Faculty of Engineering
and Information Technology

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ABSTRACTS

CAPSTONE PROJECT PRESENTATIONS

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Broadway Campus

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Comparison of Flexible (Asphalt) Pavements with Rigid (Conventional Concrete) Pavements with a Proposition to Expedite Conventional Concrete Pavement Construction with Precast Prestressed Concrete Pavement Construction - 6cp

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Major: Civil Engineering

Flexible (asphalt) and rigid (conventional concrete) pavements including, but not limited to highways and roads (arterial, sub-arterial, collector and local) provide the foundations for effective and efficient methods of transportation for the public and businesses. Australia is a growing nation and is predicted to have a population of approximately 35 million people by the year 2050 (ABS, 2012).

The predicted population growth will result in a significant increase in road users on the Australian roadways which in turn will push the capacity of the current roadways far beyond their designed capacity. As such, roadways will require increased levels of maintenance and rehabilitation due to the pavements deteriorating at a greater rate, hence road users will experience delays due to increased levels of road works.

Furthermore, the increased population will promote the urban sprawl effect which in turn will bring rise to an increase in the public moving towards the rural regions. Hence the effects of urban sprawl will in essence promote the construction of new roadways to connect the rural and urban areas.

This capstone project presents a detailed comparative investigation between flexible (asphalt) and rigid (conventional concrete) pavements including the structural, functional, economic, environmental and social performance of both pavement types.

Firstly, this capstone project provides a proposition to utilise the technique of precast and prestressed concrete pavement construction based on various case studies from the United States of America as opposed to the conventional techniques for concrete pavement construction.

Secondly, an analysis using SAFE, a finite element analysis engineering program, has been used to model and the performance of flexible (asphalt), rigid (conventional concrete) and precast prestressed concrete pavements.

Finally, a life-cycle cost analysis was undertaken in order to compare and evaluate the economic performance of the 3 different pavement types.
Contaminated Marine Sediments – What is Best Practice? - 12cp

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Major: Civil Engineering

On a global scale, approximately 80% of marine pollution arises from land-based human activities such as urban development, agriculture, manufacture, transport, energy production and day-to-day domestic activity. Once pollutants or contaminants enter the marine environment they are absorbed by marine life, settle in water body sediments or flow to further contaminate downstream rivers, lakes or oceans.

Australia has currently been seeing an increase in contaminated marine sediment projects since 2000 with projects arising due to future development of coastal or port areas and unacceptable environmental or human health risks. At present the environmental remediation industry works on contaminated marine sediment clean-up projects through one of three remediation approaches which include Monitored Natural Recovery (MNR), In-Situ Capping or Ex-Situ Removal (dredging/excavation). However, with the number of projects potentially increasing in Australia’s near future what is best practice for handling contaminated marine sediment sites needs to be answered.

Through a variety of distribution methods an industry specific questionnaire was sent to experienced professionals working in the field to address questions on the type of remediation percentage of sediment remediation projects, the remediation approaches most commonly used and the barriers present to successful implementation. The questionnaire was developed through a detailed analysis of Environmental Protection Agency (EPA) literature and relevant case studies which included Homebush Bay Sediment Dioxin Remediation and the Hunter River Remediation projects. Best practice was determined to be ex-situ removal with 65% of the questionnaires identifying this method to be most effective at addressing Australia’s future marine development needs and its ability to measure and treat contaminated marine sediments.

In the future, further investigation will be required to assess emerging in-situ treatment approaches and technologies as well as address Australia’s future needs when it comes to contaminated marine sediment remediation to ensure best practice is relevant and up to date.
The Wind Contribution Factor and Transient Stability Impacts of Increased Amounts of Wind Generation on the New South Wales Electricity Transmission Network - 12cp

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Currently, a detailed understanding of how increased levels of large scale wind generation will impact the transient stability of the electricity transmission network of New South Wales is not known. The transient stability of an electricity network is of most importance during periods of peak electricity demand and if wind generation is to increasingly displace the generation from convention generators, the transient stability impacts of increasing wind farm penetration to the electricity network during periods of peak electricity demand need to be understood.

In order to determine a reliable generation contribution factor (wind generation that can be expected at least 85% of the time) from wind farms during the times of highest electricity demand (peak 10% of demand), the wind patterns at four existing and 26 proposed wind farm sites in New South Wales have been analysed and correlated with electricity demand for New South Wales. After analysing these sites it has been possible to estimate the percentage of wind generation from each site which can be relied upon in times of peak electricity demand in the future, which is known as the contribution factor. The contribution factor has then been applied to the proposed wind farm sites and used to determine the level of reliable generation for each site which has then been used in the transient stability studies. The transient stability studies investigate how parts of the New South Wales transmission network will be affected by increased wind generation as well as mitigation measures which can be used to increase stability.

It has been found that the contribution factor of wind generation to peak demand is generally low in New South Wales and as such the transient stability impacts are generally minimal. However, transient stability can be of concern if wind generation increases and this impact is investigated.
Cisco Network Management and Audit System – CNMAS - 12cp

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Major: ICT Software Engineering

Consider the implications of a downtime for telecommunication companies, educational/financial institutions and for companies like Google, Amazon and Facebook among others for whom a network downtime can cause serious business implications both financially and for its customers who rely on these services. Network management refers to the use of a system that monitors a computer network to detect slow or failing systems and avoid downtime of the network caused by overloaded and/or crashed servers. Network downtime or outage is the period of time that a system fails to provide or perform its primary function.

Cisco Network Management and Audit System (CNMAS) is a software system developed to analyse complex network raw data that is generated from Cisco devices on a weekly basis to assist Network Engineers within the Operations team at Cisco Systems. Since the customer network typically consists of tens of thousands of devices, the amount of raw data produced is large and it becomes a tedious task for engineers working on these networks to analyse and manually identify any issues relating to key performance indicators such as device total switching throughput, CPU/Memory utilization, interface counters/utilization/errors, buffer failures, and device uptime.

The CNMAS system analyses and transforms this complex raw network data into intelligence that can be used to identify issues in regards to network health and take proactive measures to tackle them on time. The Network Regex feature of the tool allows network engineers to extract information by providing a set of regular expression rules. The configuration comparer feature of the tool allows engineers to monitor configuration and identify incorrectly configured devices within the network that may lead to performance or security issues.

Apart from that, this system allows the engineers to compare the current network data with previous weeks/months providing information visualization and trending using different graphs and performance analysis to assist them in identifying patterns in regards to network issues. The aim of the project is to improve the network audit process, make it more efficient by automating it hence reducing the need for manual and repetitive effort required by the engineers. The project will produce a working proof of concept that will be adopted by the Cisco engineers working on customer networks.
Reliability Engineering in Asset Management -12cp

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Modern society relies on engineering assets that support the foundation of modern life. Vast amounts of money is invested by governments and business in delivering and maintaining highly mechanized and automated transport systems, telecommunications, energy, manufacturing plants, military systems, to name a few. The services these assets provide are taken for granted, by the general populace, until a failure occurs or a service is interrupted for a substantive time.

Management and maintenance of engineering assets has historically been driven by vendors and Original Equipment Manufacturers (OEMs). Maintenance programs are generally costly, conservative and very labour intensive, resulting in a restrictive regime for its execution, resulting in high unavailability of assets, in most instances. Many modern engineering assets are operated and controlled by sophisticated control systems that monitor, collect and store large volumes of “condition” data. Condition data can provide asset managers with an enhanced management capability, reducing the cost of ownership and providing increased availability/reliability.

This Capstone explores the use and benefits of condition data, being part of an integrated effort to improve the availability/reliability of engineering assets. It uses as its principal source historical sensor and alarm data gathered from an actual control system operating a large motorway network in Sydney, Australia. This Capstone analysed the data and its findings proved the key role that condition information plays in data driven decision making processes, when managing engineering assets. It also highlights the importance of ICT engineering in facilitating the collection, management, analysis and reporting of real-time asset condition data.
Technical Considerations for the Design of Ballasted Track Formations - 6cp

Christopher Barrett - S12-010

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Major: Civil Engineering

The track structure of a railway consists of several elements which aim to distribute the dynamic operational load of rolling stock to an appropriate axial stress on the subgrade beneath the track formation. The track formation specifically is the earthworks structure containing all foundation, structural treatments and capping layers upon which ballast is laid.

Formation failure is one of the most significant contributors to long term maintenance costs as treatments often require closure of the line, removal of the track structure, significant earthworks and high levels of labour. By considering all elements of the track structure in the initial design of ballasted tracks, it is hoped formations can be designed which provide further savings over the design life of the track.

This project seeks to investigate the contribution each element of the track structure has upon formation performance and provide a means by which track engineers can analyse the suitability of existing or proposed track structures for required operational loading. A computer program has been developed for this purpose to provide an easy to use interface where by data of the track structure is entered, the suitability of this data analysed and appropriate report produced specifying suggested structural depths whilst highlighting areas of failure. By utilising current theoretical formulas and proven relationship between elements of the track, rail, sleeper, ballast, capping and subgrade material it is hoped this program will significantly contribute to the design and analysis of appropriate ballasted track formations.
It is becoming increasingly difficult to ignore the heightened concern regarding carbon emissions and the subsequent demand for more environmentally friendly building solutions. Timber concrete composite (TCC) flooring systems provide a sustainable alternative flooring solution to multi-storey buildings. The system consists of a laminated veneer lumber (LVL) or a glulam beam overlaid by a reinforced concrete slab with an interlayer connection. The system utilises the strengths of each material with concrete subjected to compression while timber is subjected to tension. The shear connection is crucial to the structural efficiency of the system where high composite action is desired. Not only does TCC provide structural benefits over the typical reinforced concrete slab system, but it also offers significant environmental benefits due to timber being a carbon neutral material.

The overall objective of this study was to investigate the design and construction philosophy behind the TCC system. A comprehensive literature review was undertaken in two parts - (1) to provide a solid background of the system including design approaches, construction methodology and short and long term behaviour and (2) to synthesise an extensive amount of past international research on shear connection design. To gain a practical understanding of the applicability of TCC to multi-level buildings, two case studies on state-of-the-art timber buildings have been carried out: Nelson Marlborough Institute of Technology (NMIT) Arts and Media building and the LifeCycle Tower One. While each building successfully utilises the system in a distinct form, the case studies highlight that there is a lack of training and education in the engineering and building industry with timber and timber products. This issue must be addressed in order for the TCC system to become more feasible and readily adopted.

TCC systems must be designed to satisfy both serviceability and ultimate strength requirements. An investigation into the structural issues indicates that serviceability aspects, in particular fire, acoustics and dynamics, are the governing factors when designing TCC systems. The constructability has been analysed in the form of a rating table, highlighting the most effective method of construction in terms of cost and assembly time. A Life Cycle Assessment approach of a TCC system from cradle-to-grave has also been examined.
Home Energy Usage Indicator System for Indigenous Communities -12cp

Mark Benjamin - A09-166

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Major: Electrical Engineering

Electricity usage in Australian Indigenous community households can be more than twice the national average. This has a significant economic impact on the Indigenous community, with a significant proportion of the household income being spent on electricity costs.

The Centre for Appropriate Technology (CAT) is a federal government funded organisation which seeks to improve the standard of living in Indigenous communities through the use of technology and education. CAT has commissioned the Demand Side Management Project which has the objective to reduce Indigenous household electricity consumption by implementing a system that gives the household a real time indication of its electricity usage. Previous studies have indicated that such a system provides a greater awareness of electricity usage to the household which can result in a reduction of power consumption by up to 25%.

This capstone project details the design and implementation of the CAT Home Energy Usage Indicator System (CHEUI). CHEUI is an electronic system which consists of the Current Measurement Unit, and the In House Display Unit. The primary function of the CHEUI system is to measure the electrical current from the main electrical wire feeding the household, calculate the power consumption and daily cost of the electricity consumed. The power consumption data is transmitted through a wireless interface to the in house display unit which has been designed to present the daily electricity cost in a simple to understand format which is contextually appropriate for Indigenous communities.

Three fully functioning prototype units have been built and tested, and have been field trialed by CAT in a number of operational environments. Feedback from the field trail has shown that the design meets all specifications and functional requirements, and works reliably. At some stage in the future the project will be taken to the next phase where 100 preproduction units will be manufactured, and deployed to a range of different Indigenous households for comprehensive user trials.
Steel is the second most used material in construction compared to concrete. Its unique ability to offer high tensile strength and high ductility makes it the preferred choice for engineering. Steel is evaluated for its mechanical performance by measurement of its yield strength, modulus of elasticity and ductility. The tensile test is used to establish such mechanical parameters, and in Australia, tensile testing practices are governed by criteria listed under Australian Standard (AS) 1391. One limitation of AS 1391 is in the inexplicit testing parameters defined as part of testing methodology, which in turn may affect data obtained and design calculations. This study assesses varying grain orientation, specimen grip end positioning, specimen grip end length and transition radius geometry on the resulting tensile properties of structural steel.

Two types of sheet steel (hot rolled low carbon steel and zinc coated mild steel) were assessed for their tensile behaviour. Uniaxial testing was carried out at 45°, 90° and 180° to grain orientation; at full and half grip end position; at varied grip end lengths; and, at transition radii of 10, 15, 20 and 25 mm. Steels tensioned at 180° to the grain signified lower yield strength (11%) and higher ductility (37%) compared to steel tensioned at 90° to the grain. For the hot rolled steel, an increase in transition radius from 10 to 25 mm demonstrated a 19% decrease in yield strength and a 67% increase in ductility. In contrast, the zinc coated mild steel increased by 8% in yield strength and ductility remained constant. In conclusion, this study emphasises the need to take grain orientation, transition radii and gripping criteria into account to maintain consistency of practice, reproducibility of results and accuracy of steel properties for design.
Investigation and Implementation of Enterprise Telecommunications Expense Management Tools Using an Agile Software Methodology - 12cp

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Major: ICT Software Engineering

Managing expenses in business can often become a daunting task, especially when dealing with thousands of employees. One area that has seen a vast amount of growth, in the volume and complexity of these expenses, is telecommunications. This is due to increase in communication products and subscription plans. As a result an industry known as Telecommunications Expense Management (TEM) has been formed to assist enterprise customers navigate the complexities of contracts and investigate bill integrity.

At the UXC Consulting TEM division, the customer of the system, many ad hoc software tools had been developed to assist analysis of the large volumes of data. This proved problematic as the vast array of scripts and versions were unmanageable, which made it difficult for new analysts to learn the necessary skills. This project aimed to investigate how other TEM systems worked, in order to start from the ground up in creating a new software system to solve the problem.

As a secondary goal, an analysis of software methodologies was also undertaken from a practical point of view. As a result, an agile methodology was chosen due to the possible changes of the requirements from developing the solution. This factored heavily into how the project was structured, with many of the aspects of an agile methodology being utilised and documented. Throughout development Object Oriented Design (OOD) principles were also followed to create a system that could easily be modified to suit future changes in requirements.

Whilst remaining within the scope of the exercise, the resulting system differed greatly from initial discussions with the customer. This justified the need for an agile approach, where by implementing the solution further informs the problem that needs to be solved. The newly developed system meets a real need for the customer and is currently being tested, running as a parallel process with the previous method of analysis.
Lower Limb Exoskeleton for Mobility Assistance: Design of the Assistive Controller - 12

Matthew Bugeja - A12-015

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There are a significant number of people with reduced mobility due to physical disabilities. In order to recover use of their limbs, patients require rehabilitation conducted by trained physiotherapists. Current rehabilitation is limited by the physical capabilities of the therapist. Manually administered therapy has low repeatability, and its effectiveness is difficult to quantify.

Powered exoskeletons are currently being investigated as options to perform rehabilitation procedures. An exoskeleton is a wearable mechanisms designed to enhance the physical capabilities of the user by applying assistive forces to the extremities. Exoskeletons are useful because they do not become tired, can infinitely repeat assigned exercises and allow measuring of variables such as angular velocity and force exertion.

