Faculty of Engineering

And Information Technology

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ABSTRACTS

CAPSTONE PROJECT PRESENTATIONS

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Bamboo is one of the most environmentally friendly plants on earth. The use of bamboo is associated with the culture of countries in East Asia, South Asia and the South Pacific, where bamboo is used for virtually anything. Bamboo has outstanding physical characteristics that can be engineered to suit different applications, and increase its use in the construction industry to eventually reduce the use of conventional construction materials such as concrete, steel and timber; and hence reduce the carbon footprint of the construction industry particularly in developing countries around the above mentioned areas.

The purpose of this project is to review and develop different treatment method of producing engineered bamboo with predictable physical characteristics, to increase confidence in the use of bamboo for structural applications. Bamboo has limited durability when exposed to UV rays and humidity, and its thin walls and empty internal diaphragm imply that it has poor fire resistance. With the advancement of science and technology and the tight supply of timber, new methods are needed for the processing of bamboo to make it more durable and more usable in terms of building materials The project will concentrate on two main species of bamboo (Dendrocalarnus strictus and Bambusa bambos) and their treatment process to make a better and strong engineered bamboo in terms of mechanical and physical properties.
Carbon Emission from Seawater Desalination Plants - (12cp)
Fahad Al-Mosawae - S14-176

Supervisor: Huu Hao Ngo
Assessor: Wenshan Guo
Major: Mechanical Engineering Major BE and BEDipEngPrac

The growing concerns of the impact of carbon emissions on global warming, coupled with the expansion of seawater desalination plants to meet water shortages, will place pressure on seawater desalination plants to reduce carbon emissions. There are a wide range of processes that can be used to desalinate seawater. Often there is a trade-off between efficiency of production and environmental impact. With the likelihood of the introduction of a price on carbon emissions, the minimisation of carbon emissions will become an important issue in the immediate future.

This capstone project will seek to identify the current carbon emission from the range of processes that are used in desalination plants and the modifications that might be needed to reduce carbon emissions. The project identifies the range of processes that are currently being used to extract fresh water from salt water, the source of energy for the processes and the environmental cost. New technological improvements will be investigated that are being developed for reducing the environmental impact of desalination plants.

Arising from an assessment of the current situation and new developments, this capstone project will recommend the optimum solution for reducing carbon emissions and areas where further research is needed to reduce the energy consumption of seawater desalination to 0.8 kWh/m3 and a reduction of carbon emissions by up to 25%. The findings of the capstone project will benefit companies seeking to invest in the improvement of the carbon efficiency of seawater desalination plants.
Comparative Study of Electrical Machines with Soft Composite Materials - (12cp)
Faris Alghamdi - S14-165

Supervisor: Youguang Guo
Assessor: Steven Su
Major: Electrical Engineering Major BE and BEDipEngPrac

Enhancing electric machines has for a lengthy period of time been featured in broad studies by researchers. Nowadays research has been made simpler owing to the usage of latest materials that include hard and soft magnetic composite materials. Lately, these endeavours have been made simple through the invention of new materials, for instance hard magnetic composite as well as soft materials. For instance, a 3D core motor may be easily constructed by the use of Soft Magnetic Composites (SMC). The primary goal of motor designs is generally grounded in its application, however in general the major purpose concerns attaining to have high torque density, low cost in addition to heightened efficiency. Taking into account the dwindling global resources and environmental issues the aim of achieving the optimum efficiency point is becoming considerably critical.

In addition, this document will focus on the topologies of the two motors that used SMC, which are Claw Pole Motors (CPMs) and Transverse Flux Motors (TFMs). In detail, the two machines will be compared in several sections, for instance dimensions as well as structure, 3D numerical field investigation and performance analysis. Furthermore, the differences between the two motors will be identified as well as problems for example, high magnetic hysteresis loss and low magnetic permeability. Lastly, this paper will conclude with the motor that has the most beneficial impact on the performance from using SMC and provide some recommendations.

In order to provide a fair comparison between the two motors, they have similar dimensions and structures, however more permanent magnets and copper in the structure are located in TFM than CPM due to the structural occurrence. In addition, different range of frequency was used for both motors, therefore different output power are calculated. However, TFM’s output power is greater than CPM that might be due to the additional materials that used within TFM for example, more steel rotor and copper which increase the output power of the motor. Both motors are in functionality since the efficiency of both machines were close.
Positive and Negative Road Furniture Contribution on Road Safety - (12cp)
Mohammed Alotaibi - A15-258

Supervisor: Huu Hao Ngo
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Majority of success transport network is a key factor of a country or population development. This project report shows the importance of roads and how road furniture can contribute in achieving road safety. It demonstrates the history of road furniture and the differences of road furniture techniques being used in number of countries such as Australia and United Kingdom. United Kingdom and other European countries have expanded and developed their colony by establishing an extensive roads network to increase accessibility. Australia and United States roads transport network were built and developed hundreds years ago due to the European colonialism. In Middle East such as Saudi Arabia, was not colonised and age of the country only hundred years ago therefore the road network system is continuously developing since then.

This report found the history and technology of road network growth roughly followed same pattern in aforementioned countries. In old ages, travelers created their own tracks when over walking on the same pathway. Modes of travel had developed and travelers began to use carriages and caravans. In the late 18th century, British engineers Thomas Telford and John McAdam had developed trace construction method. The idea was to clear the route and smoothing it to facilitate the trip for horses and carriages. In the 20th century, civil British engineer Hooley discovered admixtures of tar and aggregate prior lay down on the surface and using the compactor. This is the modern method, which has been used worldwide today.

In the 20th century, road furniture attributes started to emerge by smoothing the road surface. The magnificent creation that has significantly increased the road safety is traffic light. Road authorities developed road contraction and adding shoulders to both sides of the road. Furthermore, addition of more lanes on both sides has rapidly raised road safety. Design speed limit and caution boards have also a major role on reducing accidents. Seat belt and its advertising campaign that is run by road authorities increased the awareness of road users in UK. However, in Saudi Arabia, the level of road safety is significantly weakened as well as lack of awareness among road users.
The rate of demand on energy sources has been escalating since the industrial revolution and up until these days. The intensity of the demands is driven by many factors such as the increasing population of our world, the vastly expanding cities and the energy depleting industrial projects, evolving every day. The majority of our energy sources nowadays is based mainly on substances that has been forming underground for hundreds of years. These substances are extracted to be processed then used as a source of energy for almost every energy demanding thing on our planet and commonly called Fossil Fuel products. Fossil fuels are known for its greenhouse emission, its unsustainability and also the environmental impact it causes. This has initialized a wakeup call for the humanity to find a new sources of energy which can provide a clean as well as a sustainable source of energy that can provide the security in terms of environment and economics.

This research paper will be studying specifically Algae as a sources of biofuel that has been the centre of attention and a promising clean energy source of the future. This paper will study comprehensively, the latest development and advances in the research of Algal biofuel around the world providing the most up to date production and processing data. It will include the major research initiatives which has been worldly known and was well funded to be able to apply their theories in a real life projects. Each of those research projects will be evaluated based on number of criteria’s and will be analysed against the other sources of biofuel.

The main objective of this research paper is to gather the most recent research initiatives about algal biofuel and put it to the test to form a firm opinion on the validity of algal biofuel as a source of energy. Another objective, is to do an economic feasibility study of the current technologies and processes used to grow, extract and refine algae to be a source of clean energy. Based on the outcome of the previously mentioned stages of the research, a conclusion can be drawn to indicate the research’s opinion and a discussion will be presented to negotiate a set of recommendation for the current and future research promising pathways.
Challenges and Recent Advances of the New Austrian Tunnelling Method in Weak Ground - (12ep)
Maddison Bailey - S14-130

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The rapid expansion of major cities around the world has resulted in a growing demand for infrastructure such as roads, railways, water, sewer, and utilities. The declining availability of land space for infrastructure has led governments to head underground in order to cater for the needs of growing cities. Many large cities, such as London, are built upon weak ground with unfavorable geotechnical characteristics. The ground condition, coupled by a need to limit deformation to protect existing assets, has presented engineers with tunneling projects more complex than ever before experienced.

The New Austrian Tunneling Method (NATM) is a tunneling method traditionally used in strong rock applications. However, its usefulness in soft ground applications where alternative tunneling methods, such as Cut & Cover and Tunnel Boring Machine (TBM), are not feasible, has been realized.

This project investigates the historical advancement of NATM from its inception in the 1960’s, to its modern applications in urban environments. The cost, time, design, safety, risks, advantages, disadvantages and suitability to application are all investigated and discussed.

As can be seen from examples such as the Santiago Metro expansion, NATM can result in significant social, economical and environmental benefits when compared with alternative tunneling methods. This project also investigates the London Heathrow Express Tunnel collapse. To optimise the use of NATM in Australia, many recommendations have been made and the resulting lessons learnt from the failure of NATM in weak ground have been reported.
Restoration of Total Body Nitrogen Facility for Pediatric Use - (12cp)
Kogulan Baskaran - S14-159

Supervisor: Ahmed Al-Ani
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The human body is composed of fat, bone, water and muscles. A healthy body contains a balanced proportion of these elements, and imbalance of these elements is directly related to many health risks and diseases. There are only limited methodologies to accurately calculate the body composition. The Total Body Nitrogen (TBN) facility at the Westmead Children’s hospital uses an in vivo prompt gamma neutron activation analysis (IVNAA) to measure body protein. It also uses a dual energy X-ray absorptiometer (DXA) to accurately estimate a four-compartment body composition model. Due to the exposure to neutron radiation dose, the usages of these machines are limited. As of 2012, the TBN at Westmead was the only one available for paediatric research in Australia. Having this technology provides the Westmead Children’s hospital with a great opportunity to make ground breaking research findings.

