University, Gold Coast).</p>	<p><a href="mailto:chonga@usq.edu.au">chonga@usq.edu.au</a>  <a href="mailto:talal.yusaf@usq.edu.au">talal.yusaf@usq.edu.au</a>  <a href="mailto:Kevin.mcdougall@usq.edu.au">Kevin.mcdougall@usq.edu.au</a></p>
<p><b>Title:</b> 3D modelling, 3D positioning and analysis (human body man-made or natural structure, artefact, manufacturing, tooling, defence and surveillance) using image processing techniques.</p> <p><b>Available for Major/s:</b> Spatial Science/ Electric, Electronic and Computer Engineering</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The research involves the development of new methodologies in the 3D modelling, 3D positioning and analysis of physical objects including images captured by visible light, near-infrared, X-ray and sound sensing devices. Research in human exercise and physical impairment study may include the spine, muscles and limbs (in conjunction with the School of Physiotherapy and Exercise Science (Griffith University, Gold Coast). The research is aimed at Masters and PhD level.</p>	<p>Dr Albert Chong                  Assoc Prof John Leis                  Assoc Prof Kevin McDougall</p>	<p><a href="mailto:chonga@usq.edu.au">chonga@usq.edu.au</a>  <a href="mailto:john.leis@usq.edu.au">john.leis@usq.edu.au</a>  <a href="mailto:Kevin.mcdougall@usq.edu.au">Kevin.mcdougall@usq.edu.au</a></p>

<p><b>Title:</b> Airborne LiDAR data and high resolution remote sensing imagery for natural resource and environmental management</p> <p><b>Available for Major/s:</b> GIS, Remote Sensing, Surveying, Geomatics, Environmental Science, Physical Geography, and Computer Science</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>The rapid progress of remote sensing technologies provides scientists with new ways of solving conventional problems. Newly available high-resolution spatial data from various sensors such as airborne LiDAR, WorldView-2 satellite, and UAV (unmanned aerial vehicle) offer capability of capturing and modelling spatial features in much more detail than ever before. Detailed description and modelling of natural and human phenomena are required for sustainable environmental management in adaption of climate changes. Advanced new remote sensing technologies and urgent requirement in reply with important environment problems inspire researchers to develop and test more reliable approaches to discover new knowledge for improvement of the applications of these new technologies in natural resource and environmental management.</p> <p>High degree research students can select topics they are interested in from the following:</p> <ul style="list-style-type: none"> <li>• High quality DEM generation from LiDAR and high-resolution imagery for flood plain mapping and hydrological modelling;</li> <li>• Urban sprawl and land use/land cover change analysis;</li> <li>• Forest biophysical feature extraction and species identification;</li> <li>• Applications of UAV for mining industry or riparian ecosystem management;</li> <li>• Development of new algorithms and data processing methods for detection, interpretation, characterisation, and modelling of Earth surface features.</li> </ul>	<p>Dr Xiaoye Liu Mr Zhenyu Zhang</p>	<p><a href="mailto:liux@usq.edu.au">liux@usq.edu.au</a> <a href="mailto:zhang@usq.edu.au">zhang@usq.edu.au</a></p>
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<p><b>Title:</b> Carbon accounting and modelling from different types of farming systems</p> <p><b>Available for Major/s:</b> Carbon Trading/ Environmental Science/ Agriculture Science/ Forest Science/ GIS and Remote Sensing</p> <p><b>Project Description/Direction(s)/Information:</b></p> <p>Agricultural productivity in the world has been growing mainly due to the result of the intensification, mechanisation and the modernisation of agricultural systems, which might be expected that this would result in a net increase in greenhouse gas (GHG) emissions per hectare. More intensive land use might involve more fuel, farm machinery and agrochemicals and the production, packaging, transportation and application of these requires significant energy resources leading to an increase in GHG emissions. Continuing cultivation results in a loss of soil carbon that adversely affects soil fertility, the soil water holding capacity and plant-available water capacity. Several alternative farming systems have been developed all around the world so that they could help restore soil carbon levels and solve these problems. The aim of this graduate research study is re-evaluate different types of farming systems including GHG values. The specific objectives are:</p> <ul style="list-style-type: none"> <li>• To assess GHG emission and sequestration dynamics of different farming systems <ul style="list-style-type: none"> <li>– To assess GHG emissions related to production, packaging, storage and transportation of agrochemicals (fertilisers, herbicides, insecticides, fungicides etc)</li> <li>– To assess N<sub>2</sub>O emissions from soils associated with the use of N fertilisers</li> <li>– To assess trends in soil carbon amounts on farms</li> <li>– To assess fuel and electricity-related GHG emissions</li> <li>– To assess machinery related GHG emissions</li> </ul> </li> <li>• Re-evaluate the economics of different farming systems including GHG values</li> <li>• To develop an integrated matrix from farming system to determine the trade-off between productions, GHG emissions, N<sub>2</sub>O emissions and soil C dynamics, as a result of changes in the farming system.</li> </ul>	<p>Dr Tek Maraseni Assoc Prof Armando Apan</p>	<p><a href="mailto:Maraseni@usq.edu.au">Maraseni@usq.edu.au</a> <a href="mailto:apana@usq.edu.au">apana@usq.edu.au</a></p>
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Staff Research Interests <http://www.usq.edu.au/engsurv/research/strengths>