This project involved the development of the assistive controller for a lower limb hip-joint exoskeleton, capable of synchronizing with the walking gait of the user. The goal of the controller is to reduce the metabolic cost of walking and to increase the user’s preferred walking speed.

The control architecture involves two layers of control. The first layer is the baseline controller, which employs admittance control to minimize the mechanical resistance felt by the user wearing the device. The second layer involves the assistive control proper, which collaborates with the voluntary movement of the user’s leg as necessary for the rehabilitation process. In order to assist the user, the controller learns the fundamental dynamics of the leg’s motion by means of an adaptive frequency oscillator.

Preliminary results show that this method can successfully adapt to the dynamics of a particular user and provide assistance, as they require it. Further experimentation of this control is necessary to confirm whether it can successfully reduce the metabolic cost of walking.
Sustainable Chippendale – An Investigation into Using Pale Road Media to Cool an Inner City Suburb - 6cp

Joseph Caparrotta - S12-019

Supervisor: Ken Halstead; Michael Mobbs
Assessor: Michael Mobbs
Major: Construction

Global climate projections within the next century present scenarios of an inhabitable earth. Poor urban development and a lack urban planning foresight, has resulted in an embedded system of operations that employ inefficient and environmentally degrading means of energy production and distribution. These unsustainable energy systems are shifting climate conditions towards a future of exponential growth in the demand for energy and cities around the world are discovering they are suffering from this two-fold. Firstly from global warming and secondly from the Urban Heat Island Effect, exacerbating the inherent environmental and financial implications.

This report discusses Australia’s global position in the carbon pollution economy, the ability to generate clean energy and focuses on how the inner city Sydney suburb of Chippendale can ameliorate the impacts and contribution to the Urban Heat Island Effect. Specific attention is given to dark coloured road surfaces. They are identified as the key factor in creating an environmentally and economically sustainable solution.

By increasing the albedo of road surfaces, impending impacts on the environment include: lowering ambient temperatures, reducing or eliminating the Urban Heat Island Effect, lowering the demand on energy and inevitably reducing human induced carbon pollution and global warming.

The solutions presented are analysed to determine their feasibility for employment in terms of: financial cost / benefits and environmental cost / benefits.

The report makes final recommendations on current road maintenance and how a change in the paradigm will create an era of sustainable urban development.
Investigation into the Efficiency and Accuracy of Blast Modeling Methodology for Critical Reinforced Concrete Columns - 6cp

Mathew Carter - S12-020

Supervisor: Bijan Samali
Assessor: Ali Saleh
Major: Civil Engineering

The risk of Improvised Explosive Devices (IEDs) being detonated on structures is becoming more prevalent in today's society. As a result, structural engineers need a greater understanding of techniques used to determine the response of a system under blast loads. There are several analysis methodologies that can be used. These range from first-principle numerical simulations to empirical methods and real world experimental models. The most appropriate methodology depends on a number of contextual factors. These include the type and size of blast, standoff distance, required accuracy, cost, time and availability of resources. The following thesis paper will compare the accuracy of two numerical methodologies.

The investigation involved subjecting a critical reinforced concrete column to several loading scenarios. These scenarios varied with respect to the charge weight of the explosive device and the standoff distance between the point of detonation and the nearest column face. The response, or in this case, the time-history displacement of the column was determined using an equivalent Single Degree of Freedom (SDOF) approach and a more accurate finite element Computational Structural Dynamics (CSD) approach. A simple Microsoft Excel spreadsheet was used for the SDOF method whereas the general purpose finite element program, LS-DYNA, was used for the CSD approach.

Typically, the SDOF approach is relatively accurate when standoff distances are large. As an IED approaches the target and becomes more close-in, the accuracy of the SDOF method diminishes. Comparing these two methodologies over a range of standoff distances will provide insightful information and general guidelines as to when the more expensive but more accurate CSD approach should be used.
Collaboration in the Design and Construction Industry (12cp)

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Major: Civil and Environmental Engineering

Collaboration in the Design and Construction Industry is considered integral to success and thus the quality and effectiveness of collaboration is crucial. There is a multitude of ways to improve collaboration, such as utilising team building techniques or technology. However, these will not be effective without first understanding what is hindering good collaboration.

This report will define the meaning of good collaboration and in the context of the Industry evaluate the advantages of such collaboration as well as associated problems. Suggestions will also be provided on how to implement, maintain and improve collaboration. Of particular focus will be the collaboration technology, Building Information Modelling (BIM). BIM is still a rising technology in the Industry in Australia and its benefits versus its costs are being debated. A case study evaluating the use of BIM as an effective collaborative tool on a current project will be provided.

To gauge the outlook on collaboration in the Industry a survey was conducted. From the results it was found that the majority felt that they could improve on their ability to collaborate and that those with whom they have worked could improve as well. This highlights that there is a need for clear guidance specific to the Industry on effective collaboration and it is the aim of this report to provide such information. It is also intended that this guidance will be used by companies to develop and improve their current collaborative processes.

In conclusion, improved collaboration in the industry will save time, save money, reduce miscommunication and reduce conflict between the various stakeholders.
An Investigation into Alternative and Innovative Connections for Timber-Concrete Composites - 12cp

Benjamin Chen - A12-029

Supervisor: Christophe Gerber
Assessor: Anne Gardner
Major: Civil Engineering

Timber Concrete Composites (TCCs) are a structural solution that combines timber and concrete into a composite system in order to exploit the mechanical properties of each material favourably. Typically a concrete slab sits on top of timber joists with the composite action achieved through mechanical connectors at the interface. Concrete performs well in compression whilst timber is adequate in tension. Consequently the resulting structural system is stronger, stiffer, more durable and has improved acoustics and fire resistance properties over a non composite system.

The type of shear connection used at the composite interface is the key factor in determining the strength and stiffness of a TCC system. A significant amount of research into TCC systems has been focused on assessing the strength and stiffness of different types of TCC connectors through experimental programs involving push-out tests. However, the majority of research has been conducted overseas with a considerable portion in European countries, where TCC systems have gained more popularity since the early 1990s than in Australia, where it has only achieved prominence since the mid 2000s.

The primary aim of this project is to investigate alternative shear connector designs. This is because these alternative connectors may provide improved strength and stiffness characteristics and favourable economic and constructability advantages over existing connectors. Three shear connectors were tested in the form of an L connector, a U connector and a standard coach screw. Each shear connector was assembled into five TCC test specimens resulting in the push-out test of 15 TCC specimens.

Results from the push-out tests highlight that the L connector was the strongest shear connector failing, however, in a brittle manner due to shear failure of the screw used to connect the L connector to the timber joist. The U connector failed in a very ductile manner as a result of the U connector yielding around the screw holes. The coach screw had the lowest strength and failed in shear in a relatively ductile manner. A predictive model was used in order to compare the failure modes according to Eurocode 5, with the results of the push-out tests. Recommendations were also made as to the relative advantages of each connection design.
Rethinking the Design of a Medical 3D Ultrasound Transducer - 6cp

Trudi Crawford - S12-029

Supervisor: Bruce Moulton
Assessor: TBA
Major: Mechanical Engineering

The technology of 3-dimensional (3D) medical imaging is relatively new and is a quickly growing technology within the medical field. 3D ultrasound is used in many speciality fields within medicine, for example neurology and cardiology, though it is mainly known for the usage in the obstetric/gynaecology field. Ultrasound allows for a relatively safe detection of any possible abnormalities of internal organs or to monitor foetal health, when taking precautions of time of exposure being as limited as possible and frequency levels being appropriate for the tissue being tested.

Within obstetrics/gynaecology there is a need to provide a safe option for data collection from patients who require medical treatment. This is especially true when considering the health of women in regards to their reproductive system. The 3D ultrasound used for this purpose is done transvaginally, and currently this is the best way that data can be collected to provide an end product of a high-resolution image. Currently the design of the transducer is a rigid probe, where different images need to be collected requiring multiple angles and views. The collection of these multiple views requires the rigid probe to be manoeuvred within the vagina, which creates difficulties the ultrasound technician to gain the appropriate images and also causes the patient a great deal of pain.

This report follows the idea of being able to provide possible changes to the transvaginal 3D ultrasound transducer that puts forward a new idea to combat the current restrictions. The possible variations offered in this report are made with the understanding of current 3D ultrasound technology and identifying other products that use actuation.
Investigation into Compressive Strength Behaviour of Cement-Based Mortars Incorporating Ferronickel Slag for Partial Replacement of Portland Cement – 6 cp

Michael Cross -

Supervisor: Kirk Vessalas
Assessor: Robert McLaughlan
Major: Civil Engineering

Concrete is recognised as the most prolifically used construction material worldwide. A key component of concrete is Portland cement (PC), with 10 million tonnes of PC produced in Australia in 2010, and about 400 million tonnes produced worldwide. Due to its widespread use and energy intensive manufacturing process, PC is estimated to generate 10% of the world’s carbon dioxide emissions posing a significant environmental concern. The cost of manufacturing PC is also increasing due to rising electricity and energy prices. To address these concerns, an effective way of reducing PC usage involves the use of supplementary cementitious materials (SCM) such as fly ash (FA), ground granulated blast furnace slag and other siliceous-rich waste materials. Ferronickel slag (NS) is a siliceous-rich waste material generated as a by-product from the nickel smelting process whose potential as a novel SCM has yet to be established.

This study investigates the feasibility of using NS as a potential SCM in cement-based systems. Compressive strength behavior of mortars containing 20% and 40% NS for partial replacement of PC has been assessed at 7, 28, 56 and 91 days. This behavior has been compared to a control mortar (100% PC) and mortars containing 20% and 40% FA (the most used SCM worldwide). Strength results to date demonstrate that mortar containing 20% NS undergoes a significant strength increase from 7 to 28 days with a 38% and 44% strength gain noted over FA and 100% PC mortars respectively. In addition, mortar containing 40% NS underwent a 6% increase in strength when compared to the FA equivalent mortar for the same age period. These results suggest pozzolanic reactivity demonstrated by the NS at 20% and 40% PC replacement levels. Longer term strength testing at 56 and 91 days will reveal the level of pozzolanic activity and the viability of using NS as a potential SCM.
Comparison of the Global Factor of Safety to the Partial Factors of Safety Used by the Australian Standard, AS 4678-2002, for Earth-Retaining Structures - 6cp

Erikas Datenis - S12-034

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Assessor: Behzad Fatahi
Major: Civil Engineering

Safety factors are used in the design of earth-retaining structures to reduce the probability of failure by accounting for uncertainties associated with loading conditions, material properties, design approximations and the construction quality. Two common methods for integrating safety factors into earth-retaining structures are the traditional Global Factor of Safety (GFS) method, which is based on an overall factor of safety against failure, and the Partial Factors of Safety (PFS) method which involves modifying nominal values through the application of partial factors. Both of these methods are recognised by the Australian Standard, AS4678-2002; however it prescribes the latter one.

In this study, GFS and PFS methods are compared to assess the variability of design outcomes to determine which method is more conservative and identify safety factors inherited in structures designed using these methods. For both methods, three types of retaining walls, including Gravity, Cantilever and Embedded walls, are analysed in terms of overturning, sliding and bearing failure modes by applying various test cases with cohesionless soils. To achieve this comparison, a detailed computer model, using MATLAB software, has been developed allowing design calculations to be carried out simultaneously for GFS and PFS methods and enabled design outcomes to be obtained for various test cases.

The key findings presented in this report include:

1. The PFS method gives more conservative design outcomes than the GFS method for all three wall types analysed, as Gravity and Cantilever walls are on average 45% and 49% wider, respectively, while Embedded walls are approximately 14% higher when designed using the PFS method.

1. Bearing and sliding failures are the most dominant failure modes for Gravity and Cantilever walls for both the GFS and PFS methods while the overturning failure mode is the least dominant and in fact it produces design outcomes that are similar for both methods.

1. For simple Embedded retaining walls, the PFS method requires embedment depths that are similar to the GFS method, however the maximum moments determined using this method are about 80% larger.

1. Gravity and Cantilever walls complying with overturning, sliding and bearing failure modes inherit Global Factors of Safety of approximately 1.9, 2 and 6.5, respectively for analysed test cases.

These findings and in-depth discussion provided in this report will assist practising civil engineers to better assess the consequences of using either the GFS or the PFS method in their retaining wall designs.
Construction of an Interactive Claw Machine for the Purpose of Machine Learning Through Human Interaction - 12cp

James Davies - A12-035

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Major: Mechanical & Mechatronic Engineering

Collecting physical data on human behaviour is often a time consuming task. In most cases it requires many hours of personal interactions to gain a relatively small sample size. Also with a limited number of individuals, confidence in the results is reduced and are difficult to repeat. These difficulties are especially evident when attempting to use machine learning to interpret gestures, which play a huge role in human communication. This is fundamentally due to the large variation in gestures created in the loop of control, perception and action. To overcome these difficulties, there is a need to interact with members of the public who are unbiased and unpredictable, in large numbers. The immediate objective of this project is to develop a robotic platform capable of interacting with the public in a safe and novel manner. This will provide an interface where user gestures are dependent on an end goal while performing the interim controls.

Existing hardware from an arcade machine was modified and extended to create a large scale dropper claw style machine, measuring 3.6m square and mounted on the ceiling of a research laboratory. Development of this platform required mechanical, electrical and mechatronic design and installation of the new hardware. Developing a control system while minimizing costs presented unique challenges and the design of the hardware resolves many complications with building a light weight simple gantry crane style device.

The experimental setup contains windows making up one wall of the laboratory overlooking a thoroughfare area within the University, this platform provides an excellent base for developments requiring interaction with the general public. Currently, through the application of a Microsoft X-Box Kinect camera, Users can control the movement of the claw and use it to pick up objects. Games can be developed to encourage members of the public to use the device and provide the unique and diverse data required by a successful machine learning algorithm.
Evaluation of Flood Estimation Methods in Rural Catchments - 12cp

Hayden Dent - A12-040

Supervisor: James Ball
Assessor: Jaya Kandasamy
Major: Civil Engineering

Australian Rainfall and Runoff (ARR) is the precedent guidance for design flood estimation for engineers and designers in Australia. ARR is currently in the process of being updated, proposing the first major changes in industry practice since 1987.

Flooding can have detrimental effects on society including the destruction of property, loss of agricultural crops, and in severe circumstances, loss of human lives. Flood estimation involves the prediction of flood behaviour in order to either assess or avoid the harmful impacts of flood flows.

In rural catchments, where no recorded data is available, calibration and validation of flood estimation results cannot be achieved. This introduces additional uncertainty in estimating flood flows from rural catchments. For rural catchments, a Regional Method for flood estimation is implemented to account for the lack of data.

This project evaluates the predictive capacity of the new Regional Method of Flood Estimation, the Parameter Regression Technique (PRT), proposed in the updated ARR. Four test catchments in rural New South Wales have been selected for testing of the PRT method. Results from the PRT method are compared to recorded flood flow data in order to assess the robustness of flood predictions.

Additionally, an in-depth case study of the Oxley River catchment using flood simulation software, Watershed Bounded Network Model (WBNM), has been undertaken. This process involves the application of scientific method to replicate the complex natural processes as a catchment responds to a storm event. This study will assess the viability of computer-based runoff-routing methods in flood estimation in rural catchments.
Using GIS as a Project Management Tool for Small Scale Civil Construction - 6cp

Matthew Dingle - S12-037
Supervisor: Jane Brennan
Assessor: Allan Brady
Major: Civil Engineering

Geographic Information Systems (GIS) are a powerful technology that is currently used in a variety of applications across different professions. Some of these include civil engineering, environmental impact assessment, logistics, cartography and statistical analysis. In Civil Engineering, GIS can most commonly be found in transportation planning, water modelling, asset management and large scale civil construction management. Within small scale civil construction companies GIS has gone unnoticed.