The TBN facility has several parts to its functionality. It consists of a bed where the patient is placed and moved towards the radiation chamber to be exposed to neutron beams. Neutron collision with hydrogen atoms in the patient’s body is captured by nitrogen and hydrogen nuclei causes gamma rays to emit. This is detected by the Sodium Iodide detectors and used by a program to calculate the total body protein. It also has an interface for the user to interact with the control unit, which controls 3 stepper motors that drive the movement of the bed and the activation of the neutron sources. As with any medical instrument, there are many safety features involved for each part of the system.

Unfortunately, the control unit malfunctioned several years ago. The new control unit replacement was totally different from the original one, and hence it needed re-wiring and re-programming. The focus of this project is to restore the control over the bed, neutron sources and the safety features. This report presents the uses of the facility, the software architecture, design diagrams, interface design and scope for future developments.
Restoration of Total Body Nitrogen Facility for Pediatric Use - (12cp)
Sagar Bhandari - S14-146

Supervisor: Ahmed Al-Ani
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When exposed to a neutron beam, common elements like Hydrogen (H), Calcium (Ca), Nitrogen (N) and Phosphorus (P) present in the human body produce a spectrum of gamma ray energies with peaks corresponding to each of these elements. During an in vivo Neutron Activation Analysis, this spectrum is then analyzed to calculate the amount of the elements (H, N, P or Ca). The Body Protein Monitor (BPM) at Westmead Children’s Hospital utilizes this method to measure the amount of Nitrogen in the patient’s body. The amount of protein is then calculated to the nearest gram using this measurement. Change in Total Body Nitrogen (TBN) of a patient during different supplementary nutritional programs was used to study the impact of these programs on the body protein in children. The only BPM device in Australia is located at the Westmead Children’s Hospital. That device has become idle for the last three years due to malfunction in the control unit.

The BPM consists of a movable bed, two neutron sources with shutters positioned above and below the bed and four gamma ray detectors, with each detector comprising a crystal of sodium iodide. Currently, a control unit has been supplied but is yet to be integrated with the rest of the protein monitor assembly. The overall purpose of the project is to restore total functionality of BPM and develop a new user interface to control the table and source movements, and to measure and interpret the collected data. The focus of this capstone project is to restore control over the patient bed, neutron shutters and safety devices, such as incremental rotary encoders, limit switches and emergency stop switches.

The project report includes a detailed description of the mechanical and electrical configuration of the BPM assembly, a literature review on the principle of operation and a user manual outlining necessary steps to initialize the BPM for data collection. This project was a collaborative effort and the details on development of the user interface are included in the project report by Kogulan Baskaran.
Evaluative Study of Night Sky Radiation - (12cp)
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Supervisor: John Dartnall
Assessor: Guang Hong
Major: Mechanical Engineering Major BE and BEDipEngPrac

Roofing technologies have greatly improved over the past decade. “Green” initiatives in combination with products like paints have improved internal cooling temperatures to provide soothing indoor climate. Buildings located at hot and humid regions are known to consume the most energy. The need to build more energy efficient buildings has encouraged engineers around the world to go beyond conventional air conditioning mechanisms.

Night Sky Radiation is a perfect example of this mechanism. The cooling effect of night sky is used to generate “passive chilled water temperatures that are useable for air conditioning applications. “ (Baverstock, 2009). For this experiment, we use a specially designed radiator panel consisting of a dry aluminium upper surface and laminated with ethylene vinyl acetate foam for effective insulation. The coated surface is sprayed with water to cause an evaporative cooling effect on top of the radiative cooling effect.

A part of the paper will go into detail of the design and mathematical modelling of thermal radiator panels used in the NSR mechanism, the developments made in this mechanism and what lies in the future of NSR. Discussions will be carried out on other similar methods of innovative design approaches to reduce energy consumption and provide enhanced occupant comfort. One such design is the BATISO cooling method which will also be discussed in detail. The paper will also look into newly researched ideas like magnetic cooling technology, which have been very recently developed. When more than one such technology are collaborated into residential or commercial buildings, energy consumption is vastly reduced and the system is defined as low exergy design, meaning that the system will consume low energy but will be highly efficient.
Vacuum Systems for Organic Waste in Buildings and Precincts - (12cp)
Alberto Burgada Ruiz - A15-063

Supervisor: Stuart White
Assessor: Saravanamuth Vigneswaran
Major: N/A

The sanitation systems that are currently under use by most developed countries use large amounts of fresh water; 20 to 40% of the water consumption is utilized for flushing toilets in sewered cities, turning scarce resources into waste, while there is a possibility to use fresh water more efficiently and turn wastewater into a valuable resources including the energy and nutrient content.

The proposed sanitation system includes the use of vacuum urine-diverting toilets that separate blackwater into two different streams, urine and faeces, and an on-site treatment of the wastewater. The purpose of using these toilets is the saving of water, energy production through anaerobic digestion and nutrient recovery. Vacuum toilets can use 10 times less potable water than conventional gravity toilets, substituting water by air as the main agent of transport. Suction created by a vacuum pump is used to remove faeces from the toilet, that travel through the piping system to a collection tank, in which they can be treated in absence of oxygen, resulting into biogas and a sludge that will have the potential to be used as a fertilizer, after appropriate treatment. The separated urine can travel in a different set of pipes to a collection tank through gravity. The nutrient recovery, specially phosphorus, nitrogen and potassium, is of critical importance, as the world is facing a critical problem due to a global limited availability of phosphate, essential for food production in the world.

The collection of household organic waste (kitchen waste) is also included in the system, as mixing of it with blackwater helps increase the dry matter content, which will result in a more efficient biological treatment and biogas production.

New concepts have to be applied in the world, as a high pressure is being exerted in our natural resources, and sanitation has the potential to be highly improved.
Performance Evaluation of Continuous Motorcyclist Safety Barrier Systems (NSW) - (12cp)
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Supervisor: David Eager
Assessor: Chris Chapman
Major: Mechanical Engineering Major BE and BEDipEngPrac

As proven countermeasures, roadside safety barriers are commonly used on New South Wales (NSW) roads to protect vehicle occupants from roadside hazards. In contrast with other vehicle types, motorcyclists are shielded only by the protective clothing that they wear. As such, in the event of a crash motorcyclists may be exposed to significant injury risk from some safety barrier components. Recognising this risk along with increasing use of motorcycles on the NSW road network this project, undertaken in conjunction with the NSW Centre for Road Safety, seeks to evaluate the protective effect of currently available motorcyclist safety barrier systems (MSBS) for use with steel W-Beam safety barriers by means of full-scale crash testing.

All crash tests were undertaken in accordance with AS/NZS 3845:1999 Road safety barrier systems and CEN/TS 1317-8:2012 Road restraint systems – Part 8: Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers. This testing methodology for motorcyclist impacts is industry best-practice. To ensure the results of this testing could be compared with roadside safety barrier systems installed within NSW; the W-Beam barrier was installed as per Roads and Maritime Services specification, all motorcyclist protection systems were installed as per manufacturer specification and care was taken to ensure that AS/NZS 1698:2006 Protective helmets for vehicle users, meeting the neck response corridor in CEN/TS 1317-8:2012, were used.

To evaluate injury risk two levels of biomechanical indices are given in CEN/TS 1317-8:2012. While all three MSBS evaluated showed a significant reduction in injury risk when compared with an unshielded installation of W-Beam, a number of tests exceeded the maximum admissible biomechanical indices given. Of the three MSBS evaluated only two met the requirements of CEN/TS 1317-8:2012. This testing supports the Australian safety barrier assessment panel’s recent decision to approve these two MSBS for use Australia-wide.
Software Defined Networking - Applications and Uses - (12cp)
David Butler - S14-125

Supervisor: Anthony Kadi
Assessor: Mehran Abolhasan
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This project entails the development of Software Defined Networking (SDN) based environment that will aim to prove the capabilities of the technology its application in modern networks and potential for the future.

SDN is an up and coming technology that ties in with the cloud computing ideology in respects to deploying network infrastructure. The major benefit of SDN is that it allows the administrator to deploy a virtualised networking infrastructure that binds the virtual computing environment together. With the expansion of SDN technologies, organisations are able to deploy environments in a fully virtualised manner from specific servers and storage elements to network infrastructure. This will result in lower costs to the organisation. Some key elements to this report cover the benefits of SDN, these include:
- A centralised control point
- Virtualisation of components
- Reduced complexity
- Programmable forwarding

The outcome of this project is to prove the abilities of an SDN environment to meet the expected abilities of current networking environments. The project will firstly cover the development of an SDN environment in a tailored manner, then the ability of that SDN environment to deploy a variety of architectural deployments and finally prove existing network technologies/protocols a part of a specified architecture. From these test scenario architectures, future conceptualisations can be made with reference to literature review in the field.