Typically, small scale civil construction companies are late adopters of new technologies because of the increase in overhead costs as well as the time required to use and implement them. As such, they still use traditional methods for management and day to day running of construction projects. While there is no substantial issue with these traditional methods, there is always room for improvement.

This capstone aims to determine if GIS can be a viable technology for use within small scale civil construction companies. This will be done by implementing a model of a live project within ArcGIS, for a small scale civil construction company. The function of the GIS will be to serve as database of the project’s design, and then the construction progress. This database will be used as a management tool to make planning decisions about the project. It will also be used to replace traditional activities associated with managing a project such as quantity take offs for estimating. Additionally, it will provide new tools such as a visual method of reporting to the client.

Based on the experience of establishing the live project model within the GIS, this capstone will evaluate the viability of GIS as a tool to assist project management during the construction phase of a project for small scale civil construction companies.
The User Adoption of ICT Systems on Construction Projects - 12ep

Anthony Doig - S11-031.

Supervisor: Hiyam Al Kilidar
Assessor: TBA
Major: Mechanical Engineering

The exponential growth of computational capabilities of computers since the 1950’s in combination with the applications of Project Management have contributed to increased ability of handling complexities in construction projects. There is however, quite often a gap between the potential and actual outcomes of a construction project. Whether these gaps come in the form of increased costs, increased duration or reduction in quality of a project, they are all major problems for the stakeholders.

User adoption of information communication technology (ICT) systems on construction projects is a key contributing factors to these outcome gaps. The ability for an organization to accurately determine if an ICT system will integrate successfully on a project would help to bridge them. In the event of an ICT system not being successfully adopted, it would be beneficial to determine why.

This project has extended the Unified Theory of Acceptance and Use of Technology (UTAUT) model to predict the adoption of an ICT system on a construction project, and its use as a tool in the post project analysis of an unsuccessfully adopted ICT system. The contribution of this project to the UTAUT model was to add the moderators of role and management level.

The extended UTAUT model was developed and tested through interviews and a survey of 36 candidates from a multibillion dollar infrastructure project in Australia, where one of the ICT systems used had not been properly adopted by its users.

The results validated the extended UTAUT model, while providing an improvement upon its predecessor. Potentially, the extended UTAUT can be used before the initiation of projects to determine the readiness of an ICT system to be successfully adopted on a construction project, as well as during the construction phase. The results showed a stepping stone to further confirmation of the extended model.
Design and Manufacturing Process for Low Yield Ground Water Wells using a Piston Pumps - 12cp

Jason D'Silva - A12-041

Supervisor: John Dartnall
Assessor: David Eager
Major: Mechanical Engineering

At present, approximately 5,000GL of the total 24,000GL of water used by Australians each year comes from groundwater, with a further 21,000GL of groundwater available for sustainable use (Water Resources in Australia, 2000). Approximately one million Australians in six hundred communities are primarily reliant on groundwater (Guidelines for Groundwater Protection in Australia, 1995).

This project presents a piston pump design and a selection of manufacturing processes that can be used as a sustainable way to pump the available ground water sources. It will enhance the everyday lives of the people that rely on groundwater through an easier and cheaper means of accessing such a vital commodity.

The aims of this project are as follows:

• To address the developing niche market of low yield ground water pumps both within Australia and the United States of America with an economically viable piston pump design. This market primarily comprises of households that live out in rural locales and farmers who are unable to procure their water supply, whether in full or in part, from a main water source.

• To provide a design for manufacturing (DFM) process that can be easily manufactured. This process can be adapted later to be injection molded for mass production. The use of mass production methods would mean this pump is even more economically viable.

In order to achieve these outcomes a detailed design process and cost analysis were performed. Part of this design process involves using currently available products in order to keep manufacturing cost down. This project adds to the quality of life of many rural communities that are sometimes forgotten about in modern society. It does so via simple and financially viable means given the low socioeconomic level that many of the target market live within.
Testing the Extent to Which a Selected Commercially Available Stepladder Conforms to Australian Standards - 12cp

Jamie Dsouza - A12-042

Supervisor: Bruce Moulton
Assessor: TBA
Major: Mechanical Engineering

Ladder related injuries result in a substantial number of admissions to hospitals each year, and faulty ladders are a contributor to these admissions. The project involved testing a selected commercially available stepladder to determine whether it conforms to Australian standards, and therefore determine whether the ladder is appropriate for safe use in Australia. The testing procedures were performed as per the standard AS/NZS 1892.1:1996. Firstly, the general and particular requirements of stepladders were observed. Secondly, the following 6 tests were selected and performed on the chosen stepladder:

1. Tread Torque Test – Test determined the ability of a joint between a tread and a stile of a stepladder to withstand a designated torque.

2. Stability Test - Test determined the stability of a stepladder, when subject to non-simultaneous forces applied in the forward, sideward and rearward directions.

3. Walking Test – Test determined the resistance of a stepladder to movement relative to the supporting surface, when subjected to the fluctuating forces.

4. Stile & Back Leg Cantilever Test - Test determined the resistance of a stepladder to lateral bending.

5. Dynamic Drop Test - Test determined the effect of inward cantilever dynamic loading, on the stepladder for each stile section size.

6. Foot Friction Test - Test determined the coefficient of static friction between the ladder and the test surface.

The results of the tests have shown that the stepladder did not meet the requirements of the tread torque test, walking test, dynamic drop test and stile & back leg cantilever test. Failure of these tests indicates that the ladder may present a hazard to the user and their environment, particularly when used on unflat surfaces. Improvements to ladder design to account for real world hazards, along with user education and compliance can together work to reduce ladder related injuries.
Investigation of Boiler Efficiencies in Power Generation; Exploring Possibilities for Improvement - 12cp

Scott Franks - A12-045

Supervisor: John Dartnall
Assessor: Guang Hong
Major: Mechanical Engineering

As the world's energy consumption increases so too does the depletion rate of our fossil fuel resources. This is having a profound impact on the environment, prompting a need to implement cleaner fuel alternatives for energy production. In Australia, electrical generation was the largest carbon dioxide emitting sector, producing 38% of Australia's carbon emissions in 2011 (Australian Government Department of Climate Change and Energy Efficiency, 2012). The Australian government has introduced a carbon tax that charges emitters per tonne of carbon released into the atmosphere in order to promote alternative ways of increasing energy efficiency and to encourage the use of clean energies.

This project examines efficiencies of the power station boiler, which is an integral component in electrical generation, responsible for creating high energy steam by applying heat energy to circulating water. To gain a complete understanding of boiler efficiency it is vital to understand combustion, energy transfer from fuel to steam and thermal efficiency. This project examines the fuel properties of coal, conventional oil, natural gas and biomass comparing each fuel's efficiencies and environmental impacts.

The central idea behind achieving maximum boiler efficiency is not only to select a fuel that has a high internal energy but to design the boiler to reduce heat losses in flue gases. This project examines components such as economisers, preheaters and soot blowers whilst also exploring possible methods such as combined cycles and superheating steam as a means to increase efficiencies.
Effect of Novel Additives on Shrinkage and Expansive Behaviour of Mortars (12cp)

Nicole Galea - A12-217

Supervisor: Kirk Vessalas
Assessor: Robert McLaughlan
Major: Civil Engineering

Concrete is recognised as the most commonly used construction material in the world; however, addressing serviceability concerns associated with its use in structures is paramount to sustainable construction. This includes drying shrinkage, which is defined as strain deformation occurring from moisture exchange with the service environment over time. Drying shrinkage is responsible for volume change in concrete that may lead to excessive deformation. Internal forces combined with restraint from reinforcing may further contribute to the onset of cracking, subsequently compromising durability. The use of intrinsic additives in concrete mix design aids with shrinkage reduction. This practical-based study investigates the use of shrinkage compensating additives (SCAs) and fibre incorporation in cement-based systems and their effect on shrinkage behaviour.

Three novel additives were selected for use in evaluating a range of shrinkage mitigating mechanisms: namely, an SCA in the form of an inorganic ammonium polyphosphate chemical; and two fibres, a naturally-occurring wollastonite microfibre and synthetically prepared polyethylene microfibre. Mortar was selected as a behavioural model since it is more sensitive to shrinkage strain than concrete incorporating coarse-sized aggregate. The effect of these additives on shrinkage and expansive behaviour was assessed up to 168 days for mortar stored in a dry (65%RH at 23°C) and saturated environment, respectively. Results signify that shrinkage can be reduced by 20% and 6% with the addition of 1.2% ammonium polyphosphate and 0.6% wollastonite fibres, respectively. The addition of 1.2% ammonium polyphosphate was also found to increase expansion of mortar in a saturated environment by up to 250%, as well as increase 180 day compressive strength by 12%. This study demonstrates that ammonium polyphosphate and wollastonite addition can reduce drying shrinkage, potentially improving serviceability and reducing service deformations in structural applications. This may ultimately enable reduced concrete cover and efficient member profiling to be adopted in structural design.
As demand for vehicle ownership continues to rise globally, the need to ensure occupant safety has increased. The development of child safety devices has been a key focus from child restraint systems, booster seats and head rests/protectors, to baby capsules with multi point fastening seatbelts. Several of these safety devices still rely on the primary seatbelt remaining latched and secured, so that they can perform their function. There have been attempts to circumnavigate this issue by developing physical restrictions to stop the belt being removed, such as the Hurphy Durphy Buckle Guard or Tadvic Buckle Cover, the latter of which requires written approval from Roads and Maritime Services NSW (RMS).

This project aims to present an Automated Seatbelt Lock system concept that could be integrated in new vehicles, eliminating any intrusive devices or permissions required. As this concept is required to be integrated within current vehicle systems, current technology and standards highlight the viability of this concept in a vehicle. The concept and firmware have been developed on two 8 bit microcontrollers from STMicroelectronics, STM8S208MB and is written in C.

This microcontroller has been chosen to allow the implementation of the CAN and LIN protocols, and has an equivalent microcontroller in the automotive series for implementation within vehicles. The project emulates the operation and use of the Automated Seatbelt Locks by allowing operators to simulate occupants in the vehicle and when they have fastened their seatbelt. The project also emulates the vehicle speed, latches locking and what happens in the event of a collision.

The completed and operational product provides a solid framework and concept that can be used to demonstrate the realistic implementation of Automated Seatbelt Locks in vehicles and the benefits it provides.
Application of External Post-Tensioning for Strengthening Reinforced Concrete Deck Slabs - 12cp

Amanda Hanna - A12-057

Supervisor: Bijan Samali
Assessor: Ali Saleh
Major: Civil Engineering

The establishment of bridge infrastructure is a pre-requisite for achieving sustainable public transportation routes. However, over half of the world’s bridges are over four decades old and with their deterioration increasing over time, there is a maintenance problem for many of our world’s existing bridges today. An important factor influencing the durability of RC bridge decks is the fast upgrades to transportation for supporting economic growth. With trucks possessing a higher load carrying capacity, this creates a higher stress on older infrastructure to carry the increasing concentration of traffic loads that they were not originally designed for. Among the various methods developed for strengthening bridge decks, an innovative system using external post-tensioning with fibre reinforced polymer (FRP) bars has been proposed. The post-tensioning technique induces compressive forces which increase the flexural capacity of bridge decks. This coupled with FRP’s exceptional structural strength, corrosion resistance, cost effectiveness and easy installation creates an efficient post-tensioning system.

Various non-linear continuum based finite element (FE) models were developed within the framework of the software ATENA. The FE models take account of geometrical and material non-linearities such as concrete cracking and crushing, yielding of reinforcing steel as well as the post-tensioning effect introduced into the structural system. Within this analytical program, three different phases were developed for analysis of reinforced concrete deck slabs. The first involved verifying the validity of finite elements models developed using ATENA. This is demonstrated by comparing the predicted response of the models with the results obtained from various experiments. After this, 3D models are developed to accurately idealise the entire system structure, and consequently validate its effectiveness for strengthening of RC bridge decks. The last phase of this project involves investigating the behaviour of these models when the parameters are changed in order to find the most effective level of post tensioning. The results have provided baseline data on the ultimate loading capacity of strengthened slabs.
Mobile Antenatal Support System - 12cp

Simon Hedge - S11-053

Supervisor: Zenon Chaczko
Assessor: Doan Hoang
Major: Software Engineering

Smart phones and smart devices are widely used communication tools that run a variety of different mobile applications. Pregnancy and antenatal support are an inevitable stage of the human existence. This project’s focus is to merge these two concepts to help provide the wide user base of smart devices with a mobile application that will help provide antenatal support. The mobile operating system that is the main focus of the mobile application development is the Google Android operating system which currently holds the largest market share in the mobile operating system market. The final outcome of the project is a fully featured mobile application that is able to provide pregnant women with antenatal help and support.
Design and Construction of Roads on Expansive Subgrades in Western NSW - 6cp

Cassandra Hill - S12-056

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering

The shrink-swell property of expansive soils presents a problem with the design and construction of roads on expansive subgrades. Due to this characteristic pavements are not achieving their design life due to failures occurring early and therefore, resulting in premature rehabilitation. This problem represents the need to determine design and construction recommendations to assist in pavements on expansive subgrades reaching their design life without the need for premature rehabilitation.

The main goal of this project is to create a user friendly program using MATLAB software to determine the expansive nature of the soil and generate design and construction recommendations. The user can input parameters from laboratory testing to generate information on how expansive their material is and what treatment methods are suitable. By giving the user a number of different treatment options informed decisions can be made.

Expansive subgrades are constantly encountered in western NSW and there is a continuing trend of these pavements failing prior to reaching their design life and requiring premature rehabilitation. This project presents four case studies, where pavements on expansive subgrades have been rehabilitated. The focus of these case studies are to input data from laboratory testing into the program and use geotechnical reports to analyse the effectiveness of the chosen treatment and demonstrate the use of the program as a tool to recommend alternative treatment options that could have been adopted.

The outcome of this project are to give a better understanding of the problems associated with design and construction of roads on expansive subgrades and present a computer program that can be useful in industry as a tool for selecting appropriate design and construction techniques.
Penmanship – Handwriting Improvement App - 12cp

Jun Huang - A12-065

Supervisor: Chek Tien Tan
Assessor: Sam Ferguson
Major: Electrical Engineering

Recent studies have found that the decline of handwriting has worsened due to the increase of dependence on computers, emailing, mobile texting and other forms of communication technologies. (Claire Suddath, 2009) The need for good handwriting skills isn’t as pressing as we have reached an era where most handwritten tasks can be completed using faster computerized techniques. (Merry Gordon, 2012)

My capstone project is to develop a mobile application which helps users improve their handwriting by allowing them to practice handwriting on mobile devices that have touch screen, such as modern smart phones or tablets. It will give those with bad handwriting a way to practice and improve their handwriting in a low-cost, convenient and, most importantly, entertaining way. My project also contributes to the serious game community by demonstrating that games can be a good alternative for educational training purposes. Prior literature have found that games help enhance engagement in the learning process by utilizing concepts like experiential learning, inquiry-based learning, self-efficacy and goal setting (Oblinger, 2004). My application will assist children in learning clear cursive handwriting, help adults improve their handwriting, and potentially have an impact on helping patients with Asperger’s Syndrome.

This primary game mechanic used in this application is similar to tracing words on traditional handwriting worksheets commonly seen in early primary school years. Words will be shown to the user on the screen and the user will have to trace these words to clear each level. Scores will be given to the user based on the similarity between the user’s inputs with the given words. The game will challenge the user by imposing a time limit during in each level.

The prototype of this application has been successfully built and used for user evaluations. A pilot study has been carried out to allow twenty users to test this application and provide relevant feedback. It was found that all users believed that this application is useful in improving their penmanship and helping children with handwriting. Also it’s a more entertaining method than traditional handwriting worksheets.
Safe Water Delivery: An Assessment Toolkit for Sourcing Water Treatment Solutions for Developing Communities - 6cp

Lachlan John - S12-071

Supervisor: Prasanthi Hagare
Assessor: Hokyong Shon
Major: Civil Engineering

Achieving access to safe drinking water for those without is a mandate of great importance. The Millennium Development Goals, established by the UN in 2000, include a call to halve the number of people without access to improved water sources by 2015. In many ways, the world is on track to meet this target; however, the world is not on track to end the water issue forever. Recent studies have called for a reassessment of the way water development is conducted if we are to completely eradicate this issue, not merely keep pace.