The project will focus on an open source SDN solution that is attracting a large amount of traction within the computing community as a viable deployment. From this report a level of confidence with the open source solution and the technology as a whole will be achieved in ability to provide specified network architectures and to adhere with standard practices. Furthermore, conceptualisations will be made to the areas of development and future abilities/benefits of SDN.
Transport Planning in the Sydney CBD: A Psychogeographical Study - (12cp)
Katelyn Bywaters - S14-077

Supervisor: Jack Wang
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In 2014, approximately 480,000 people travelled to the Sydney Central Business District each day with a key trip purpose of either business or leisure. This is a fundamental characteristic of a Global Activity Centre and is significant in determining the behavior of those travelling into the heart of Sydney. The unique geography and stimulated development of the urban fringes has resulted in a primarily road dependent transport network.

In order to facilitate better movement through public transport corridors, the strategies, goals, and plans implemented by key parties have been analysed to determine the impact on pedestrian movement at access points for CBD stations and immediate surrounds. Subsequently, concerns regarding existing pedestrian infrastructure, increased pedestrian activity, congestion, and customer dissatisfaction have been identified.

A key element of transport planning is predicting the travel behavior of system users. In regards to pedestrians this is a relatively unexplored element, and in order to gain better insight, the concept of Psychogeography is explored.

Comprehensive research, data collection, and analysis, have been conducted to identify the current Level of Service (LOS) at which CBD stations are operating, whilst determining which psychogeographical principals draw parallels with tangible urban design features. Findings indicate there are several stations which are underperforming and are forecast to worsen. Psychogeographical findings indicate that a pedestrian’s emotional response is directly related to their trip purpose.

As part of this report a Level of Service criteria and rating system has been developed. If actively implemented it will benefit key planning parties and ensure that the needs of pedestrians are effectively addressed. By implementing traditional urban design techniques in conjunction with developing technologies pedestrian behavior can be effectively influenced subsequently improving flow at station exits. In addition, there is potential to further develop, explore, and conduct psychogeographical studies, adding to the understanding of pedestrian travel behavior.
Bamboo and Rattan Non-Timber Forest Products: An Overview and Investigation into Composite Construction - (12cp)
Thomas Caruana - A15-055

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The world has become heavily reliant on the use of steel-reinforced concrete structures and many timber based products. In the case of the steel used for concrete reinforcement, and to a lesser extent structural steel, one has to remember that steel is a non-renewable resource that is difficult to produce in third world countries, and even more difficult to transport to remote locations. Timber as a structural product is not as commonly used as steel, but throughout the planet is used for a number of different construction related items; from housing frames and roof trusses, to particle board and plywood. Over-harvesting and deforestation are seeing the decline in natural forests and leading to concerns of the longevity of trees and their lumber. Studying these two materials leads to the question of what can be used to replace them, especially in third world countries.

This project outlines the possible composite based construction materials that can be created by using non-timber forest products. The focus was on bamboo and rattan as non-timber forest products that have properties appropriate for the use in composite construction materials. An overview of each was included to brief readers on the current applications, harvesting and production methods, and the two genera as a whole.

The heart of the project revolves around composite construction materials using some form of bamboo or rattan, in either a natural or processed state. The composite materials that can be produced were compared to current alternatives, both steel and timber based, to gauge the effectiveness of bamboo and rattan in their respective applications.

The report concludes with a summary of the findings in the form of a discussion and recommendations. All of the information obtained from this report will be highly valuable for engineers looking to help those in remote locations of third world countries, design engineers looking for greener alternatives to current construction materials, and people from third world countries where bamboo and rattan grow, that could benefit from a vast and profitable non-timber forest product business.
Investigation into the Australian Economy and Preparing for the Change after the Resources Boom - (12cp)
Royce Choe - S14-149

Supervisor: Stuart Nettleton
Assessor: Suwin Sandu
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The mining boom the Australian economy has experienced over the past decade is fading out slowly if not it is already finished following the slowing of world economies in particular China. The Australian economy has been fortunate from the beginning in the sense that it has experienced different moments of ‘resources boom’ starting from wool to the most mining boom. Therefore the Australian economy must prepare for next possible resources boom. This is particularly evident through the campaign of Dr Karl Kruszelnicki, “The challenge of change.” In order to prepare for the next “boom” for Australia it investigates the use hydrogen as the next source of power.

This paper through the use of literature reviews looked into the global movement of new hydrogen technology. This movement were particularly evident in Europe, Asia and USA. This was followed by the use of an input/output table using the Japanese economy as a case study. The hydrogen analysis projected a 20 year outlook on how the Japanese economy will look like if the proposed plans for hydrogen were to take into effect.

The results gathered from this research paper showed how other global economies have already started in implementing new hydrogen technology and have seen in benefits particularly in the area of climate control which is a trending global debate. The 20 year projected analysis of the Japanese economy in implementing new hydrogen technology saw growth in employment and new industries. It also produced the declination of current industries which were expected.

If this proposed change was to take effect in the Australian economy it is seen a beneficial to the Australian economy as it will become a global leader in the new hydrogen economy. The initial change will be installation of hydrogen infrastructure which results in an increase of construction.
Towards Less Train Congestion through Passenger Intention Inference - (12cp)
Peter Colborne-Veel - S14-099

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In public train stations, the designed wayfinding tends to induce individuals to conform to specific egress patterns. Whilst this can be desirable, it can also lead to congestion at specific points in the station. Which, in turn, increase the time a train must remain stationary, for example, loading and unloading time increases with concentrations of people trying to load/unload onto the same carriage. Clearly, an influencing strategy that is more responsive to the current station situation could have advantages.

Prior research has suggested it is feasible to influencing passengers egress patterns in real time but this was limited to a “Wizard of Oz” study. A first contribution made by this capstone was the development of a wireless communication component to enable an autonomous influencing system. With this technology, a new study was conducted at UTS to test the effect of different levels of interaction with an autonomous system.

These studies suggested the possibility of active counterbalancing of the egress-alternatives while maintaining wayfinding. However, the prerequisite for such capability is the availability of knowledge of passenger's intention at a point in their journey where viable egress-alternatives to their destination exist. A second contribution was made by this capstone project towards an early (in the passenger journey) passenger intention inference system necessary to enable active egress-alternative influencing.

This contextually grounded approach infers intention by incorporating observed system and passenger cues in conjunction with a-priori knowledge of how train stations are used. Empirical validation of the intention inference system, which was conducted with data acquired during operations on a platform in Brisbane’s Central train station in Queensland, is presented and discussed. The findings of the two contributions are employed to argue the feasibility of an influencing system to reduce passenger congestion and the potential service impacts.
Prepaid Water System with Matlab GUI Implementation - (12cp)
Fady Costandy - S14-148

Supervisor: Youguang Guo
Assessor: Steven Su
Major: Electrical Engineering Major BE and BEDipEngPrac

Automation; involving service automation or manufacturing automation is inversely related to automatic control. In urban region automation are much less common and developed than manufacturing and industrial sectors. Along with the know efficiency benefits, automation also provide different project to facilitated in environment regulator and human especial needs and challenges.

There are a few factors that limit switching to full automation in urban society. The main purpose of this project is to develop small-scale application of automation, which will be cooperatively for various urban applications. To do so, I have proposed to apply automation for water/liquid sector and services. It must be real-time/practical and economical enough to implement in different urban applications. This project /capstone presents an economical and practical of automation execution for water/liquid services employing Matlab Graphic User Interface (GUI).

My methodology to this idea is to build and design an automation system for water tanks system that allows the user to install and build with less expenses and practicality with much more approachable interface and viable for the user. Achieving this, the system will be fully automated using Arduino Mega 2560 as microcontroller to control the pumps with transducer Ultrasonic for sensing the distances and feedback, and for accessibility employing Radio-frequency identification (RFID) the user will be provide with RFID card to access/activate the system. The system itself is utilize for pre-purchase services as the consumer can purchase a desired amount of water/liquid from the provider/supplier then claim it later at your convince period by RFID card. Matlab is as s tool to communicate with Arduino and operating GUI to present the system from a computer.
Lifts are a mechanical system that are used around the world, even more so in the modern era of construction where desirable land space is at a premium and buildings are growing ever taller to meet the increased demand for usable space in developed areas. The demand for quick, smooth and efficient operation of lifts has increased along with their level of usage and the rapid growth in the number and height of high rise building developments, meaning that operation must yield higher speeds and carrying capacities to meet demand, yet provide smooth, seamless acceleration and deceleration to maintain user comfort.

In order to assess the ride quality of a given lift, a number of dynamic measurements must be considered and analysed. While many would consider velocity to be an important consideration in assessing ride quality in lifts, acceleration and jerk, defined as the rate of change of acceleration, are more influential in the human perception of ride quality; meaning that a ‘jerky’ lift operating at lower velocity but with rapid changes in the rate of acceleration will produce a less comfortable ride quality than a lift operating at higher velocity with smoother, more gradual changes in the rate of acceleration. There is also an issue with perceived safety of the system by the user, where a ‘jerky’ ride is subjectively viewed as less safe than a smoother ride, even with equivalent safety systems in place.

Acceleration data was collected by measuring a number of different lifts during their operation using an accelerometer device and analysing the data using various computer software packages. However, this report did not investigate the possible causes of excessive jerk, such as lift drive control systems or drive mechanisms. Further research and investigation would be required to establish trends based on such data.
Tropical aquarium enthusiasts enjoy the beauty of a healthy and well maintained aquarium, however they generally dislike the tedious process of controlling water quality. Water quality is commonly maintained either through test kits which require samples of water, or single parameter measuring devices. Test kits require the user to take up small samples of aquarium water and add test solution to the sample. The sample will then change the colour of the water which is referenced to a supplied chart to determine the value of the given parameter. This process can be lengthy and inaccurate. The second method is using digital measuring devices such as probes, which generally measure only one parameter per device. This process is much more efficient, however its down side is only one parameter can be measure per device. This gives rise and a path to the Tropical Aquarium Parameter Logger (TAPL).