In the spirit of this approach, I have researched the current situation in the water development field to compile a database of current water treatment methods and systems with performance information on each. From this I have created a consulting tool to assist engineering and non-engineering staff alike in addressing water quality issues in developing areas.

This tool will use existing situational information, such as resource availability, flow characteristics, and desired results given in terms of quality indicators such as total coliform, total suspended solids etc., to recommend the best method, or combinations thereof, for any given situation. Once the recommended method(s) have been found, users will find an accompanying list of available organisations which can be contacted to investigate implementing these methods.

By doing the tedious research and engineering assessment beforehand, I hope to cut down the time and money necessary to deliver development solutions, allowing communities access to effective solutions where the cost was previously prohibitive. Also, aid staff hours will be able to be spread further, achieving more in less time.

I hope the flexibility of my tool will expedite the development response to overcome the growth rate of increasing water demand and contribute to achieving safe drinking water supply in any development scenario.
The Application of a MoTeC ECU to a Mitsubishi 4G93T GDI – 6cp

James Keane - A12-075

Supervisor: Guang Hong
Assessor: TBA
Major: Mechanical Engineering

The Mitsubishi 4G93T GDI engine consumes less fuel, produces less CO2 emissions and produces more power than similar conventional port-injection engines. The 4G93T GDI features direct injection, turbocharging, 1.8-litre capacity and a range of fuel saving and emission reducing features. It is the perfect base for research and experimentation into further improving engine efficiency and reducing harmful emissions.

The installation of an aftermarket engine management system (EMS), such as the MoTeC M800, increases the potential benefits of the 4G93T GDI as greater control over engine parameters is possible. The EMS will also allow for the control of rich ethanol/gasoline blended fuel or dual ethanol-gasoline injection.

Direct injection engines are only recently gaining attention in Australia. As a result of this, the conventional method of receiving a base map from MoTeC for the engine was not an option. The solution was to create my own base map that could then be imported into the MoTeC ECU Manager software.

Once the base map is input the engine can crank and idle. Subsequently, the MoTeC M800 will be used to finely tune the 4G93T GDi on the engine dynamometer, in the UTS engine lab.
Investigation into the Fresh, Mechanical and Structural Properties of Synthetic Fibre Reinforced Concrete - 12cp

Michael Kelly - A12-076

Supervisor: Bijan Samali
Assessor: Rasiah Sri Ravindrarajah
Major: Civil Engineering

Currently, concrete is the most widely used construction material in the world and with this large scale usage comes a number of sustainability requirements that could be improved. Therefore, this Capstone Project aims to investigate a more environmentally friendly concrete by exploring different types of synthetic fibre reinforced concrete (FRC), which have the potential to exhibit improved overall performance. In order to achieve this goal, a comprehensive set of experiments were undertaken and analysed to study the effect of different fibre volume fractions of these synthetic FRC specimens on the fresh, mechanical and structural properties of the concrete. The two types of synthetic fibres that were utilised were polyvinyl alcohol (PVA) fibres of 6mm and 12mm geometric lengths, as well as monofilament and fibrillated polypropylene (PP) fibres. 30% Fly ash (FA) was also used as partial replacement of Portland cement (PC) in all mixes. However, an extra mix without FA was also included in order to study the effect of adding FA.

From analysing the results obtained in these investigations, a number of conclusions could be made. An increase in the percentage volume of PVA and PP fibres within the FRC resulted in a decreased slump and hence, a less workable concrete. Furthermore, adding synthetic fibres also caused a slightly higher air content while a decrease in the mass per unit volume was also noted. In terms of the mechanical properties, the optimum fibre content was 0.25% for both PVA and PP fibres, while the 6mm PVA fibres and fibrillated PP fibres performed better than the other fibre types. The compressive strength, indirect tensile strength and modulus of rupture of the FRC improved with the addition of PVA fibres, while the post peak flexural behaviour was not significantly affected. Finally, the beam-column joint test showed that PP fibres were found to improve the structural ductility and energy dissipation in the structural element.

Therefore, this Capstone Project demonstrates the potential that synthetic FRC has to be utilised in the future as a viable construction material due to its improved environmental sustainability and enhanced performance capabilities.
Mobile Android Cardiac Monitor and Telerehabilitation Platform - 12cp

David Latham - A12-083

Supervisor: Steven Su
Assessor: Youguang Guo
Major: Electrical Engineering

The cost of delivering health services is rapidly increasing. The Productivity Commission has claimed that Australia’s health expenditure has grown by 70 per cent over the past decade. An ageing population and the failure to effectively continue to manage the effects of patients with chronic diseases are significant contributors to this increase in spending.

Governments are attempting to absorb these increased costs and balance their budgets; however, without innovative solutions services will be cut.

Evidence shows that persistent rehabilitation has lasting beneficial effects for patients – saving money and freeing up vital hospital beds. Despite these benefits our health system is not making efficient use of rehabilitative services because patients are often prevented from accessing them due to social, physical or financial barriers.

Modern mobile platforms such as Android and iOS could provide the basis for a solution which can bridge the gap for patients who wish to continue rehabilitative services but would have otherwise been prevented to by these barriers.

Android is an open source mobile operating system designed by Google. It currently dominates the market and is emerging as a health services platform.

In collaboration with the CSIRO this project has developed the base platform on an Android device to efficiently collect cardiac data from wireless portable sensors by using Bluetooth. Through further research to be conducted this data will be used in a controller within the Android application which will execute a rehabilitation program designed by health professionals.

The mobile capabilities of the Android platform will be exploited to facilitate live monitoring of the program as well as provide interactivity between patients at home and health professionals at work – this will be telerehabilitation.
Gamification in the Workplace - 12cp

Elliott Lawrenson - A12-084

Supervisor: Yusuf Pisan
Assessor: Chek Tien Tan
Major: Software Engineering

Gamification is the use of game design elements in a non-gaming context. Examples of this include adding game elements such as points, achievements, special tasks which offer rewards, and leader boards to non-gaming systems like websites or phone apps. Gamification processes are added to many different systems to try and increase user enjoyment and engagement. Many different companies are implementing gamification systems to either increase their workers’ enjoyment or increase user interaction with their system.

Gamification systems are being implemented in many different places in society, and they are becoming more common on websites and in enterprise. More enterprise companies are willing to try gamification as research points to it being a positive motivator and having the potential to foster relationships between its users if implemented correctly. Many well-known companies including Microsoft, Nike, SAP, and Samsung have gamified at least one of their processes or client facing systems.

This project examines the use of a gamification system in an enterprise situation at a software company. The users of this system are involved in general maintenance of a software system and use an issue tracking system called Trac to aid in this. A gamification system has been built and implemented with the users providing direct feedback during the development and implementation using the Trac system’s database. The results of the implementation showed that no direct increase in productivity was observed, yet due to the nature of the work the users do, this was not unexpected. However, all participants found their work more enjoyable, were motivated to do extra tasks to gain an achievement in the system and the majority believed there was a better relationship within the team because of the gamification system.
Subsynchronous Resonance in Power Systems - 12cp

Matthew Ley - A12-087

Supervisor: Li Li
Assessor: David Dorrell
Major: Electrical Engineering

Series capacitors have been used for many years to improve the capability and operations of a power system. As transmission lines in power systems are inductive, series capacitors are used to cancel out part of the inherent reactance of the line bringing the power factor closer to unity. This was until 1970 where a 750MVA turbine generator in south western U.S.A experienced shaft damage when a 500kV series compensated transmission line was switched in. This was later discovered to be a type of Subsynchronous Resonance.

Subsynchronous Resonance is an electric power system condition where the electric network exchanges energy with a turbine generator at one or more of the natural frequencies of the combined system below the synchronous frequency of the system. They’re three known types of Subsynchronous Resonance interactions currently known that include torsional interaction, torque amplification and induction generator effect. This paper includes the analysis of both torsional interaction and torque amplification on the IEEE second benchmark model as well as the analysis on part of TransGrid’s real network.

To conduct the studies of torsional interaction and torque amplification a few tools will be used for the analysis of subsynchronous resonance. An Electromagnetic transient program called ATP will be used to modal the electrical system in a time domain simulation. This will be used to show the slow growing torque oscillations that the system is expected to experience through torsional interaction and for torque amplification ATP will demonstrate the initial peak torques as well as the contributing factors to these peak torques such as fault clearing time, fault location and fault type. Matlab will be used extensively alongside with ATP to complete the studies.
Shear Strength Properties of Soft Soil Using Shear Box - 12cp

Hao Liu - A12-092

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering

The capstone project is based on the method of using shear box to determine the shear strength of soft soil. As know of all, soft soil is defined as fine-grained soil which composed by hydrated silicate of aluminium. The main two units of soft soil are Silica Tetrahedron (SiO\textsubscript{4}) and Alumina Octahedron (Al(OH)\textsubscript{3}). By using shear box testing, geotechnical engineers can find out the peak shear strength, the residual shear strength, the cohesion and the friction angle for the soil sample. Soft soils show low permeability, low shear strength, low bearing capacity, high compressibility and high shrink-swell potential. These characteristics are very important for contractors and engineers, because those features of soft soil will cause many technical and construction challenges and risks in the real world.

As a civil engineering student, my aim is to be a geotechnical engineer in the feature so that soft soil will play an important part in my future working life and this capstone project will be one of my milestones in my engineering life. Nowadays, the features associated to soft soils will cause some problems such as settlement of structures, unstable of embankments and excavation slopes and drainage problems. From my project of view, I can find out the different strengths of different soft soils and the significance for the shear box testing is to prepare for the construction engineers and geotechnical engineers. For example, results of shear box testing can prevent building from settlement and keep retaining wall stable. These can reduce the risk for the construction.
Investigation and Development of a Measurement Model of the Environmental and Financial Benefits of Virtualisation to Australian Companies - 12cp

Salma Maatouk - A12-095

Supervisor: David Eager
Assessor: Ravindra Bagia
Major: ICT (Telecommunications) Engineering

Virtualisation is an emerging technology that a number of Australian companies are either investigating or implementing in order to reduce the budget allocated to operating their data centres and/or to reduce their environmental footprint. This revolutionary technology promises to allow industries in Australia to shrink their data-centres considerably by converting expensive physical servers to environmentally friendly virtual servers of which hundreds coexist onto one physical host. This Capstone Project attempts to assign a dollar value to the promised financial savings of installing a virtual infrastructure taking into account the effect of the Australian Carbon Tax and to assess the environmental impact of this technology compared to the traditional physical infrastructure.

In order to achieve this purpose, a model with both financial and environmental aspects was developed by investigating current literature and technical reports and using the Vensim PLE software programme which helped establish the interrelationships between the various model components. Data was sourced from a multinational Australian company and applied as a case study to the model developed hence enabling analysis to be carried out and showing the potential monetary savings and environmental impact of virtualisation under the assumptions made.

This study concluded that virtualisation not only delivers technical improvements in data centre management but more importantly, it brings about both financial savings and environmental benefits which is an achievement not easily accomplished with today’s technologies. This study also concluded that the main contributor to financial savings is the reduction in annual energy consumption which exceeds by far any other identified expense and makes a significant difference to an organisation’s environmental footprint. These findings will also be of assistance to data centre management teams worldwide that may be considering the implementation of virtualisation or facing obstacles proving virtualisation’s sound financial and environmental grounds.
The Design and Implementation of a Multi-Configurable Semi-Active Hydraulic Suspension System - 12cp

Adam Martinez - A12-101

Supervisor: Nong Zhang
Assessor: Holger Roser
Major: Mechanical Engineering

In the financial year of 2010/11, there were 367 fatalities recorded in NSW alone – an 18% reduction from the previous financial year’s statistics and a 300% improvement since the 1970’s. This can be partially attributed to improvements in road safety legislation and partially attributed to an injection of research and development into improving road safety by developing the mechanics of vehicles. Whilst statistics appear tremendous over the last forty years, improvements in road safety have begun to stagnate in recent times averaging around 417 fatalities over the past four years.

As engineers across the globe endeavour to exploit the next level in vehicular safety, the University of Technology, Sydney, has previously validated a Demand Dependant Active Suspension (DDAS) system concept which provides a resisting moment to lateral acceleration imposed upon a vehicle’s longitudinal axis opposing body roll as required during extreme driving conditions.

A similar notion, the Semi-Active Hydraulic Suspension System developed in this project employs a closed loop hydraulic integrated circuit to convert fluid energy into linear mechanical energy utilising double acting actuators controlled by a number of solenoid cartridge valves. The system has the ability to manipulate the actuators to accommodate four scenarios, addressed as modes, experienced in an assortment of driving conditions from harsh cornering, to bumpy roads and off-road terrains.

As the primary objectives of this project were to authenticate the aforementioned concept as well as entertain the prospect of having the system installed onto the Ford Territory test vehicle upon future development, a double acting hydraulic actuator was designed and manufactured to accommodate the parameters imposed by the nature of the test vehicle. The entire system was installed onto a custom build test rig for visual validation of the concept.
An Investigation into Kasperson's Theory: Social Amplification of Risk - 6cp

William McAnulty - S12-088

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There is often a disparity between calculated risks by risk experts and the perception of risk by the general public. New events, especially ones associated with dread, are often misinterpreted by the public and an irrational focus is placed on these risks. Several theories have been devised to explain this phenomenon and to attempt to model how this process occurs. The most complete and accurate theory is the Social Amplification of Risk theory also known as Kaspersons Theory. An example of amplification of risk is after a plane accident report in the media, the aircraft sector see a drop in passengers due to the irrational perception that flying is now dangerous.

At present there are many fragmented papers and sources of information, some written by Kasperson himself, however a complete and clear paper that synthesises the research into one complete source does not exist. Analysis of primary survey data and exploration of several case studies has been used to complement an in depth literature review to support and show that the theory explains the behaviour of the discrepancy between the perception of a risk and the mathematically calculated risk.

Social Amplification of Risk is an effective way of explaining how the perception of risk is changed as it is communicated to the wider public. The theory explains how a risk is amplified through the process of the risk being perceived and then communicated to the next person, with each communication step involving the potential for amplification to occur. While the capstone successfully explores the theory, further exploration into better graphical representations of the model would be beneficial in future research.

The application of applying the theory has proven to be a valuable way to help understand the theory and to support the previous literature.
The Behaviour of Pedestrians at Signalised Intersections in the Sydney CBD in Relation to Crossing Delay, and Recommended Intersection Treatments - 6cp

Claire Mead - S12-092

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Major: Civil Engineering

The last 50 years of Sydney traffic management has largely focused on improving the road environment for vehicles, but has ignored the needs of pedestrians completing the walking element of their journey. However, walking efficiency and safety is now critical to the success of the CBD as a multi-purpose, transport-heavy centre.

It has become necessary for Sydney planners and engineers to investigate the behaviour and needs of the average pedestrian walking across the CBD. Sydney pedestrians experience the most cross-CBD walking delay at signalised intersections. Where there is significant delay or where the crossing is located on a major pedestrian link, a proportion of pedestrians will not comply with the crossing signals and walk against the ‘red man’. This compromises the safety of themselves and other road users.

This study aims to define the behaviour of Sydney CBD pedestrians at signalised intersections in the daytime, the reasons for this behaviour, the inherent road safety risks and what steps may be taken to improve CBD walkability and road safety for pedestrians. The study analysis examines the mathematical and statistical relationships between pedestrians’ behaviour and influencing factors including the delay experienced, road geometry, signal operation, traffic flow characteristics and footpath crowding. After examining these relationships, the study will present a road safety risk analysis, and recommend crossing conditions and infrastructure required to meet pedestrian walkability needs.