The TAPL aims to bring together multiple measuring devices into a centralised unit which focuses on simplifying the overall water testing procedure for tropical aquarium enthusiasts. The current design is a proof of concept that adopts a method of having multiple probes connected to a centralised unit which allows the user to measure a variety of parameters through one interface.

Using an Arduino UNO with a Wireless Shield as the central controller, four sensors have been utilised to allow the user to digitally capture multiple parameters (pH, oxidation-reduction potential, temperature, ammonia) concurrently. This data is then represented through a graphical user interface which allows the user to clearly and simply view the values of the various parameters within their tank. In addition to this monitoring is achieved by allowing users to set parameter boundaries and receive alerts if they are exceeded. Overall this project has proven the concept is plausible and future developments include additional parameters to be monitored.
Novel Bioengineering Method for Ground Improvement in Infrastructure - (12cp)
Yang Dong - S14-178

Supervisor: Behzad Fatahi
Assessor: Hadi Khabbaz
Major: Civil Engineering Major BE and BEDipEngPrac

With the increasing development of the technology and advances in science, the traditional civil engineering especially in terms of the soil strengthening techniques has revolutionized to enhance efficiency as well as economy. Many methods are employed to improve the property of the soil for construction purposes. However, the recent advancement of biological sciences has provided a precious opportunity for bio-technical approaches to improve the soil property with more advantages compared to the traditional ways.

The purpose of the project is to enhance the clay shear strength though a bioengineering method specifically using the environmentally friendly bacteria. The project is focusing on the verification of whether the adopted bacteria is capable of improving the shear modulus of cemented clay after 7, 28, 56 days of curing. The most significant component of the project is data collection and analysis, in which 30 samples were prepared in order to conduct the shear wave velocity and density tests. All samples were cured in standard curing bath. It is concluded that the there is an optimum bacterial content resulting in the maximum soil stiffness while other bacterial contents may have adverse effects. It is concluded that cement usage can be minimized for construction projects when the bacterial is utilized for ground improvement.
Holistic Design and Analysis of Pile Foundations under Vertical and Lateral Loading - (12cp)
Christopher Eftimovski - S14-139

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering Major BE and BEDipEngPrac

Pile foundations are deep support structures capable of resisting tremendous loads and limiting deformation magnitudes beyond the capabilities of shallow foundations. However, most civil engineering students are only exposed to basic forms of pile design and familiarisation with advanced theory is usually only gained through optional study or industry practice.

Therefore, one of the main purposes of this project is to compile a comprehensive guide on the holistic design and analysis of pile foundations through Soil Mechanics, covering most soil types and geological conditions and allowing the determination of preliminary capacity and deformation magnitudes. The project specifically addresses the determination of axial capacities, lateral capacities, vertical deformation and lateral deflection, in cohesive soil, cohesionless soil, rock and layered systems and for the following pile types:

- Displacement and non-displacement
- Floating, end-bearing and rock-socketed
- Free head and fixed head
- Concrete, steel and timber
- Circular, rectangular, H-section and CHS
- Single piles and pile groups

A MATLAB program has also been developed for the holistic analysis of single piles in a user-defined system with any number of soil layers and any one of the pile types mentioned above. The program has been completely automated to utilise necessary design charts and formulae and creates an immersive learning experience to supplement concepts from the report. The program is also capable of producing user-defined parametric studies, allowing comparative investigations on the significance of specific design variables in relation to pile performance.

Other project aspects warranting special mention include the mathematical modelling of layered systems and their assimilation into lateral and axial analysis frameworks and the tabulation of important design charts through computer plotting tools.
Design of a Floating Device to be Used in Sewer Monitoring - (12cp)
Mel Enriquez - S14-088

Supervisor: Sarath Kodagoda
Assessor: Shoudong Huang
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

The formation of hydrogen sulfide and volatile organic compounds as well as odorous and corrosive substances can negatively affect the quality of concrete and metal sewer pipeline infrastructure. This, in turn becomes very problematic for sewer personnel as the precarious environment of sewer networks can cause many health-related issues. Ultimately, water and sewerage companies are exploiting advanced technologies such as laser-based systems, ultrasonic-based sensors, infrared (IR) thermography and ground penetrating radar as possible solutions to reduce human operator subjectivity and tackle the intricacies of sewer monitoring.

The focus of the project will revolve around designing a floating device that is able to navigate through sewer networks, and in conjunction to be able to withstand a sensory payload. The literature review on sewer monitoring encompassing a synopsis on the sewer pipeline system, the necessity for environmental sustainability through sewer monitoring, a comparative study on existing sewer inspection robots and an examination on technologies coupled with direct and indirect methods for sewer inspection will function as a benchmark during the design process.

With sewer inspection robots generating upbeat benefits for environmental sustainability and adding economic value, a business feasibility study was conducted quantifying Porter’s Five Forces, PESTLE and SWOT Analysis, and Risk Analysis on the sewer inspection robotic industry in Australia.

Using SolidWorks, the floating device along with its sensory constituents was assessed through FEA Analysis and Flow Simulation, as well as validating the mechanism system design incorporating the Laws of Floatation and Archimedes Principle. Properties comprising of superior strength to weight ratio and high corrosion resistance are desirable characteristics and therefore Stability Analysis was then conducted using different materials such as S – Glass / Epoxy Composite, Wood, Aluminium and Steel. Results are then classified based on various stability conditions of achieving the criteria for stable, unstable and neutral equilibrium.
Stability Analysis of Truss Bridges - (12cp)
Daniel Espanon - A14-197

Supervisor: Emre Erkmen
Assessor: Hadi Khabbaz
Major: Civil Engineering Major BE and BEDipEngPrac

Trusses are structures composed of straight pin-jointed members where all forces are assumed to be applied only at the joints. Truss members have axial forces only, tension or compression and no moment or shear exist in a pin-jointed truss member. When these axial forces reach excessive values, excessive deformation in the material may occur which can cause a structural member to yield or buckle. Buckling of a member due to a large compressive force is particularly important because the resistance to bucking is directly related to the geometrical properties and area of the member’s cross section.

Generally truss structures are comprised of many elements and the analysis required in order to determine the member forces and deformation can involve significant computation. In the case of statically indeterminate trusses member compatibility needs to be satisfied to analyse the structure. This process generates many equations and makes the hand calculation of such structures very tedious and time consuming.

The purpose of this project is to develop a user-friendly computer program that is aimed at helping the user in the design of trusses by analysing the structure and determining buckling loads. The program utilises the input provided by the user such as, truss geometry, loading and support conditions to return the truss deformation, member forces and stress, as well as bucking potential.

Throughout this project three programs have been developed:
• 2-dimensional and 3-dimensional truss analysis program.
• 2-dimensional truss analysis program with fixed joints (truss frame).

The validation for all programs has been carried out by comparing the results obtained from the programs to numerical examples. Step by step calculation of these examples are provided in the report. This report also outlines the method used to develop these computer programs and presents the results of analysing as well as comparing different truss structures.
Performance Analysis of a Rain Water Tank Cooling System - (12cp)
Marcelo Guilherme - A15-052

Supervisor: Bruce Moulton
Assessor: TBA
Major: Electrical Engineering Major BE and BEDipEngPrac

The aim of this project is to analyse the performance, benefits and viability of a household cooling system that uses cooled water stored in rain water tanks to cool the air. The main principle behind this method of cooling is to offset the use of energy from peak hours (day time) by cooling the water inside a rain water tank during electricity consumption off-peak hours (night time) and then using this cooled water to facilitate the air cooling during the day.

The system analysis is done by installing temperature monitoring sensor across the cooling system which deliver information on-line from a prototype system already installed at a residential dwelling.

Should this project confirm the financial viability of this method of cooling, it could be used on a large scale to reduce the peak hour electricity demand. A benefit of this would be to reduce the strain on power grids which currently struggle to keep up with peak demands while being left underused during off-peak electricity demand.
Anti-Rotational Pneumatic Cylinder and Position Indicator - (12cp)
George Hinings - A15-047

Supervisor: Phuoc Huynh
Assessor: Tien Thanh Nguyen
Major: Mechanical Engineering Major BE and BEDipEngPrac

This report investigates two elements of process control and seeks to better integrate more efficient, anti-rotational actuators and position indicators. The mining and water treatment industries’ process control systems utilise control equipment such as pneumatic to pneumatic (P/P) and current to pneumatic (I/P) positioners as well as proximity and reed switches to manipulate the valves on which they are mounted. Due to the size and complexity of these processes, operators look for simpler and better-integrated solutions, for workplace health and safety (WHS), reliability and ease of use. The product would be at the core of Jindex’s competency as they design and manufacture pinch valves and dart valves as well as provide on-site support to their customers. Over the last five years Jindex has gone through a sustained period of growth. This new line of superior-performing pneumatic actuators with integral position indicators would be patented and increase their core product range as well as providing control over a major component cost, when manufacturing their own valves.

Isolating each element of the project lead to identification of the key issues which included:

1. Rotation induced by fabrication techniques
2. Low speed, high frequency oscillation
3. Part minimisation
4. Visibility of positioning equipment

Concepts addressing all issues were generated and assessed holistically, as composite designs and using robust, systematic performance analysis of the individual components, at operating extremes, to optimize prototype selection. The materials and fabrication processes were selected with knowledge of current conventions and thorough discussion with the potential suppliers of the new elements and technologies required for fabrication of the equipment items.