A series of video surveys has been completed at 20 typical intersections (locations with pedestrian non-compliance) during daytime peak periods. While these videos show visual proof for the risks associated with crossing against the red signal, the data collected also shows that pedestrians are more likely to comply with crossing signals when there are more frequent green signals. Other options to improve walkability include pedestrian infrastructure, which bypasses the delay altogether.
On The Spot Points - 6cp

Elie Nakhel - S12-100

Supervisor: Peter Leijdekkers
Assessor: Peter Leijdekkers
Major: Civil Engineering

On the Spot was conceptualized and began being researched in August of 2012, the basis of this technology is to allow the user of the app to more easily connect with the organizations in charge of taking care of OH&S matters in a convenient manner.

It is designed to put the power back into the hand of our future, the work force of today so it can build and continue to work towards our future.

With today’s society adapting to the use of more mobile applications to do confidential and secure tasks such as banking transactions, it makes reporting a serious work place issue a step away and now it is here introducing On The Spot.

Easier and more simple than ever before, using digital media On The Spot to produce a report in no time, the first app that allows a site investigation before it is altered and covered up, it can allow proper assessment by authorities with digital evidence.

The student which is leading the research is Elie Nakhel a final year Engineering Student at UTS, Sydney. He takes an innovative approach to solving problems with the mind set to conceptualize, develop and implement solutions. This project is also Supervised by Dr. Peter Leijdekkers a Senior Lecturer School of Computing and Communications at UTS, Sydney.

On The Spot's mission is to make the work place safer and user friendly, it is designed to promote safe work practices and develop a convenient united system that can be recognized in all industries universally. This is the key to protecting the skills of all countries as it is designed for all nations around the world.
High Strength Concrete with Ultrafine Fly Ash and Hydrated Lime - 12cp

Benup Neupane - A12-111

Supervisor: Rasiah Sri Ravindrarajah  
Assessor: Shami Nejadi  
Major: Civil Engineering

In recent years, high strength concrete in civil engineering has risen in popularity due to its benefits of reducing the allowable sizing of structural members such as beams and columns especially in more extreme weather conditions. Since high strength concrete is a staple material, there is a real demand for a sustainable means of production. This is because the conventional production method: uses only cement as binder constituent, induces a high carbon footprint and is relatively expensive. Thus, in today’s environmentally conscious world, a substitute binding material is required as a partial replacement of cement in high strength concrete.

The purpose of this project is to improve the pozzolanic reaction of fly ash in high-strength concrete by adding hydrated lime into the mixture as an activator and to accelerate the curing process. Additionally, the substitution of PC with fly ash and hydrated lime reduces carbon emissions significantly as 1 tonne of cement production induces 1 tonne of carbon dioxide. Determining the resultant early-age strength was a key point in the experiment as the addition of fly ash slows down the pozzolanic reaction, resulting in lower early-age strength. Hence, hydrated lime was added in a separate sample and early-age strength comparisons were undertaken.

The investigation involved examining the strength properties of high-strength concrete, MoE and Pulse Velocity up to 90 days; indirect tensile strength of 28 days, and drying shrinkage up to 56 days by employing 5 samples of high-strength concrete, having the 28 days compressive strength above 80Mpa distinguished by mix proportion. Bayswater’s Normal (Fine) and ultrafine (Microash) fly ash from the same source were used to examine the effects of fineness of fly ash. 25% (by weight) of normal and ultrafine fly ash was used as partial replacement; further 10% of fly ash in both mixes was replaced by 10% of hydrated lime. Thus, the obtained results will be used to evaluate the influences of fineness of fly ash and the development of strength on replacement.
Development of a Mobile Experimental Energy Flow Meter - 12cp

Nicholas Newland - A12-112

Supervisor: Peter Tawadros
Assessor: Nong Zhang
Major: Mechanical Engineering

Testing and recording vehicle performance has historically been an expensive and difficult task, necessitating high overheads, complex plant, and specialist operator training. This has meant that facilities such as vehicle dynamometers have only been accessible to automotive manufacturers, regulators, and specialist workshops, who are highly resourced and able to offset the expense based on a period of continued use. Conversely, interest groups with limited resources are simply unable to conduct detailed testing of the same scale or accuracy.

As complex alternative powertrains develop, the lag between the testing capabilities of vehicle manufacturers and other interest groups has increased, and it is often some years before new developments in powertrain technology are comprehensively disseminated in the public domain. Further, the inflexible architecture of traditional dynamometer facilities cannot easily be expanded to incorporate testing of a much greater variety of powertrain architectures. This means that regular and accurate vehicle testing is often not economically feasible for parties such as the academic, automotive aftermarket, and surface logistics industries, as well as individual enthusiasts.

This project addresses this deficiency by developing a cost effective, beta prototype, mobile vehicle energy flow monitor. When coupled with basic sensors, this offers similar functionality to a traditional vehicle dynamometer, whilst offering additional functionality and flexibility by coupling with a vast array of sensors available in the market. This is achievable through miniaturization of transducer technology, coupled with decreasing cost of electronics.

The particular focus of this project is research activities at academic facilities such as UTS, where floor space and financial capital are increasingly strained. Such institutions conduct regular research and testing projects, but may not be able to justify the high cost of ownership of heavy plant for relatively low use. By developing a mobile unit that can be fitted to an instrumented vehicle, the need for dedicated space and facilities can be dispensed with drastically reducing research costs. In essence any suitable road surface can be used as a testing facility gaining valuable data from inside the vehicle.
Investigations of Stress Wave Propagation Behaviour of Timber Utility Poles Using Finite Element Method - 12cp

Van Nguyen - A12-119

Supervisor: Jianchun Li
Assessor: Emre Erkmen
Major: Civil Engineering

This capstone project aims at gaining fundamental understanding of stress wave propagation in timber utility poles to assist the development of a non-destructive test (NDT) for the assets management of timber utility poles. The study primarily utilizes the finite element analysis tools (such as ANSYS®) to model stress wave propagation in the timber utility pole with or without structural defects. The numerical results are then used to compare with experimental results whilst considering the theory behind wave propagation in timber.

A finite element model of the timber pole is established using commercial finite element package ANSYS®. Stress wave propagation is induced by impacts and ultrasonic impulses. The modelling is completed in several stages. The initial model uses a simplified material model by considering the timber pole as an isotropic material. An orthotropic material modelling is considered later to be more representative for the timber material. Both flexural waves and compressional waves are studied in detail by analysing the nodal solution data and observing animations of stress wave propagations that are created in ANSYS.

Experiments are conducted to obtain results to compare findings from the simulations in ANSYS. Transducers and sensors (such as accelerometers) are placed around the timber pole specimens and the acceleration values are recorded when the timber is induced by different types of impacts/impulses.

Once FE analysis on the undamaged model is completed and the results are validated by the experimental data, defects are introduced to the model to study the damaged cases. The study is then focused on the influence of defects to the behaviour of stress waves in the timber so that the experimental results can be analysed and interpreted to assess the damage conditions in the timber pole. Tomography is also studied and applied to find defect in timber poles.
Modelling the Long Term Behaviour of Conventional Steel Reinforced and Steel Fibre Reinforced Self-Compacting Concrete Slabs - 12cp

Ryan Noney - A12-120

Supervisor: Shami Nejadi
Assessor: Anne Gardner
Major: Civil Engineering

Steel fibre reinforced self-compacting concrete (SFRSCC) is a relatively new composite concrete material. The developments in mix design allow for self-compacting concrete to achieve sufficient compaction without the need for external stimulation. The addition of steel fibres in self-compacting concrete can enhance the properties of the mix with specific regard to tensile strength, cracking behavior, fracture toughness and ductility.

Ongoing research at the University of Technology, Sydney, is investigating fibre reinforced self-compacting mixes with particular attention to predicting deflection, creep, shrinkage and cracking behavior of these mixes under long term service loads. Using the non-linear finite element modeling software ATENA, this study aims to contribute to this research by providing engineers with a suitable method for modeling deflection and cracking behavior in conventional steel reinforced concrete slabs and SFRSCC slabs.

Using previously conducted research, steel reinforced simply supported concrete slabs are modeled over a 400 day period under 30% and 50% ultimate loading with varying reinforcement configurations. To ensure repeatability when later modeling SFRSCC, methodology is verified by assessing the accuracy of the finite element mesh, stiffness transfer between finite elements of different material properties and comparing the behavioral differences of initial loading with static time-independent models.

SFRSCC simply supported models were created of externally conducted research which is pre-cracked before sustaining load for 250 days. Models are created using compressive and tensile strain functions provided through current UTS research. The behavior of these functions was compared against recommended default program functions for modeling fibre reinforced concrete.

Overall acceptable results were obtained in this study. Models showed repeatable and accurate cracking behavior with more accurate deflection results observed in the conventional reinforced models.
Design of a Motor Controller Board for Rehabilitative Robotics Control with Simultaneous Digital Health Monitoring over WLAN for Patient Rehabilitation Using the Upper Limb Exoskeleton - 12cp

Albert Ong - A12-123

Supervisor: Dikai Liu
Assessor: Kenneth Waldron
Major: Mechanical and Mechatronics Engineering

Rehabilitation robotics and mobile wireless patient monitoring are emerging industries that are gaining much attention from governments; to tackle issues associated with providing healthcare and rehabilitation to the growing aging population. However, limitations such as constrained functionality, poor system flexibility, difficulties in measuring efficacy, and high costs, are constraining the market attractiveness and commercialization potential of these rehabilitative and monitoring devices.

This Capstone project employs an explorative approach to design a solution which integrates two fields of research – mobile digital patient monitoring and rehabilitative robotics – in order to synergistically improve the commercial viability of these devices and provide a future platform for software-based medical monitoring devices. This solution comprises of a novel, low cost, stackable motor controller and data acquisition system, which simultaneously acquires medical data for rehabilitative robotic control, data logging, and viewing over WLAN on a tablet PC. As a proof-of-concept, we have interfaced the proposed system to the CAS upper limb exoskeleton, granting it electromyographic control and vital sign recording.

The system is able to gather medical data, and relay this information wirelessly to a doctor to remotely monitor patient progress during rehabilitation. This method could also use the recorded physiological data to fine-tune the exoskeletal control.
Investigation of Stress and Deflections from the Austroads Six Axle Groups on Plain Concrete Pavements - 6cp

James Painting - S12-106

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering

Currently in NSW, concrete (rigid) pavement designs are completed according to Chapter 9 of the 2004 revision of the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design, which is itself based on the 1984 Portland Cement Association (PCA) method. There are four main types of concrete pavements in NSW, but plain concrete pavements (PCP) are the most common, hence this project is focused on PCP. Some general research into PCP analysis and design methods is summarised, with some advantages and limitations of several methods.

There are several other methods for concrete pavement design that are used around the world, including the use of finite element analysis programs. One such program is EverFE, a freeware finite element program created jointly by the Universities of Maine and Washington for calculating stresses and deflections of plain concrete pavements subjected to traffic loading and/or environmental effects.

This project provides information to assist in deciding whether EverFE could be a useful analysis tool, particularly for NSW Roads and Maritime Services (RMS), where it may have potential to be used as a complement to the Austroads method. Some general information about the capability of EverFE is provided, to further assist in deciding whether EverFE should be used by RMS. Furthermore, the results of a parametric study are provided to determine the sensitivity of the program to changes in input parameters. Results from the program are presented to show the response of plain concrete pavements to the Austroads six axle groups. Numerical outputs are compared to the results of the Austroads method, to investigate whether the computed values from EverFE can be used to predict the results of the Austroads method. Some suggestions are made for further research that would be required to investigate the capability and usefulness of the EverFE software package.
Comprehensive Analysis and Comparison Between Australian and Canadian Timber Code and Practice - 12cp

Michael Palamara - A12-125

Supervisor: Christophe Gerber
Assessor: Chris Wilkinson
Major: Civil Engineering

Engineering design is a continually evolving discipline that deals with unknown variables. Factors of safety are used to ensure that structures or their elements fulfil the service expectations during their design lifetime. Designs are restrained by resources, actual material capacity and our knowledge about the material.

The comparison between the Australian and Canadian timber codes offers an insight into different ways engineers approach design solutions. The methodology to approaching problems and the overall design capacity of an element varies indeed between each code. The evaluation of each code was limited to structural application of timber. While the Australian timber code (AS1720.1-2010) and the Canadian timber code (SA 086-09) use Limit States Design (LSD), the Canadian code uses the European Yield Model (EYM) design approach for bolts, lagscrews and nails. It included the mechanical properties of timber, and the design of structural members and joints.

Several designs for beams and joints were developed to determine actual differences between the design approaches. Minimal differences were identified in the design procedures of beams between the codes, whilst more significant differences could be observed with the design of bolted connections. For this reason, bolted joints were selected to be laboratory tested for further investigation. This aimed to compare the actual performance against design performance and identify how the design approaches of the codes agree the test results. This investigation thus identifies the level of safety (safety factors) applied in each design method.

The literature review seemed to indicate that currently the EYM is favoured for the design of connections worldwide. The laboratory investigation also suggested that EYM provides better understanding, control and reliability of the connection design. Therefore, whilst more research is required for Australian timber species to verify the EYM design principles, the Australian code would benefit from implementing a number of the EYM principles for joint design. To this end, further research is also required to determine the effectiveness and benefits from varying the location of bolts of the connections.
The Compilation of a Program that Analyses and Designs a Reinforced Concrete Beam - 6cp

Michael Paleologos - S12-107

Supervisor: Emre Erkmen
Assessor: Ali Saleh
Major: Civil Engineering

Reinforced concrete is a composite material that consists of concrete and steel reinforcement bars. The development of this composite is initiated due to the limited performance that concrete inhibits when exposed to tension actions. Steel is a ductile material and performs well when exposed to compressive and tensile actions. By strategically placing reinforcement steel bars in a mass concrete element; reinforced concrete can perform well for bending, shear and deflection related purposes.

This capstone will expand on the compilation of a program that designs a reinforced concrete beam in accordance with Concrete Structures (AS3600) and Structural Design Actions (AS1170.0, AS1170.1). The program is a graphical user interface (GUI) compiled using Matlab and the program will also structurally analyse continuous beams using the direct stiffness method as well as design concrete beams in accordance to AS3600 for strength and serviceability requirements.

In practice for design analysis purposes commercial engineering software packages are used however, a handicap for a design engineer is that he/she has limited access to the procedures of the commercial software. This program is not intended to compete with advanced finite element applications however, by developing my own program I will have a better understanding of the background procedures and develop skills to improve it further in the future.

This program can also be used in parallel to assess the accuracy of analysis and detailing of designs in a seamless manner. Therefore regarding the program that I have developed, my objectives are to achieve simplicity and also to remove any vagueness that may be inherent for a user when commencing a design. This tends to happen with commercial related software packages that provide limited access and resources explaining the procedures that they have followed to reach a specific solution.
A Comparison of Experimental and Numerical Shake Table Results for a 15 Storey Structure With and Without Soil Base - 12cp

Vanessa Pretila - A12-129

Supervisor: Bijan Samali
Assessor: Bezhad Fatahi
Major: Civil Engineering

Due to the possible high damage and cost destruction caused by earthquakes, a significant part in designing successful structures is analysing the behaviour of the design when subjected to ground acceleration. Although physical experiments are readily available to analyse scaled models, the increase in complexity of modern designs may increase the cost of the project. Finite element software’s are used throughout engineering to model simple to complex designs in order to analyse its behaviour through a micro to macro level when subjected to loadings. As the effects caused by an earthquake may result with great damages to a structure, the reliability of finite element software’s in simulating a structures behaviour is significant in order to gain confidence in the results obtained by the analyst.

The aim of this project is to identify the capabilities of the finite element method in simulating the behaviour of two 15-storey scaled models used for a previous research, one with a fixed base and the other with a soil base to the ground accelerations caused by the Kobe Earthquake.