This report provides a full design solution with a proven, integrated, visible indicator and demonstrates that a square-sectioned actuator will provide the required performance enhancement due to its anti-rotational properties and surface area. This element can be operationally proven, once Jindex is able to commit more financial resources to the project and complete the final stages of cycle testing.
Simulation Skin Design and Development for Application to Advanced Human Patient Simulators - (12cp)
Brendan Howe - S14-080

Supervisor: Adel Ali Al-Jumaily
Assessor: Ganesh Naik
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The Healthcare industry in Australia, and indeed globally, is forecasted to come under significant demand in coming years due to the pressures of an aging population. To combat this, heavy investments have been made into the training of new healthcare professionals, which is now primarily done through simulation based training.

Advanced Human Patient Simulators (HPS), such as SimMan 3G, are key instruments used in simulation education. Improvement of HPS related technologies provides the means of increasing the realism of HPS, which in turn strengthens student’s engagement with simulation scenarios. A key area identified as lacking in realism is the skin of HPS. Enhancing the realism of HPS skin has the potential to provide students and clinicians with important clinical clues, which may help guide them in the diagnosis and treatment processes thereby improving their learning experiences and future patient outcomes.

It has been identified that improved tactile feedback and visual indicators can be achieved through simulation of temperature, perspiration and enhanced texture of the skin. The aim of this capstone project is to design and develop a novel prototype simulation skin that incorporates these characteristics. The system will be computer integrated so that each feature can be accurately controlled via a user friendly interface.

The project outcome is a fully functional prototype system. The system design was conducted in a number of stages from conceptual design through to a final prototype design. After fabrication of the final prototype, it was evaluated by registered nurses and potential system operators to guarantee feedback by those most qualified. Feedback was predominantly positive, with the nurses particularly impressed with the realistic texture and temperature of the skin simulation system. Future work would see improvements made to the perspiration feature, which could be enhanced with greater manufacturing resources.
Trampoline Usage in Australia using Satellite Images - (12cp)
Elsa Huynh - S14-113

Supervisor: David Eager
Assessor: Chris Chapman
Major: Mechanical Engineering Major BEBBus and BEBSc

This Capstone project is an investigation into trampoline usage in Australia and the potential link of this data to various demographic characteristics. The purpose of the project was to collect and analyse data of trampoline usage in Australia through the use of satellite images and to then establish an extrapolation method to determine an accurate estimation of the entire trampoline usage population within Australia without a need to survey each and every individual household.

The investigation was limited to the analysis of 11 suburbs in New South Wales. These suburbs chosen based on socio-economic data found through an ABS overlay. Each suburb was fully investigated, and resulting information was categorised by the type of trampoline, safety features and if these respective backyards also had in-ground or above ground swimming pools.

The analysis of this data was performed on Microsoft Excel, with trampoline data plotted against various demographic data including socio-economic index, median weekly household income, number of families with children and physical suburb area. From this, it was noted that no strong relationships could be drawn between the number of trampolines per suburb and each respective demographic criteria. This investigation presents the findings and discussions of results and draws conclusions about trampoline usage in Australia, as well as provides recommendations for future research in the area.
Influence of Material Handling and Refrigeration on Workplace - (12cp)

Abdul Kamal - S14-132

Supervisor: John Dartnall
Assessor: Guang Hong
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Air Conditioning refers to process by which thermal properties (mainly temperature, air quality and humidity) of air in an enclosed area can be altered to provide comfortable working environment. This is effectively used in areas where outside temperatures are very high usually above 30°C. The required cooling by air conditioning is achieved through refrigeration cycle, which gives flow to heat at higher potential area resulting in drop in temperature of workplace area.

Air conditioning has history dating back since Ancient Egyptian and Roman times where different types of methods were used to maintain internal atmosphere at workplaces or at homes. Since then many developments have been made in developed countries such as European, American and in Australasia. Conventional mechanical techniques have been replaced with large complex electromechanical systems. Air conditioning now has a greater application in Industries such as chemical and biological plants, food processing plants, and textile and Nuclear plants along with many others.

The thesis is a detailed report on the influence air conditioning on the workplace in different industries pre-dominantly in Food processing industry. Historical backgrounds of the process followed theoretical knowledge related to the individual processes that are integral part of air conditioning are described in the report. A discussion of comparison of industries from developing countries and developed is provided. Industrial calculations relating to designing of air conditioning systems justifying load requirements in different industries and as a comfort application in homes. Some suggestions for improvement in air conditioning are part of the report with future of the process in industries has been discussed.
Control and Monitoring of Wireless Sensor and Actor Networks Through Natural Language Processing - (12ep)
Denis Kaynarca - S14-048

Supervisor: Zenon Chaczko
Assessor: Doan Hoang
Major: ICT Engineering Major BE and BEDipEngPrac

Internet-capable sensor and actuator devices have grown in range, number and complexity in recent years. As the cost of these devices has fallen, many have been marketed for domestic applications. The Internet of Things (IoT) market has been fragmented by introduction of devices by many vendors, often with proprietary communications interfaces and device-specific user interfaces. At the same time, the use of search engines for accessing and filtering large amounts of data, originating from a multitude of places and existing in many formats, has become nearly universal skill.

Conjunction of Natural Language Processing (NLP) technology, user familiarity with search engine-style interfaces, and growth in the IoT sector presents an opportunity for blending components of each. A search engine-style interface for IoT devices has the potential to give users a familiar method of interacting with a range of smart devices that can be widely distributed geographically. An additional advantage to text-based computer interaction is the natural extension to leveraging speech recognition techniques, especially for use with mobile applications.

The aim of this capstone project is to demonstrate the practicality of using an NLP text-based interface to interact with IoT devices by designing a web-based management system and a lightweight protocol to communicate with devices using existing transport frameworks. An implementation will provide users with access to a variety of internet-capable sensor and actuator devices, and a mechanism to group and control their devices using logical statements parsed from informal language. Functionality of the system will be demonstrated by implementing a set of simulated IoT devices and interfacing them with the system to share a common user interface.
How does BIM Change the Way Companies Work Together within the Australian Construction Sector - (12cp)
Shant Keverian - S14-205

Supervisor:  Anne Gardner
Assessor: Jennifer Macdonald
Major: Civil Engineering Major BE and BEDipEngPrac

Over the last 5 years there has been ongoing controversy over a new means of planning, executing and monitoring a project. This software enables architects, engineers, contractors and other stakeholders to work in close collaboration with one another to produce a more reliable, sustainable, feasible and sustainable final product. This new platform is the so-called BIM (Building Information Modeling). This process enables physical and functional characteristics of a structure to be digitally represented providing a transparent image of design conflicts such as service clashes or constructability issues by using 4D simulation models. With the ability of BIM’s intelligent decision-making, clash detection and its many other benefits, the construction sector can use BIM’s potential to reduce the number and the scale of errors incurred throughout the life cycle of a project.

This project encompasses a review of the literature, findings from interviews with professionals, a case study and simulations, along with analysis of observations and self-reflections on the use of BIM. Within the literature review, background research describing BIM and its functions can be found along with how its use is being driven in the Architectural, Engineering and Construction (AEC) sector. The case study is the exceptional project 1 Bligh Street, Sydney. As this was the first BIM project within NSW a lot of observations were recorded and shared with the public, so that private organisations could adopt BIM within their workflows.

As larger AEC organisations initialise their rollover to BIM, more and more medium sized organisations are adopting BIM and adjusting their work culture to overcome the issues encountered with the use of this new way of working with projects, such as BIM’s legal matters. The new processes and procurement guides assist with the cultural change required as organisations shift from a single user interface to a multiple integrated operating system.

Amongst the project findings the following points have been highlighted in the discussion section of the project. Firstly the question of whether a mandate is needed within Australia to promote the growth of BIM has been discussed. Secondly the advantages and disadvantages of the use of a standard open source file, such as an IFC file has been investigated and the findings have been documented. Thirdly, as more organisations take on the risk of uncertainty and retrofit their project timelines to accommodate BIM contracts, more resources have been allocated during the feasibility and planning stages, rather than the sequential construction and operational stages. Lastly with technology rapidly evolving, it is time for confidential information such as digitised house models to be stored securely in a centralised cloudbank deposit, governed by a government agency similar to the Land and Property Information Office. This will allow for a more systematic, effective and efficient way of dealing with property costs, maintenance and other asset management issues.
Kinematic Design and Implementation of a Powered Exoskeleton for Treadmill Based Gait Assistance - (12cp)
Benjamin King - S14-090

Supervisor: Gabriel Aguirre-Ollinger
Assessor: Alen Alempijevic
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Treadmill-based rehabilitation for gait impairments is not only a physically arduous task for patients but also for therapists. Current rehabilitation practice often requires up to three therapists to physically mobilise the patient’s legs and support the upper body for gait assistance. This creates physically demanding and injury-prone work conditions for rehabilitation therapists.

Powered exoskeletons have been proposed as a replacement for providing gait assistance, thus reducing the physical demands on therapists. Existing treadmill-based exoskeletons achieve this by providing supplementary actuation to the patient’s lower extremities. This means that actuators and other mechanical components are, in a sense, “worn” by the patient. The weight and inertia of the mechanism must therefore be compensated for in the design. Furthermore, additional actuators are often required to maintain alignments of the exoskeleton with the patient. This can result in a very complex and expensive design. As an alternative solution, this research presents a lower-limb exoskeleton with a fixed-actuator design.