The computer models have been created and analysed using the finite element software ANSYS for comparison with the results obtained in the physical experiment. Both results have been compared with explanations to the possible causes of discrepancies. Verification of the elements and modelling methods used has been completed within this project as part of identifying the capabilities of the finite element method.

This project has allowed for the capabilities of ANSYS in modelling earthquake behaviour of the particular structure to be obtained and deemed as suitable to a certain limit as discussed within the report.
An Assessment of the Impacts and Analysis of Community Expectations of Motorised Mobility Scooter Use in Port Macquarie - 6cp

Thomas Reed - S12-122
Supervisor: Ken Halstead
Assessor: David Eager
Major: Civil Engineering

Port Macquarie is a large regional town on the New South Wales Mid North Coast comprising of 44,300 people with an average age of 43 years as compared to the state average of 35 years, keeping Port Macquarie mobile over the next two decades will soon become a challenge. Motorised Mobility Scooters (MMS), also known as buggies and gophers, are an important tool in keeping the aged and vulnerable independent. MMS devices are growing rapidly in popularity as sales over the last ten years have substantially increased. As the population continues to age the predicted number of MMS devices in use around Port Macquarie is set to rise.

At present no management plan has been formulated to determine what measures would be appropriate for implementation in regional towns. Preliminary studies have investigated the opinions of those who utilize and assist MMS devices to address what measures they would believe to be effective. However, no study to date has been commissioned to collect a database of the greater community’s expectations and preferences on the use of MMS devices.

The primary objectives of the study has been to assess options for reducing incident risk and injury related to MMS device use and to prepare a framework within which future development can proceed in accordance with best transport planning and management principles. The study has determined several risk mitigation recommendations to adequately provide a safe environment to improve mobility equality. A community questionnaire was circulated to 1200 homes across Port Macquarie targeting those who use MMS devices and those who frequently are impacted by their use, 217 responses were received from a broad spectrum of the community resulting in a number of recommendations being made. A site investigation was then undertaken to determine the feasibility of strategies to implement the community’s expectations.
Developing Cost Effective and Sustainable Technologies for Urban Stormwater Harvesting Designs - 12cp

Nicholas Reedy - A12-133

Supervisor: Prasanthi Hagare
Assessor: Hokyong Shon
Major: Civil Engineering

Most major Australian cities use centralised systems to supply residential and industrial areas with water. Continued expansion of metropolitan regions coupled with reduced rainfall and periods of drought, has placed great pressure on these systems to meet the growing demands of society. Recent investment from local, state and federal governments has emphasised the importance of managing water resources more sustainably by developing research into sustainable water resource options and their efficiencies.

Urban stormwater harvesting presents one solution to integrated water cycle management which has a significant advantage over other methods due to its indirect ability to minimise the impacts associated with unmitigated runoff that occur as a result of urbanisation. The aim of this project was to investigate recent research completed on the efficiency of Water Sensitive Urban Design (WSUD) Measures and their application using Best Management Practices (BMP’s). The results of this study were then used to develop a case study outlining the implementation of WSUD for an existing urban environment.

This case study includes a feasibility report which assesses the conceptual implementation of WSUD measures at different sites in Sydney, outlining specific opportunities and constraints. The most feasible site was selected and the opportunities identified were further developed into design proposals based on catchment areas derived by topography. The Upper Parramatta River Catchment Trust (UPRCT) technical guidelines and relevant Australian standards were used to calculate the optimum design parameters for a permeable pavement system for a car park structure and the design of a sand filtration device for a separate catchment on the same property. Treated flow rates, hydraulic conveyance systems and storage systems have also been calculated to illustrate how the proposed design integrates with the existing environment. To evaluate these designs with regards to sustainability, a cost estimate of the design is presented that includes capital investment (construction materials and labour) and maintenance costs. Recommendations have then been made with regards to local council planning and approval processes.
An Investigation Into Major Heavy Patching by Road and Maritime Services (RMS) on the NSW State Road Network - 6cp

Michael Rheinberger - S12-123

Supervisor: Ken Halstead
Assessor: Tom Anderson
Major: Civil Engineering

Traffic loading on NSW State Roads is constantly increasing due to increase freight movement and increased road user demand. The increased loading on road pavements, environmental effects and pavement aging, has lead to an increase in pavement failures which need to be repaired by the road authority to keep the road open and safe for road users.

It is critical for Roads and Maritime Services (RMS) to ensure NSW State Roads are kept trafficable to ensure the safety of road users and the efficiency of freight transport tasks. Heavy patching is one option used by the road maintenance community to maintain the road network; this involves the removal, or treatment of the failed pavement material, and replacement, or modification with suitable material to repair the road defect. This process aims to ensure road user safety, during the treatment and for the duration of the remaining existing pavement life. Heavy patching is required as a quick, effective maintenance treatment to maintain the road networks condition. Heavy patching treatments need to be cost effective, and withstand traffic loading and environmental effects until rehabilitation or reconstruction work can be done on that segment of the road network. Heavy patching is constructed to match the surrounding pavement’s expected remaining life, which is generally less than ten years.

This project will research and review common practices in the road maintenance industry relating to identifying, prioritising and repairing road pavement defects requiring heavy patching work, for both flexible and rigid pavements. Data will come from Australia and also internationally. An analysis and comparison of Roads and Maritime Services’ procedures used on NSW State Roads and other procedures used in the industry will be conducted, identifying possible improvements to RMS’ methods. The findings and recommendations provided in this project will be beneficial to the future direction relating to heavy patching maintenance in NSW by RMS and maintenance contractors.
An Investigation to Identify and Capitalise on the Effect of Friction in Timber Concrete Composite (TCC) Elements – 12cp

James Riley - A12-135

Supervisor: Christophe Gerber
Assessor: Chris Wilkinson
Major: Civil Engineering

The composite action in Timber Concrete Composite (TCC) elements is conventionally provided by the mechanical connectors between the timber and concrete members, whilst friction is ignored. The presence of frictional resistance at the timber - concrete interface of a composite joint has received very little attention and is regarded as insignificant and arguably inconsistent by most. With the quest of the most optimal composite action and the development of numerical models, it is now understood that frictional resistance has an important role in the behaviour of TCC elements.

This research investigates the frictional force present in TCC elements. With TCC solutions becoming increasingly popular due to economic and environmental benefits, an accurate understanding of the behavioural responses of TCC structures is required. Therefore, the contribution of frictional resistance needs to be quantified and its effects on minimising slip and deflection needs to be understood.

This report presents the findings of a detailed investigation that aims to identify coefficients of friction under direct contact conditions between timber and concrete elements. Observation and analysis focused on the behaviour of different timber element configurations and surface preparation techniques. It also investigates how frictional resistance at the timber - concrete interface can become more consistent and be magnified with the introduction of surface activation and mechanical fasteners.

A dynamic frictional force was identified with all timber element configurations. This parameter exhibits a significant increase and more consistency in series where the surface of the timber was ‘activated’. On the other hand, the inertia – initial static friction – appears inconsistent. On completion of the testing procedure, the defined friction coefficients are introduced into TCC beam models and design procedures. The benefits of more accurate predictive values are assessed using data from literature.
An Investigation of High-Speed Surface-Piercing Struts Using Computational Fluid Dynamics - 12cp

Thomas Roberts - S10-136

Supervisor: Dr Matthew Gaston & Dr Peter Brady
Assessor: John Reizes
Major: Mechanical Engineering

The study of fluids and their interaction with matter is of importance to the advancement of many existing technologies, including various modes of cargo and passenger transportation in air and water vehicles, military and racing applications, to name but a few. Accordingly, ongoing research continues to be of significant value to both society and industry alike. As the nature of fluids is such that behavioural patterns and resulting performance characteristics are often very complex and difficult to predict, exact solutions are rarely available. Hence, computer models must be developed and simulations run in order to develop craft that exhibit desirable performance characteristics whilst still effectively carrying out their primary function.

The work described in this presentation examined the turn-fin (also known generically as a 'surface-piercing strut') of an existing hydroplane racing boat operating at high-speeds. The research utilises Computational Fluid Dynamics (CFD) to investigate differing strut designs and their performance under a range of operating conditions. The major objective of this research, however, is to specifically analyse the more dominant effects of fluids in high-speed free surface flows - in particular, the associated lift and drag forces generated by the strut.

This is primarily achieved by investigating the use of two differing strut shape designs - a dihedral strut and a quarter-elliptical strut with identical planform and cross-sectional foil profiles employed in both models - in order to determine which provides the best performance profile. However, a far more interesting - and unplanned - result of this research is the occurrence of ventilation under certain conditions. This phenomena, and it's mechanisms of inception, are still only loosely understood by the engineering and scientific community at the present time. As such, its presence in the affected simulations is examined and discussed in detail, along with both its apparent mechanism of inception along the strut, and the adverse effects on performance resulting from this phenomena.
Combined Thermostat/Hygrostat for Environmental Control of Reptile Enclosures - 12cp

Daniel Sachs - A12-140

Supervisor: Peter McLean
Assessor: Ben Rodanski
Major: Electrical Engineering

Reptiles in captivity require artificial humidity sources and thermostatically controlled heat sources to maintain their health. Currently, there are a number of different thermostats available in Australia but they all use a single temperature probe meaning that, generally, one unit must be used for every enclosure. It is possible for these single probe thermostats to be used to control multiple enclosures but there are inherent problems and dangers and it is generally regarded as a technique only to be used by the most experienced keepers.

There is currently no real commercial option in Australia for humidity control.

A system which is capable of controlling both of these variables while having modular capabilities would help to improve the health of animals in captivity and would make reptile keeping much simpler and cheaper.

A modular control system has been developed which allows for the control of temperature and humidity in reptile enclosures. The modular design means that the number of enclosures that a single system can manage would be determined by the end user simply through the addition of extra modules.

The prototype for this project has been designed around a single PCB design capable of being set up as a master or a slave. Currently, communication between units is achieved through the RS-485 standard with the aim of moving to wireless communication in the future. Each board utilizes a microcontroller as the “brains”, with each slave using fuzzy logic to control a pulse proportional (PWM) output on the thermostat and a simple, hysteretic controller for the hygrostat. An LCD screen is to be utilized for user information and feedback for input control.
Evaluation Study of Super-Efficient Air Conditioners Using Maisotseiko Cycle - 12cp

Pulkit Saxena - A11-142

Supervisor: John Dartnall
Assessor: TBA
Major: Mechanical Engineering

The project deals with analysing, reviewing and evaluating the efficiency of air-conditioners using M-cycle which are claimed to be highly efficient than conventional air-conditioning units which require substantial amount of energy to run. Thermodynamically an M-cycle evaporative air-conditioner passes primary or product air over the dry side of a plate and secondary or working air over the opposite wet side of a plate. The wet side absorbs heat from the dry side by evaporating water and therefore cooling the dry side with the latent heat of vaporizing water into the air; this overall provides for better user experience.

The primary deliverables for the project will involve providing a research and detailed description into how M-cycle functions as a whole and the key factors that make this cycle efficient. I will also provide assistance in installation process of the M50 unit that has been installed in the Air conditioning labs at UTS. I will also compare theoretical data for the system which has been obtained from a previous capstone to the actual data which was obtained from testing by using highly sensitive equipment (VAISALA) to measure humidity and temperatures. Overall the equipment will measure air flow rate (in and out), humidity levels (In and out), wet and dry bulb temperatures (in and out), power consumption and water flow rate.

From the results I will calculate the systems coefficient of performance (COP) and compare that to the acclaimed data provided by the manufacturer (Coolerado). As a whole I will also add in my recommendations for the system suitability to the Australian environment and society for commercial or private use. For future development I will comment on my recommendations to make the system more efficient if possible.
Design and Prototype of a Localisation System Using Node.js - 12cp

Hong Shi - S12-132

Supervisor: Xiaoying Kong
Assessor: Zenon Chaczko
Major: ICT Software Engineering

Localisation systems have allowed us to know about our whereabouts from virtually anywhere in the world. The application of localisation technology has been implemented in a wide range of information systems, software applications and portable devices. These localisation systems leverage the power of Global Positioning Systems (GPS) and Inertial Navigation Systems (INS) along with a complex process of data filtering, processing and normalisation to accurately calculate the geo-coordinates.

This capstone project attempts to use a systematic software engineering approach to design and prototype a simple real-time localisation system in JavaScript using a combination of GPS and INS sensors to accurately determine the instantaneous location. Raw data will be processed and normalised to get rid of abnormalities and improve precision of the sensor readings. The use of server-side JavaScript framework for data acquisition through serial ports provides better integration between the inner workings of the system with the front-end interface.

Traditionally the developments of such hardware constrained embedded systems are carried out through one of the many C flavoured languages. Modern programming languages like Java and Ruby cannot compete with C implementations on multiple fronts specifically dealing with application memory footprint and execution speed.

With the rise of Web 2.0, JavaScript has being known to be the language of choice when it comes to developing a feature rich and highly interactive web service. Only until recently the use of JavaScript in robotics have being explored through talks by Nikolai Onken and Jorn Zaefferer on Robotic JavaScript and open-source projects like Noduino. Server-side JavaScript implementation like Node.js provides many features of modern programming languages like dynamic typing of variables and native non-blocking input/output (I/O) model that does not exist in traditional C languages. This allows the development of data-intensive real-time applications without compromise on speed or memory.
The concrete roads of New South Wales are becoming older and older each day. As time passes these roads are slowly deteriorating and failing. As a result maintenance crews around the state repair these failures as they arise. Repairs commonly involve closing lanes of traffic from anywhere between 9 hours to a few days to repair these concrete failures. Highways and main roads that have large traffic volumes need these failures to be repaired over night. This is to minimize traffic build up from closing lanes to perform the repairs.

Overnight lane closures require accelerated concrete to be used to replace the failed concrete road. These concrete mixes are different to normal mixes as they contain a Calcium Chloride accelerator. This accelerator speeds up the strength gain of the concrete. This allows traffic to ride on the concrete road as early as 6 hours after pouring the concrete.

A case study of this accelerated concrete will be included in this capstone. The case study is of three concrete slabs that were replaced on the Mittagong Bypass with accelerated concrete. A few days after repair large longitudinal and transverse cracks had appeared. This sparked the need to ask questions as to why these large structural cracks occurred. Was it a lack of proper construction techniques? Was it a bad mix design? Was it due to environmental factors? An experimental study of the accelerated concrete was performed to try and answer some of these questions.

The experimental study will involve testing two concrete mixes. One concrete mix will be an exact replica of the accelerated mix used in the case study. The second concrete mix will be the same as the case study except no accelerator will be added. This experiment will help to determine any differences or similarities when an accelerator is used and when one isn’t used. Laboratory analysis of these mixes has highlighted that an accelerator admixture does not necessarily lead to early strength gain. Shrinkage of accelerated concrete is also dramatically increased in comparison to normal concrete.

Findings inside this capstone may be used by the Roads and Maritime Services. The information may then be used to help construct future concrete roads and modify maintenance techniques.
Modelling Current Transformer Saturation in Power System Protection Schemes - 12cp

Michael Stanbury - A12-151

Supervisor: Youguang Guo
Assessor: Steven Su
Major: Electrical Engineering

Current transformers (CTs) are regularly used in electrical power systems to measure currents for protection purposes. In certain situations they may undergo saturation and fail to represent the current accurately. The traditional solution to this problem has been to use very large CTs which are unlikely to saturate. Ausgrid, an electricity distributor in New South Wales, is now procuring new fixed pattern switchgear for its zone substations. This smaller switchgear means that Ausgrid’s traditionally large 11kV CTs will not fit inside the enclosures. The aim of this work is to investigate whether smaller CTs can be used on Ausgrid’s network, without additional risk to the network.

In this work I present a novel, physically based CT model which includes saturation, hysteresis and minor loop phenomena. This model is based on the Preisach theory of hysteresis, and its parameters are algorithmically deduced from experimentally measured B-H curves. I use this model to simulate several through-faults on City South transformer 4 on Ausgrid’s network. The resulting saturated waveforms were injected into a real differential protection relay to observe its behaviour under saturation. The results show that modern protection relays can appropriately handle a moderate amount of CT saturation. The tests also show the amount of saturation resulting from different CT core sizes. The performance of my model is compared to two others.