Prior to design, gait data was obtained using a motion capture suit worn by test subjects. An adaptive frequency oscillator was implemented to extract the stepping phase and frequency components from the data. Through dynamic movement primitives the average trajectories were then encoded as a weighted sum of Gaussian functions. These motion trajectories form the principal geometric requirements of the design.

The exoskeleton is designed to assist the hip joint muscles during the swing phase of walking. Supplementary power to the hip joint is delivered through a passive mechanism transmitting torque from a side-mounted actuator to the patient’s thigh. This passive mechanism is designed to accommodate the various misalignments that occur between the static actuator and patient’s hip during walking. By utilising only two fixed-actuators, this research sets a precedent for a simpler exoskeleton design that reduces inertial and gravitational loading on the lower limbs.
Finite Element Simulation of Deep Excavation Adjacent to Existing Structure Stabilised Using Jet Grouting (12cp) - (12cp)
Enrique Law Wing Chin - S14-135

Supervisor: Behzad Fatahi
Assessor: Hadi Khabbaz
Major: Civil Engineering Major BE and BEDipEngPrac

Jet grouting is a method of ground improvement that became very popular across the world due to its wide range of applications in every soil type. Jet grouting being a relatively new method; new improvement techniques are continuously introduced for each system, in order to increase the dimensions and the mechanical properties of the jet grouted columns, reduce cost and improve production speed. However, there is still a relevant degree of uncertainty at the design stage, arising from the lack of reliable methods for predicting the diameter of the jet columns for a given set of operational parameters. Indeed, how can a designer be assured that his design will be met? What system and what parameters work best for each application and soil type? These questions are not easily answered, and in fact there is likely to be more than one system and on set of parameters that can achieve the design requirements.

This paper aims at offering some guidance for the application of jet grouting by providing methods to predict the parameters that will meet the design requirements and so optimise construction. As a practical example, finite element analysis was carried out using PLAXIS for the study of deep excavation, near adjacent structures, stabilized using Jet Grouting. The model was based on the case history of Singapore Post Center where a 9m deep excavation was carried out in marine clay. The simulation was undertaken in order to analyse the effects of Jet Grouting on wall movement and adjacent soils. The results show that the depth of the Jet Grouting plays a significant role on the predicted total displacement of the diaphragm wall at the end of the excavation.
Development of Electronic Actuators for Automated Manual Transmission - (12cp)
Rushin Lele - S14-073

Supervisor: Paul Walker
Assessor: JC Ji
Major: Mechanical Engineering Major BE and BEDipEngPrac

Transmission systems in internal combustion vehicles have long been a source of energy loss and potential driver discomfort. Over time the methods through which power from the engine is transmitted to the wheels has developed to make gear changes faster and more efficiently. As the name suggests, the Automated Manual Transmission (AMT) has been designed to be the best of both worlds between the 2 most distinct and common transmission systems; automatic and manual.

Manual transmission systems have the benefits of being cheaper to manufacture and maintain, having better fuel efficiency and giving the driver more control to take advantage of the peak torque of each gear. The main advantages of automatic transmissions on the other had is ease of use and improved ride comfort. An AMT encompasses all these advantages through shifting mechanisms involving electric actuators/motors. Simply put, an AMT is a manual transmission with electric motors that physically change the gears.

With the rising prices petrol and ever more pressing calls to reduce our environmental footprint, more and more efficient transmission systems are being sought after. This project contributes towards the development of AMT’s that are more efficient and can be retrofitted to non-AMT vehicles. The design process adopted here has been to acquire a six-speed dry-clutch manual transmission gearbox and electric servo/stepper motors to control the actuation of the gear shifting process. A fixture was then designed and to retrofit this AMT system to the traditional manual gearbox and develop the algorithms, java script (using an Arduino board) and interfacing to calibrate the system to shift gears just as a commercial AMT would.
Design of a Photovoltaic Wind Hybrid Power Generation System for Remote Area and as Backup Power - (12ep)
Michael Li - S14-047

Supervisor: John Dartnall
Assessor: Steven Su
Major: Electrical Engineering Major BEBBus and BEBSc

As Earth's population is expected to rise from 7 billion to 11 billion by 2050 the need to find alternate power supply systems to limit the effect of global warming is crucial for the existence of the human race. One solution is renewable energy technology, in recent years hybrid systems have become feasible due to the price reduction of photovoltaic and wind turbines and improvements in the efficiency.

The objective of this thesis is to provide solutions for electrification of scenarios where standalone wind or solar power is not sufficient. The hybrid solar-wind power system combined with the backup battery bank and diesel generator will be financially feasible in situations where:

- the standalone photovoltaic system with/without the battery and/or diesel generator is not feasible due to inconsistent sunlight but sufficient wind where grid connection is prohibitive
- the standalone wind turbine with/without the battery and/or diesel generator is not feasible due to inconsistent wind but sufficient sunlight where grid connection is prohibitive
- the advantage of installing the battery bank and diesel generator instead of the solar-wind-diesel generator is in situations where diesel fuel is expensive, this is common in remote locations where there are limited petrol stations and the diesel fuel could be $10/L due to the lack of competition. In this case the savings will occur as the diesel generator will be used less as there is a battery to store the excess power from the solar-wind system, this energy stored can be used when there is high demand at the load or insufficient energy supply from the solar-wind system. The initial capital costs of the battery will be recovered through the reduced diesel fuel used.

This thesis solves the problem through research of current technology in hybrid renewable energy systems, the analysis was done for the photovoltaic, wind turbines, storage technology, diesel generators, electronic controllers and converters. From the information collected a suitable financially feasible solution was analysed based on the different costs factors involved in the project. These cost-factors include the capital investment, maintenance and operation costs, energy saving and costs compared with each hybrid combination. The investigation resulted in a detailed calculation which can be used to work out the best hybrid setup for various scenarios.
Design and Construction of Cutter Soil Mixing Wall and Panels - (12cp)
Yanghua Li - S14-169

Supervisor: Hadi Khabbaz
Assessor: Behzad Fatahi
Major: Civil Engineering Major BE and BEDipEngPrac

The presence of the sand deposits, particularly in Sydney Eastern suburb areas, is not suitable to accommodate unsupported excavation, especially when structures are close to adjacent existing buildings and roads. Cutter Soil Mixing (CSM) is an advanced deep soil mixing method, which provides an effective approach for construction of cut-off walls and retaining walls for a reliable excavation support. Whereas, other systems such as driven pile walls could cause vibration induced settlement in proximity structures, and also construction of concrete diaphragm walls could be time consuming and expensive. The new cutter soil mixing method largely substitutes the conventional single or multiple auger methodology of deep soil mixing, which are capable to create relatively homogenous soil-cement mixing product.

This project provides an overview of commonly used shoring systems and the deep soil mixing technology. Additionally, a comprehensive literature review for design, construction and quality control process of cutter soil mixing wall has been conducted. Particularly, to connect the theories and practical problems, this project demonstrates a case study of a cutter soil mixing retaining wall recently completed by foundation and shoring specialist contractor in Roseberry, NSW. In the case study, a typical section of a cantilever wall is selected for parametric study using computer-aided software WALLAP, which is developed based on the beams on elastic foundation model. The numerical results are compared to the actual data collected from the site, mainly the actual lateral movement of the wall. In addition, the mix design of the CSM panels is also analysed in the case study. The results of this study maybe considered by practicing geotechnical engineers, when dealing with design of retaining walls using cutter soil mixing methodology in urban areas.
Development of an Experimental 3D Printer - (12cp)
Michael Loccisano - S14-094

Supervisor: Peter McLean
Assessor: Ben Rodanski
Major: Electrical Engineering Major BEBBus and BEBSc

The popularity of additive manufacturing techniques has increased dramatically in the past 5-10 years. This is due, predominantly, to technological improvements that made the processes a serious competitor to subtractive techniques for rapid prototyping (e.g. CNC milling). In addition, greater availability and falling costs have widened access to the technology, now known colloquially as 3D printing, and led to its adoption by the "free open-source hardware" movement in the hobbyist community.

With growing popularity, 3D printing is finding many new applications. However, many of these applications are yet to be fully realised as they are still hampered by limitations of the technology. Some examples include the production of so-called digital materials, mass customisation and 3D printed electronics.

The objectives of this capstone project were to investigate some of these application areas and their associated limitations, and to develop an experimental 3D printer design in order to test potential solutions. The design produced uses the mask image projection stereolithography (MIPSL) technique. MIPSL was selected as it is the most promising technique in terms of speed, but currently has limitations in the ability to print multiple materials. It also has some interesting design trade-offs, and has a simpler mechanical design than traditional SLA or fused filament techniques.

The design produced as part of this project uses a horizontal separation method developed at the University of Southern California. This was, until recently, the fastest method of printing using MIPSL. The implementation in this project differs by having two horizontal axes, allowing the 2D image layers to be positioned spatially. This alteration may be used to investigate trade-offs between mask resolution, print size and print time, among other uses.

Unfortunately not all applications and challenges could be covered by this project. One area of great interest to electrical engineers is that of 3D printed electronics. Although this project included research into this area, it was not able to be tested on the prototype printer. Further work could include deeper research into conductive materials, for use in the rapid production of 3D printed PCB’s.
Human Machine Interfaces (HMI) have provided a graphical solution that has removed the complexity of process control information that is hard to encapsulate without visual perspective. This approach in industrial process regimes has enabled users to decouple information from a graphical approach and control actions can be utilized by the operator allowing communication between machine and man. Supervisory Control and Data Acquisition (SCADA) systems is the combination of HMI’s, a control Centre, Remote Terminal Units (RTU) and telemetry systems. Each of these components are necessary in an control system with RTU’s providing ADC which uses telemetry such as satellite or radio towers for process control remotely.

The coupled tank system is a classic control system that has many benefits in society. Such outcomes have been water level capacity management in reservoirs, petrol stations with pre-determined car fill-up amounts by the dollar, mechanical car hoist systems and so on. This capstone shall provide a path for mimicking industrial software that implements graphical user interface (GUI) systems such as ClearScada by Schneider, whereby control of a coupled tank system shall be implemented. This control system shall be designed using state space equations and benchmarked with the traditional black box methods and observing the output. Another problem statement for this investigation is to seek whether Matlab is a feasible utility for data acquisition in real time for a control system and results shall be discussed on performance criteria. In addition to making this process as realistic to industrial regimes, wireless communication such as Bluetooth shall be modelled as a telemetry source for communication between the control Centre (Matlab) and the coupled tank system.
Development of a Wearable Sensor Unit for Enhanced Situation Awareness in Disaster Management Situations - (12cp)
William McDonald - S14-059

Supervisor:  Sarath Kodagoda
Assessor:  Dinuka Abeywardena
Major:  Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

When disasters occur, first responders and rescuers are often forced to move in without much support, relying on their senses to gather information about the environment. For interior areas such as those caused by collapsed structures, they have to remember their surroundings and then try to convey this meaningfully to those outside waiting to move in. The conditions of such areas often make it very difficult to properly determine the state of the area around them and if there is anyone trapped or if it is safe.

With the significant developments made in sensor equipment, a project was conceived to create a wearable device that would allow the recording and subsequent 3D mapping of the area the operators have moved through. A rendered 3D colour map which can be rotated and viewed from any angle would provide far greater information than a recalled verbal description. Combining these however gives even further descriptive benefits, being able to explain the nature of the environment inside in relation to a visible 3D map while being able to point out relevant areas.

The parameters necessitated a compact unit that could be worn on the front of the person whilst not restricting their movement or regular operation while exploring the area. The design involved use of the Robot Operating System, a software framework for robotic and hardware control, to permit the Raspberry Pi 2 single-board computer to interface with the Asus Xtion Live, a PrimeSense/Microsoft Kinect device, allowing the capture of both colour and depth imagery of the surroundings. This would then be used to recreate the areas the wearer had moved through. While various tests have shown that the system does indeed operate and create maps and fulfils the compact requirements of the design, further consideration and work needs to be made towards a full solution as the performance is not great due to the hardware limitations on such small devices.
Jarrah: A Life in Service. Residual Strength of Utility Poles in South Western Australia - (12cp)
Caitlin McLeod - S14-121

Supervisor: Rijun Shrestha
Assessor: Rasiah Sri Ravindrarajah
Major: Civil Engineering Major BE and BEDipEngPrac

My thesis has evolved into three parts. As there is little to no published data on residual strength of Jarrah, I have taken a broader approach to my capstone.

Firstly, I will be looking at the inherent difficulties faced by utility companies around the world in managing timber poles as an asset. As many of the existing poles within networks are coming to the end of their life cycles, it is hard to ascertain with any certainty, without large budgets and manpower, the remaining residual strength and serviceability of a pole. The other main factor to be considered here the breadth of timber species used around Australia and furthermore, the world. This section looks at statistical approaches to managing networks from case studies in Europe and North America.

My second part to my thesis is addressing specifically the Jarrah poles used in a utility company’s network in South Western Australia. Background information into the history of Jarrah and it’s uses in the region will be covered as well as the inherent properties that Jarrah has. Referencing Australian Standards, this details variables such as climatic conditions, and bringing information gathered as well as a look into current practices by the utility company and the issues they face are covered.

Thirdly, analysis of the testing of 15 small clear samples of Jarrah which have be taken from cross sections of decommissioned poles. Compression testing was undertaken due to the cross sections being cut prior to my acquisition, and therefore lengths of samples were restricted. The samples were cut from varying areas of the cross section, ie. One from the edge, two from heartwood and two near a crack. The purpose of this was to see if there was a pattern of percentage difference in strength from each of these areas.
Automatic Manual Transmission (AMT): Design of Transmission Control Unit - (12cp)
David Mehigan - S14-164

Supervisor: Holger Roser
Assessor: Paul Walker
Major: Mechanical Engineering Major BE and BEDipEngPrac

The Automatic Manual Transmission (AMT) aims to combine the best features of manual and automatic transmissions into one system. The lower cost of manufacturing and higher fuel efficiency of manual transmissions is integrated with the driver comfort and simplicity of the automatic transmission driver interface. By creating a control system to select the gears and engage and disengage the clutch in a manual transmission, rather than using human input, will enhance the overall efficiency of current vehicles.

The focus of this thesis is to improve the shift quality of a dry friction clutch in an AMT. This presents conflicting objectives:

1. To improve clutch engagement and lockup - essential to reducing friction and wear on clutch and increase overall driveline efficiency,
2. To improve overall driver comfort and reduce vehicle shock - usually associated with slow clutch engagement.

The balance between the two is crucial for commercial success for this emerging technology. A gearbox and clutch plate assembly has been chosen for the purposes of testing the presented controller designs on a pre-existing vehicle testing rig.

Presented is A Model Reference Adaptive Controller, simulated in Matlab Simulink to govern the actuator for clutch engagement. A reference tracking signal plots the desired clutch actuator path continuously and adapts to changes through self-learning control algorithms. The algorithms update the controller to the dynamic changes caused by the thermal effects that alter the kinetic friction coefficients during clutch slip. Additionally, the self-learning control algorithms readjust the kiss point contact position in the adaptive controller caused by wear on the clutch over its life. A complete simulation for engine start-up for an AMT system modelled on the proposed R32 MKIV Volkswagen Golf 6 speed transmission is achieved and meets a balance between the two conflicting objectives of shift quality.
Improving Conformance of Early-Age Strength in Precast Concrete Panels through the Application of Concrete Maturity - (12cp)
Robert Merjane - S14-105

Supervisor: Rasiah Sri Ravindrarajah
Assessor: Shami Nejadi
Major: Civil Engineering Major BBEBBus and BEBsc

Precast concrete organisations often strip and lift concrete units within 24 hours of pouring. The concrete strength development within this early time frame is critical for safe operations and conformance of products. Precasters commonly rely on cylinder specimens to determine early age strength, however this is an inaccurate representation as it does not account for the additional heat generated by the precast unit. Thus, there is a need for precasters to adopt alternative strength assessment procedures.

The purpose of this thesis is to demonstrate how precasters can improve strength estimations by applying the concept of concrete maturity to their testing regime. The project scope is dedicated to 24 hour strength within precast panels. The maturity method is a validated means of estimating concrete strength for in-situ applications. However, its implementation has not been embraced within Australia, particularly for panel products within the precast industry.

Tests were conducted on a precast panel in order to validate the effectiveness of the maturity method. Due to its slenderness, it was initially hypothesised that the precast panel would develop a thermal profile similar to the cylinder specimen. However, the precast panel’s relative curing temperature escalated by a maximum of 15.6°C, subsequently enabling a 42% increase in compressive strength. Furthermore, the maturity method predicted the precast panel’s strength to an accuracy within 5% due to its consideration of heat and time.

It is therefore recommended for precasters to adopt the maturity method as a supplementary activity within their testing regime, using the implementation methods suggested in this thesis. This adoption should not completely replace current primary testing methods, as the maturity method does not consider variations in concrete mix constituents, should a manufacturing error occur. These findings are significant, as it will allow for increased conformance and safety of precast products within Australia.
Falcon - (12cp)  
Bruno Mills - A15-058

Supervisor: Sarath Kodagoda  
Assessor: Dinuka Abeywardena  
Major: Mechanical Engineering Major BE and BEDipEngPrac

This thesis represents the work for the project ‘Falcon’ conducted by Bruno Falcone Mills in conjunction with University of Technology Sydney on the first semester of 2015. Currently the market for multi-rotors is rapidly expanding, technology is becoming viable and readily available to consumers. Multi-Rotors are frequently used by hobbyist, cinematographers and only in recent years has it entered the market for commercial use. The downfall of multi-rotors is the lack of flight-time performance.

With the rapid increase of multi-rotors as a platform capable of allowing ‘enthusiasts’ to expand beyond ground perspective, it has become clear that there is a need to improve the current designs to incorporate this technology to be used for search and rescue operations. This thesis will specifically aim at creating an efficient platform that will eliminate the need to send someone into dangerous locations within collapsed buildings, by implementing the use of an Unmanned Aerial Vehicle.

The ‘Falcon’ has been developed as an experimental platform which will allow the Centre of Autonomous Systems (CAS) at University of Technology Sydney to research into autonomous flights solution within buildings.

The Falcon combines a custom developed frame that has been well thought out to maximise thrust to weight ratio, while incorporating the most efficient electronics combination that are commercially available as of 2015. Another important part of the thesis is the use of alternative power sources that has not yet been used in commercially available multi-rotor platforms before.

I have completed laboratory tests to demonstrate and back up my choices for creating a successful designed multi-rotor platform. It will be as efficient as possible while delivering flight times that are longer than previously possible on a platform of this size.