Lastly, I developed a statistical model which predicts the probability that a CT will saturate for a given fault. This model will help Ausgrid to understand the complex influences which determine CT saturation, and calculate the probability of it occurring. This quantitative analysis will be important for Ausgrid to develop a new specification for 11kV protection CTs which are small enough to fit inside the new fixed pattern switchgear.
A Study of Voltage Unbalance Caused by Photovoltaic Arrays in a Smart Microgrid Environment - 12 cp

Ananth Subramaniam - A12-153

Supervisor: David Dorrell
Assessor: Dr Li LI
Major: Electrical Engineering

The current electricity grid has become a complex and intricate network that requires extensive upgrades in order to cope with emerging integration of renewable energy, further increase in energy demands and other needs of the 21st Century. The solution is a smarter grid that optimises the use of generation, storage, transmission, distribution and consumer end electricity uses. In order to study the feasibility of such systems many small scale smart grids, known as smart microgrids, have been implemented. These smart microgrids generate, distribute and control the supply of power to consumers in a neighbourhood.

One of the advantages of implementing a smart grid is that customers will be able to sell excess power generated by photovoltaic (PV) arrays to the local utilities at the market price. Yet when households try to supply power while connected to the current grid, which is a three phase system, through single or two phase connections, multiple issues arise. Of particular interest is the situation where voltages across each phase differ in value known as voltage unbalance.

This project aims to study the occurrence of voltage unbalance that occurs when households supply power to the grid through a single phase or two phase connection. First a literature review on voltage unbalance and current mitigation techniques are presented. Following this a custom smart microgrid model was created in order to simulate voltage unbalance and its mitigation. The simulation results were analysed and recommendations on the most effective solutions were made.

The study on voltage unbalance, caused when PV arrays are connected to a smart microgrid, will help professionals, researchers and academics further the implementation of smart microgrids and eventually bring about the development of a smarter electricity grid.
Design of an Auto-Filling System for a Medical Testing Device - 12cp

Rhys Sultana - A12-154

Supervisor: Adel Ali Al-Jumaily
Assessor: Steven Su
Major: Mechanical and Mechatronics

The demand for cochlear implants is high because 16.6% of the population has low to severe hearing loss. Thus, every effort to maximise the efficiency of producing cochlear implants needs to be undertaken. One area which has potential for improvement is Cochlear’s test systems, in particular the IT5 test system which requires three specific bottles to be filled to a precise height (within ± 2mm).

The current manual filling system is inefficient, as it relies heavily on operator skill and judgment. Therefore, this project aims to design and build an automated, cost effective solution that will decrease the filling time and increase accuracy. It is anticipated that cochlear will benefit because of an expected reduction decrease in filling time and a reduction in annual production losses, due to the elimination of human error and improvements in efficiency.

The project began with the exploration of the problem and the identification of stakeholders and engineering requirements that were necessary for designing a solution. A review of existing designs in liquid filling systems and their components was performed and assisted with the design of alternative solutions. The most beneficial design was selected through the evaluation of each design and prototyped by constructing each hardware component (valve, pump, load cell and controller) separately, before recombining them through software (LabVIEW programming).

The final prototype uses commonly available off-the-shelf products and is a self-contained system which achieved its intended purpose. The filling system, through testing was found to have an average fill time of 28 seconds and an accuracy >95%. Based on these results, a theoretical production increase of 1 implant per day is predicted. An initial cost benefit analysis projected a payback period under 18 months. This project will conclude with an initial plan of the final design and the handover of the prototype and final design report.
Applications and Performance of “Microsurfacing” and Implications on the NSW Road Network - 6cp

Henri Sutton - S12-139

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering

“Microsurfacing” is a type of bituminous surfacing that is used as a maintenance treatment on the wearing surface of road pavements. Microsurfacing falls under the larger banner of bituminous slurry surfacing systems which also encompasses slurry seals. Slurry seals are a mixture of aggregate, filler and bitumen emulsion, usually without a polymer modified binder and are limited to a single layer application. Microsurfacing contains the same constituents as slurry seals, but also contains a polymer which enhances the properties of the surfacing, making it “capable of being spread in variably thick layers for rut-filling and correction courses, and for wearing course applications requiring good surface texture”. Microsurfacing systems typically contain a quick setting bitumen emulsion, which is advantageous as it enables a faster return of traffic. These particular properties of microsurfacing make it an appealing maintenance solution in certain applications.

Microsurfacing provides some key benefits over other pavement surfacing methods. Microsurfacing can be placed in very thin layers to restore surface texture whereas asphalt requires thicker applications; this provides material and economic savings. Microsurfacing can be placed in remote locations as it is a cold application technology, whereas asphalt is constrained geographically by distance to asphalt batching plants.

Microsurfacing has been used to a limited extent on the NSW road network, whereas it has been utilised on a larger scale by some of the other State Road Authorities in Australia. This capstone project investigates if it is feasible to adopt microsurfacing in NSW for specific applications.

The aims of this capstone project are to determine what applications microsurfacing can be used for, how microsurfacing is performing in Australia and overseas and relate mix design parameters of microsurfacing to the in-service application.

This capstone project integrates literature findings with practitioner’s experiences to provide best practice recommendations regarding microsurfacing in NSW.
Study of Wave Propagation of Embedded Cylindrical Structure using Spectral Finite Element Method - 12cp

Andrew Tang - A12-156

Supervisor: Jianchun Li
Assessor: Ali Saleh
Major: Civil Engineering

There are many non-destructive testing (NDTs) methods available for the condition assessment of existing structures. Among them, stress wave methods are popular and have been widely used for many applications. Understanding of stress wave behaviour in each type of applications is essential for development and application of these NDTs. In this study, Spectral Finite Element Method (SFEM) is utilised to study stress wave propagation in an isotropic cylindrical structure for application of utility poles.

In the present study, SFEM is applied to study two types of waves, namely longitudinal and flexural waves. At first, the medium is considered as infinite media to verify the algorithm as it is simple to model and results can be easily validated by many literatures. Then the semi-infinite medium is considered to investigate the reflection of the waves. For the longitudinal wave, finite medium is also taken into account and two different boundary conditions are considered for this situation. Soil embedment is modelled by spring and dashpot and hence damping and attenuation of the wave is also evaluated. To simulate the real field testing situation, the impact is considered as broadband which is generated by a hammer. In addition, higher modes of longitudinal waves are also solved and compared with one mode theory to select the accurate and most real simulation of signal. For all the above cases, results are shown in both time and frequency domains and dispersion curves are also produced.

The time domain results obtained from SFEM are also compared with that of FEM with satisfactory. The similarities between the models highlight wave behaviour such as dispersion, resonance, reflections and phase changes. However, the computation time is much less in SFEM and also spectral relation (phase velocity and group velocity curves) and dispersion relation (frequency-wavenumber) are plotted from SFEM.
A Comparative Analysis of a Hybrid and Conventional System Used to Power a Hydraulic Excavator - 12cp

Max Torrey - A12-161

Supervisor: John Dartnall
Assessor: David Eager
Major: Mechanical Engineering

As the world experiences increased pressure on “green” technologies due to the rising demand for energy such as crude oil and its derivatives, technological advancement is the perceived key to more efficient use of non-renewable energy. The construction industry is an energy intensive industry that can benefit from these green technologies. Komatsu Japan Limited, the second largest earthmoving machinery manufacturer globally has recently developed a hybrid technology hydraulic excavator. This new machine the “HB215LC-1” gains increased fuel efficiency over a standard machine “PC200LC-8” from a hybrid system utilising regenerative energy and smart software system and control. The claimed benefits of the “HB215LC-1” were audited in this project by the comparative analysis of both machines.

The operation of both machines was studied, then a theoretical model of their performance was developed, this model was then field tested over a range of work cycles on each machine. A key factor within this project was the identification and analysis of the work equipment operation of both excavators and their influence on fuel consumption as a function of time. Variables measured over the field tests were taken by a data acquisition system measuring various physical parameters such as pressure, speed, flow rate and temperature, these were then analysed using graphical and statistical means which allowed some conclusions to be drawn. The “HB215LC-1” excavator demonstrated a range of lower fuel consumption figures while achieving the same work output as the “PC200LC-8”. The magnitude of fuel consumption saving was dependant on the particular work cycle. The “harder” the machine worked, and the extent that the duty cycles best utilised the hybrid system operation achieved even greater fuel efficiency. It is concluded that the hybrid system has the ability to achieve significant fuel consumption savings over the working life of hydraulic excavators.
Intelligent Patient Hoist – Intuitive Assisted Control - 12cp

Antony Tran - A12-162

Supervisor: Dikai Liu  
Assessor: Ken Waldron  
Major: Mechanical and Mechatronic Engineering

With the average age of the population rising, more focus is being placed in health care systems. In 2006, in the US alone, there was a shortage of over 400,000 nurses, and as time progresses the ratio of patients to nurses will only increase, resulting in a shortage of manpower in this sector. Studies have shown that in the US “1 in every 3 nurses become injured from physical exertion put forth while moving non-ambulatory patients costing their employers $35,000 per injured nurse” (Blevins 2002). Standard protocols dictate that a minimum of two nurses are required to operate a patient hoist at any given time, however with the increasing shortage of nurses, workers find themselves in positions where they must overexert themselves.

The purpose of the intelligent patient hoist project is to significantly reduce the risks posed to both the nurses and the patients in their care while transferring in a home or hospital environment. This goal is achieved by modifying an existing patient hoist and giving it capabilities that will assist the nurse in her tasks. The focus of this Capstone project is to explore the viability of implementing a touch sensor array which can recognize the user’s intentions and act upon them. When used in conjunction with a motor controller and appropriate motors, this approach will reduce the forces the nurses will have to apply to transfer the patient from one position to another, reducing the likelihood of the nurse injuring themselves, especially in the bariatric departments.
Vehicle designers and manufacturers are placing increased emphasis on the deployment of active and semi-active suspension systems to both improve performance and passenger comfort but most importantly, passenger safety. The uprising of the sports utility vehicle or SUV has seen an increase of rollover incidents due to a heightened centre of gravity and weight within the same restrained track and wheelbase dimensions to be able to travel on Australian roads.

These changes in parameters have seen an increase in roll over and cornering incidents which have pushed the advancement and testing of suspension design. To study the effects of tunable active and passive suspension systems, vehicle engineers must be able to replicate the effects of cornering forces through a vehicle’s centre of gravity and study the impact of these forces have on a vehicles tendency to roll.

Another parameter of interest to vehicle designers is a vehicles tendency to yaw, which is seen evident during high speed manoeuvres such as overtaking on a freeway. Hashimoto, T; Fukuyama, K; Oikawa and N; Kume discuss Mitsubishi’s torque varying rear differential that battles yaw at high speed, but this is a reactive system only. There is no evidence from this article and others that yaw tendencies are prevented before they occur. There is also no study evident regarding a yaw natural frequency and the study of such, which may be dependent on chassis stiffness, vehicle dimensions, weight and tire pressure.

This report details the design and implementation process of a hydraulically actuated system that can implement both an adjustable roll force and yaw force through a Ford Territory’s centre of gravity. The facility acts as an expansion of the current four wheel poster shaker rig in house at the University of Technology, Sydney (UTS) that was not capable of implementing and testing the roll-yaw performance of tuned active and semi-active suspension configurations.
Investigation of Timber-Concrete Composites Utilising Lightweight Concrete - 12cp

Jarod Wakefield - A12-173

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Assessor: Anne Gardner
Major: Civil Engineering

Over the past thirty years, investigations highlighting the benefits of timber-concrete composites (TCC) over alternative construction materials have become more established. TCCs primarily consist of a concrete member attached compositely to a timber member through the use of connectors. In some cases an interlayer between the timber and concrete may be present, working as a permanent formwork or, in rehabilitation works, corresponding to the existing timber floor. Mainstream connectors include screws, nails or metal bars, which are attached to the timber prior to pouring concrete. Currently, the most common industry applications include composite beams or floor systems.

Industry experience cites a number of advantages of TCCs versus full timber construction, including: increased strength, greater stiffness, improved vibrational response, larger in-plane rigidity, enhanced fire performance and rating, and improved sound insulation. Additionally, TCCs have advantages over full concrete construction, including: significant dead load reduction, greater efficiency in terms of carried load per unit of self-weight and reduction of the embodied energy and CO2 footprint.

The following research report aims to increase the understanding of the behaviour and failure modes of timber-lightweight concrete composites, through the analysis of a conventional and lightweight concrete samples that use types of shear connectors, SFS and SPAX1 screws. Both SFS and SPAX screws were arranged at ±45°. After the samples were constructed and cured, push-out tests were conducted to identify the shear strength and stiffness, thus characterising the composite action of these connections.

To further understand the behaviour of TCCs, three beams were constructed using a conventional concrete mix (fc = 32 MPa) with SFS screws for the shear connection. The structural properties were analysed by conducting a four-point bending test. This research aimed to relate the behavioural responses of the connectors (push-out tests) to that of the beams. A relation was explored utilising the design procedure for TCC elements presented in Eurocode 5. Furthermore, this investigation aimed to provide a tool for deriving the beam responses in correlation with the concrete strength and the type of screws.

As predicted, the strength of the connection decreased with the decreasing density of the concrete. Furthermore, overall the strength varied across the different shear connections as well as their failure modes. The SFS screws displayed a much more brittle failure compared to the SPAX screws which exhibited ductile properties.

This research suggested that there is potential for moderate lightweight concrete of approximate 2000 kg/m3 to be used in TCC systems. The design of TCC beams is generally governed by the stiffness of the shear connection. The application of SPAX screws as shear connectors seemed most favourable as they displayed greater stiffness. Furthermore, they exhibit a ductile behaviour to ultimate strength.
Novel Shape Descriptor for the Classification of Body Condition Score and Muscle Score of Cattle - 12cp

Anthony Waters - A12-176

Supervisor: Alen Alempijevic
Assessor: Bradley Skinner
Major: Mechanical and Mechatronic Engineering

As robotic and automation technologies evolve and increase in sophistication, the number of applications where these technologies can be used also increases. One instance of this is within the agriculture industry. Farmers are now able to collect and analyse an unprecedented amount of data about their crops and livestock, which can be used to develop more sustainable and cost-effective agricultural practices. For beef cattle farmers, the metrics of Body Condition Score (BCS) and Muscle Score are important as they are used to assess the relative health of the cattle as well as assess the amount of meat that can be gained from the animals’ carcass.

This thesis analyses limitations of existing methods to classify cattle BCS and Muscle Score and proposes a novel shape description algorithm which utilises the 3D representation of the cattle captured using an array of 3D depth cameras. The proposed algorithm identifies and segments the region between the Hook-bone and Pin-bone within the 3D representation of each cattle and generates a feature vector based on the resulting segmented region. This feature vector is classified with state-of-the-art classifiers such as support vector machines (SVM) to classify the BCS and Muscle Score of Cattle.

The method detailed was used to classify 148 cows with encouraging results. By including non-visual measurements such as P8 fat and Eye Muscle Area (EMA) into the feature vector, classification accuracy was further increased. The developed algorithm is the starting point for further research into the classification of the BCS and Muscle Score as part of a joint Research and Development Grant, sponsored by Meat and Livestock Australia, involving the University of Technology, Sydney and the Department of Primary Industry NSW.
As smaller and cheaper electronic devices obtain network connectivity, the possibilities of the Internet of Things grows exponentially. Ambient devices will soon pervade the ordinary home and office and be capable of controlling and reporting on many aspects of their environment. Configuring these agents to work together however requires domain-specific technical expertise, which prevents the average user from utilising the maximum potential from the synergy of hardware capabilities.

The solution involves removing the need for the user to consider the low level implementation, and instead shifting their focus purely to negotiating high level business requirements which any non-technical user could provide. This capstone project aims to develop a software system to bridge the gap between everyday users and these ambient devices through a natural language interface. A parser processes the textual input, develops awareness of the context and provisions the network from user directives. Context-awareness is crucial in decision making and ascertained through the interpretation of the network ontology by recognising entities, their classifications and their relationships to one on another. The ability to connect to external datasets enables ontological information to be supplemented accommodating for well-informed decision making.

Natural language interpretation is traditionally a computationally expensive operation, however through a combination of inexpensive analysis techniques, abstract concepts and best-guess interpretations can be formed rapidly. The system also benefits through human assisted learning in order to interrogate complex sentences or make corrections in interpretation. This software system can be used on inexpensive gateway devices in ambient systems or Internet of Things meshes with a myriad of applications such as wireless sensor and actuator networks, intelligence in non-player characters in games or even voice based conversation systems.
Dynamic analysis of moving loads & damping effects on the vibration of truss bridges

Matthew Wilde - S12-162

Supervisor: Emre Erkmen
Assessor: Ali Saleh
Major: Civil Engineering

Comprised of elements with joint connections, trusses undergo tensile and compressive forces in their members. When considering truss bridge design, it is important to take into account the forces applied through this system and there likely effects.

The main objective of this capstone is to develop a program that is able, in steps, to analyse load cases on truss bridges. The progressive iterations of the code shall incorporate:

• Accounting for static loading and corresponding effects.
• Accounting for dynamic loading and corresponding effects.
• Account for the effect of amplitudes and frequencies on vibrations, and corresponding damping effects.

A better understanding of these effects can lead to improved truss bridge design in a number of areas. Consequently, this can lead to reductions in cost, improved material selection, improved safety, and in particular, improved design in regards to serviceability.

The key to the success of this project is in implementing the program effectively. Currently, the MatLab programming language has been used to develop the program. MatLab allows for the manipulation of matrices which are essential in the writing of the program. The program is written in a ‘script’ within MatLab. The input variables and output values are obtained from and written in a simple text file format. These variables identify coordinates to determine element locations, attributes and applied forces.

In addition, Microsoft Excel has been used to assist in error checking and in results testing to ensure the program works as intended. FORTRAN is held in a standby state if there are any problems with the current setup. An effective program can thus be produced based on the required criteria.
Comparison Between the N2 Method and Non Linear Dynamic Time History Analysis in the Seismic Design and Evaluation of Masonry Structures - 6cp

Kirstie Wills - S12-164

Supervisor: Bijan Samali
Assessor: Ali Saleh
Major: Civil Engineering

The structural engineering community has widely acknowledged that a change in design methodology for seismic resistance is required. The majority of existing design codes incorporates a force based approach with the preconception that strength is synonymous with performance. However, with the realisation that an increase in strength does not directly equate with increased safety or a reduction in structural damage due to earthquakes, recent years have seen a clear trend toward implementing Performance Based Engineering in seismic design. In this technique, structures are designed to achieve target performance criteria rather than withstand one ultimate force level.

While the nonlinear dynamic time history analysis of multi degree of freedom (MDOF) structures is well known to be the most comprehensive and accurate performance based procedure to determine seismic demands, it is deemed impractical for use beyond exceptional circumstances, due to its complexity and high standards.

The N2 Method is a nonlinear static procedure that allows the performance based seismic analysis of structures. Compared to nonlinear dynamic time history analysis, this method provides a simple and effective alternative, through the incorporation of pushover analysis and the derivation of an equivalent single degree of freedom (SDOF) system.

This paper will outline and compare the N2 Method and time history analysis approaches, while focusing on their application on masonry structures. Ten masonry buildings have been modelled with both analysis approaches; and through the evaluation of the results obtained, an insight into the suitability of the N2 Method as an alternative to time history analysis will be discussed.
Development on Aching Action in RC Frames - 12cp

Jiangtao Wu - A12-181

Supervisor: Hamid Valipour
Assessor: Bijan Samali
Major: Civil Engineering

The behaviour and ultimate load capacity of laterally-restrained reinforced concrete beams in framed structures can be considerably enhanced by the development of arching or compressive membrane action. The enhancement of arching action can result in more economical design which has less amount of reinforcement. The arching action has been recognised that the laterally restrained reinforced concrete beams in framed structures show more excess strengths than those predicted by Australian Standards.

This paper is focused on the behaviour and enhancement of arching action in reinforced concrete frames. It presents the results of different finite element computer modelling on reinforced concrete beams and frames and compares them to the predicted ultimate flexural capacity using Australian Standards. A verification of finite element computer model is performed to establish the accuracy of the model. Most of the results from the verification show ratio of experimental results to FE results of less than 1.3 which is satisfied. Then, in order to maximize the benefits of arching action, several parametric studies are carried out to determine which parameters affect the enhancement and how critical they are to the enhancement. A range of boundary conditions, reinforcement ratio have been investigated. The results from parametric studies show that the maximum flexural capacity of laterally restrained beam as well as two-storey frame is corresponded to reinforcement ratio, concrete compressive strength and end restraint condition. With higher concrete strength and reinforcement ratio, the ultimate loading capacity is correspondingly higher. The results also indicate that the maximum flexural capacity with the development of arching action is in excess of those calculated using Australian Standards.

This paper highlights the development of arching action and its benefits on enhancing flexural strength of reinforced concrete frames. From the parametric study on two-story RC frames, the analytical results suggested that the arching action increases with higher concrete strength and reinforcement ratio.
Life Cycle Assessment on Duckmaloi Water Treatment Plant - 6cp

Minwei Yao - A12-215

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Major: Civil and Environmental Engineering

Duckmaloi Water Treatment Plant was upgraded with microfiltration (MF) technology in 2003, in order to provide better quality potable water to local community. MF has been developed more than 80 years. The key element of MF is the membrane sheet used in the process. The cost of membrane fabrications and operation energy consumption has reduced greatly since born, and the technology become very attracting regarding costs and efficiency. However, MF still consumes more energy than conventional treatment methods (e.g. clarifier), and requires additional chemicals to deal with membrane fouling. Hence, the economic and environmental impacts should be assessed to evaluate the exact level of the impacts and determine alternative approaches to reduce the impacts.

Life cycle assessment is a well-established tool used to evaluate the both impacts. It is regulated by ISO 14040 and 14044 and contains four basic phases. Regarding Duckmaloi WTP, membrane disposal is ignored in the LCA as it has little impacts. It is found that microfiltration process costs most among all the stages. The costs are mainly associated with energy consumption, which are closely linked to environmental costs as most Australia power plants still use thermal as main energy source. Alternatives for process optimization are researched to found the trade-offs between the economic costs and environmental costs. The results show that a lower flux with a high maximum transmembrane (TMPmax) offers a more environmental favourable outcome. Besides, backwash frequency setting could be optimized to decrease both economic and environmental impacts. Optimized filtration time between two backwashes and preset resistance value to trigger the back wash are discussed in this research.
Development of a Powered Wheelchair for Travel over Uneven Urban Terrain - 12cp

Samuel Yap - A12-188

Supervisor: Terry Brown
Assessor: Jinchen Ji
Major: Mechanical and Mechatronics Engineering

It is commonly assumed that in the modern urban environment, with wheelchair ramps, lifts and other devices, that powered wheelchair users are no longer subject to the difficulties of access experienced even a decade ago. However, while accessibility has improved for powered wheelchair users, there are still obstacles such as narrow spaces, small steps and footpath imperfections etc. which current powered wheelchairs struggle to overcome.

The aim of this project is to design a powered wheelchair which can overcome the majority of obstacles often encountered by individuals in an urban environment (single steps, enclosed spaces and uneven terrain) and to improve accessibility and comfort for users.

It was found that by addressing the shortcomings of typical commercial powered wheelchairs during the design process and through the application of updated technology, it was possible to design a powered wheelchair which provides the user with a greater level of access and freedom than currently available.

Improvements include a reduction in overall dimensions, turning radius and mass as well as improvements to single step and uneven terrain navigation. Additionally, user comfort, range and transportability were improved.

The engineering design process, CAD, FEA and Motion Analysis software were used throughout this project for both design and validation.
Uncertainties in the Prediction of Smear Zone Properties Induced by Vertical Drain Installation - 12cp

Hassaan Zafar - A12-192

Supervisor: Behzad Fatahi
Assessor: Hadi Khabbaz
Major: Civil Engineering

Prefabricated Vertical Drains have been widely used to improve the properties of normally consolidated clays by accelerating the rate of consolidation. This method provides shorter drainage paths, allowing the pore water pressure to dissipate more quickly in both the horizontal and vertical direction. However the installation process disturbs the soil surrounding the drain creating a region with reduced permeability known as the smear zone. The theory of radial consolidation has been developed to include a smearing factor that is based on the permeability and extent ratios. However there is no particular method of determining these ratios and therefore can create significant uncertainties in calculating the rate of consolidation.

The main purpose of this project is to investigate the permeability and extent ratios of the smear zone in order to accurately calculate the average degree of radial consolidation. An Artificial Neural Network (ANN) has been developed to determine if there is a relationship between the soil properties and the smear zone to allow for a more precise calculation of these ratios. The ANN uses data that was gathered from various case studies to recognize patterns using a ‘feed forward back propagation’ tool to assign weightings to several key soil parameters.

The results of this project will provide a relatively accurate method of determining the average degree of radial consolidation by analysing soil parameters that can be determined through site investigations. The numerical solution can help practicing geotechnical engineers to determine the permeability and extent ratio and therefore providing a more precise answer with substantially less errors.
Numerical Simulation of Heat Transfer in a Single Zone Air-conditioned - 12cp

Hengyi Zhou - A12-196

Supervisor: Guang Hong
Assessor: Ravindra.Ranasinghe
Major: Mechanical Engineering

In order to achieve acceptable thermally comfortable and energy efficient working environments, we have to maintain reasonable inlet conditions of the HVAC system. The aim of my project is to find and investigate ways of saving energy and to increase the energy efficiency of an air conditioning system and maintain the thermal comfort in an office environment.

In order to achieve this goal, a computational fluid dynamics (CFD) model was developed to simulate and analyse the room CB02.06.32 at UTS. Specifically, we focused on the thermal surface at one metre height. Code has been used as a platform in this modelling work. In this work, the standard k-ε turbulence model was adopted. The CFD model was developed and verified for simulating a transient process with 300 seconds physical time step for 120 times, which was 10 hours (36000 seconds) working time in total. In span of this period, it was attempted to set up different supply air angles and velocities of incidence. The results showed that the distributions of temperature and airflow were much more uniform and the working environment was more comfortable with supply air angle of incidence 30° at 0.1 m/s than that with other supply air angles.

Furthermore, we developed a Gaussian Processes (GP) based temperature model to predict the temperature distribution of the thermal surface at one meter height. In this model, we trend the distribution of temperature by using 12 points’ temperature data and compared the result with CFD result to verify the correctness of the GP model. The comparison illustrated a good agreement between the GP model results and the CFD results. This GP model can be used to efficiently analyse the temperature distribution of any surface.
The Effective Use of Various Geosynthetics in Road Pavements – 6cp

Matthew Zielinski - S12-173

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering

Geosynthetics have been used in road pavements for a number of years. The main benefits geosynthetics offer to roads is improved mechanical properties to the pavement. The Road and Maritime Services (RMS) of NSW have used geosynthetics in the last 20 years, where a variety of products have been used to mixed success.

Use of geogrids in reinforced asphalt overlays is one area where geosynthetics have been used to reduce pavement distress. In the last five years, the Pavements Section of RMS has commissioned several reports on a literature review, testing and modelling of reinforced asphalt pavements. Despite this, much of this information has either not been passed on to asset managers or has been inconclusive to the use of geogrids in asphalt pavements. Some RMS regions have carried out their own field trials with inconclusive results or trials which are too young to provide meaningful performance data. RMS currently has no specification on the use of geogrids to reinforce asphalt overlays. Geotextile reinforced seals (GRSs) have also been used in the last 20 years and seem to reduce surface distress of sprayed seal pavements. There is widespread use of GRSs across RMS regions, yet there is no published data on the benefits they offer in comparison to conventional sprayed seals.

The report covers a literature review of these types of geosynthetics, the types of pavement distress they treat, construction considerations and alternative treatment options. A review of laboratory testing and case studies which cover these uses of geosynthetics also forms the basis of this report. The results from this report firstly aim to provide a best practise guide in using these types of geosynthetics. The report also provides recommendations on how to improve on current field and testing data. Particularly in RMS’ case, these recommendations will assist in current shortfalls in research and field data which will ensure effective use of these types of geosynthetics by asset managers.
Assessment of Drying Shrinkage Behaviour of Fibre Reinforced Concrete Incorporating Polyvinyl Alcohol Fibres (12cp)

Garo Arabian - A12-209

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Concrete is recognised as the most prevalent used construction material in the world. In service, structural concrete undergoes volume change due to moisture loss by evaporation. This volume change and movement experienced in this manner is termed drying shrinkage. Strain is induced in the concrete matrix and, if restrained, tensile stresses develop that will cause cracking if member tensile strength is surpassed. Cracking is detrimental to durability, serviceability and aesthetic quality of the concrete. It has been of particular focus by researchers in recent times to minimise the extent of strain from drying shrinkage. One effective way of reducing shrinkage involves using intrinsic polymeric fibres as a form of reinforcement in the concrete matrix. The use of novel plastics such as monofilament polyvinyl-alcohol (PVA) fibres in fibre-reinforced concrete (FRC) can affect the overall properties of hardened concrete; with drying shrinkage being of particular interest; however, the exact influence of fibre length and volumetric content remains unknown.

This research project assesses the drying shrinkage behaviour of PVA-FRCs containing short-length (6 mm) and long-length (12 mm) uncoated monofilament PVA fibres at 0.125%, 0.25%, 0.375% and 0.5% volumetric fractions. PVA-FRCs have been compared to length change of control concrete (devoid of fibres) at 3 storage intervals: early-age (0-7 days); short-term (0-28 days); and, long-term (28-112 days). Results demonstrate a significant decrease in shrinkage (50%) for long-length PVA fibre with 0.125% volumetric fraction, for long-term storage conditions compared to control concrete. In addition, short-length PVA-FRCs exhibit less shrinkage than long-length PVA-FRCs for short-term storage conditions. This project demonstrates the viability of using short-length PVA fibres in FRC to reduce long-term drying shrinkage for improving the serviceability and durability of concrete in application and within its environment.
Reducing Mercury Exposure and Emissions in Small Scale Mining

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Artisanal and Small Scale Gold Mining (ASGM) is a global practice that predominantly takes place in the developing world, for example Indonesia, Ghana, and South America. ASGM is typically carried out in a rudimentary fashion by impoverished communities. An extremely dangerous aspect of ASGM is the extensive use of mercury in the gold extraction phase whereby liquid mercury is added to crushed gold ore. The resulting amalgam is then separated and heated in a retort, vaporising the mercury and leaving behind gold high in purity. This practice leads to uncontrolled mercury discharge into the environment. It also results in worker exposure to mercury; far beyond levels deemed acceptable in the developed world. The World Health Organisation deems the tolerable intake of mercury as 0.47µg/kg/day.

Ideally, the use of mercury in ASGM should cease altogether; however, an array of sociocultural, economic and ethical issues make this idea untenable, at least in the short term. In the meantime, the problem of how to reduce mercury exposure and emissions from ASGM remains a critical task.

This project will test a new design called the Venturi Exhaust Retort (VER) which could potentially reduce the level of mercury released in ASGM. The VER design redirects gas flame exhaust from the normal amalgam heating process and employs it to drive a venturi effect. The venturi effect drives an exhaust flow in the flume of the furnace taking with it vaporised mercury. The mercury vapour then passes through a condensing tube where it is recaptured, ready for reuse.

The scope of this project will be to test the VER as far as proof of concept. The aim is to produce results significant enough to justify field testing in the communities in which ASGM is practiced.