With the main outcomes from this thesis, I believe that it has opened a door to using a new power source that will allow other multi-rotors to significantly increase flight times.
Artificial neural networks (ANNs) are one of the artificial intelligence methods. They are used for complex systems that are difficult to model using conventional modeling techniques such as mathematical modeling. Artificial neural networks are based on the operation of biological neural networks, in other words they are a very simplified model of the human brain. Artificial neural networks are mainly used for classification (such as pattern recognition and image matching) as well as prediction (Extrapolation based on historical data).

Neural Networks learn to perform a function based on training data provided during the training phase. An input is presented to the neural network and a desired response set at the output. An error is composed from the difference between the desired response and the actual output. This error is fed back to the system and adjusts the neural networks weights. This process is repeated until the error is reduced and the performance is acceptable. After the training phase, the parameters (weights) of the neural network are fixed and the system is deployed to solve the problem in hand.

The objective of the project is to design and train a neural network to design and optimise reinforced concrete (RC) simply supported beam. The main goal is to develop an optimal solution for the design under consideration. This normally implies the most economic design without impairing the functional purpose of the structure moreover; the design must comply with local standards and codes including AS3600.

Upon the completion of this project, the neural network will be able to perform an optimum design complying with AS3600 of a simply supported beam based on its training which will reduce the resources and time required to complete the design from scratch.
A Detailed Analysis of the Planning, Design, Construction and Sustainability of the Urban Renewal Projects in Darling Harbour and Barangaroo - (12cp)
Sandra Nassrat - A15-265

Supervisor: Ken Halstead
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Major: Civil and Environmental Engineering Major BEBus and BEBSc

Major urban renewal developments are currently being undertaken in the heart of Sydney, two of the largest projects that are currently ongoing are at Darling Harbour and Barangaroo. These urban renewal projects will generate an economic and social benefit to many stakeholders such as the community and the city itself however; with continuous urbanisation developments there is a need to focus on the new environment conditions we create and their impact on the ecosystems surrounding.

In the previous centuries due to little knowledge and negligence the anthropogenic impacts on the environment have been detrimental in many countries. Projects were done with no attention paid to the risks associated with them and no mitigation or prevention of environmental damage was put in place. Problems such as Urban Heat, water ways pollution, air pollution and much more have impacted Australia and other countries from all around the world and the negative impacts can still be seen here in Sydney.

With the increase in the awareness of these problems, new technologies and advancements in engineering design there has been an improvement in the sustainability of urban renewal projects. The works undertaken at Darling Harbour and Barangaroo are managed by well-known engineering firms like Lend Lease and Barangaroo which aim to have Barangaroo be the first precinct of its size in the world to be climate positive and to achieve this they are working with world pronounced leaders in sustainability.

This study is aimed at analysing the planning behind these projects and the environmental engineering methodologies used to design and construct these areas to ensure sustainability. This study will also be linked to the new University of Technology Engineering building and other sustainable structures from around the world. Essentially the aim is to deduce whether the methods applied are sufficient to achieve the sustainability goals and discuss further ideas that can be implemented to improve sustainability for our city.
Designing for sustainability into the electrical sector has become a critical component of the traditional design process in an effort to increase work efficiency across wall mounted hoists or cranes lifecycle. The wall mounted cranes present a unique opportunity for development of efficiency sustainable practices from an overall perspective because of their demanding and expansive lifecycle requirements design considerations associated. Particularly, recent advancements in the materials and automation have facilitated the introduction of various processes and methods from the traditionally implemented in the manufacture of wall mounted crane components. Thus, engineers recently are able to select a wide range of some engineering considerations that will maximise the overall work efficiency.

As a pioneer in overhead crane and hoist handling, DEMAG Cranes & Components has been developing and manufacturing cranes and hoists for more than 180 years. With the aim of providing customers with the maximum benefits of demanding innovation and quality standards, DEMAG Cranes & Components offers completed concepts for optimum efficiency coupled with maximum operating safety and reliability for operators, installations and loads. Even though the safety and reliability are considerable, analysis and efficiency of usage of wall mounted cranes and hoists are highly required to improve the efficiency compared to the existing products used in industry place.

The aim of this project is to explain and perform a wall mounted electric crane and hoist analysis. The analysis will focus on what would be the methodology in the crane and hoist, and understanding of components of them. In order to achieve those issues, there might be needed to assemble modeling and calculations to obtain accurate information. Valid errors and assumption for material usages and different types of cranes and hoists should be made throughout the calculation stages, and appropriately applied on the research.

This capstone project presents and evaluates the results of the efficiency and product sustainability analysis. Current literature will be reviewed in this paper and recommendations will be made for future considerations for development.
Open Source Modular Camera - (12cp)
James Parlevliet - S14-114

Supervisor: Peter McLean
Assessor: Adel Ali Al-Jumaily
Major: Electrical Engineering Major BEBBus and BEBSc

Modern cameras are designed in a way that modularity and upgradability are of low importance, and in which devices are designed not to last and to be replaced. This approach is favoured by companies due to the high sales volume and low costs, however these low costs come at the expense of the consumer who has to pay large replacement costs when the product needs to be repaired or when it comes time to buy a new product. In addition to this, consumers also give up the right to modify their camera’s software and hardware to suit their particular needs and instead are presented with a device which has predetermined processing power and functionality, drastically limiting the device’s potential to meet the consumer’s artistic vision in the creative field of photography.

This project proposes an alternate methodology for the design of cameras, in which the number one priority in the camera’s design is openness. The project achieves this by separating a camera into its main components, in which designs are shown for an image sensor board, a Field Programmable Gate Array (FPGA) based processor board and a main board. The project discusses the design of each of these boards providing a design methodology for anyone interested in modifying the designs or creating their own boards. It is hoped that this information will then be used by researchers and the open source community to further develop these ideas and methodologies and to create a wide range of compatible hardware and software which can be mixed and matched as needed by photographers and any one else who needs an open source camera platform.

The open source nature of the project opens it up to many future developments, ranging from minor upgrades of the hardware or software up to redesigns of whole boards and major changes to software, including potential implementation of an operating system. The customisable nature of the FPGA and the modular nature of the hardware also means that the device can perform signal processing on any signals, redefining the camera as being a device that captures any signals, not just image signals.
Heart Rate Regulation in Cycle-Ergometer Exercise - (12cp)
Kevin Quach - A15-060

Supervisor: Steven Su
Assessor: Stephen Murray
Major: ICT Engineering Major BE and BEDipEngPrac

The loss of mobility in any part of the human body could lead to a significant reduction in the quality of life of an individual. Errands involving necessary everyday tasks can become difficult to complete as the individual experiences any loss of movement. As such, one of the main contributors to the quality of human life is the power of transportation (walking). Vast amounts of research and facilities are constantly in search for new innovative ways in order to assist individuals who experience loss of mobility in hope to restore impaired movement.

With the power of modern day technology the cycle ergometer has been developed in order to assist users with rehabilitation and prevention mobility loss in a safe environment. However the cycle ergometer has its drawbacks whereby the system is unable to cater to the needs of every individual who uses the device. This is due to the microcontrollers that are currently being used within the system (PID controller). There are various limitations to this as the controller is a linear time invariant based system whereby the human body is operates dynamically with varying conditions.

The aim for this capstone project is to research, document, explore and develop a new method of providing feedback to the user in the form of audio comments whilst using the cycle ergometer machine. Therefore in order to achieve an improvement over the existing system, various possible solutions have been identified in hopes to replace the existing PID Controller and develop a new method of achieving an adaptive controller.

It is clear that society has become more reliant on technology being embedded into everyday lives. With this in mind the Heart Rate Regulation for Cycle Ergometer Machine is a strong step forward in regaining confidence and life back into everyday mobility.
The purpose of this capstone project is to evaluate and identify the issues arising from material handling processes in manufacturing and processing industries. In both developed and developing countries thousand of tonnes of material is transferred from one place to another daily. One such material handling industry is the food processing industry, where large quantities of food products are handled. Dating back to prehistoric times, most of the industries had manual operated material handling processes that had greatly affected workers health and safety at workplace.

Although many developed countries have laid some international standards for their workplace to ensure workers health and safety yet issues arise for the workers inside the plant. Similar problem exists for industries in developing countries. Manual and intensive jobs in developing countries are carried out with little automation that had caused in fatal injuries and severe illness to the workers.

Data gathered by US Bureau of labor Statistics, from 1992 to 2012, showed that the rate of illness and injuries caused to workers in processing and manufacturing industries has increased severely. In developing countries like Pakistan, industrial accidents and illness has become a major problem. Large cases have resulted due to unsafe working environment, which includes manual transfer of bulky items around the industry, uncovered conveyors, slippery surfaces, defective materials and improper ventilation system.

The advent of modern industrial revolution in developed countries, implementation of automated material handling processes have reduced the health risk associated with industrial workers. As for developing countries, the awareness of automated material handling equipment and processes is of great importance and the need of installing modern equipment in developing countries have been addressed in this paper.
Building Defects: Failure of Cement Render - (6cp)
Felicity Smith - A15-045

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The facade of a building is the most exposed element of a building, and as such is most likely to have a shorter lifespan than the structure itself. A common system used on the facades of buildings is that of render, and it is particularly sensitive to underlying building defects, being a brittle product adhered to the structure’s surface. External render systems consist of a number of products - lime, sand-cement, and modified renders. Render can be applied to a variety of building substrates including concrete, clay masonry and autoclaved aerated concrete.

This report will give a brief overview of defects that a building's exterior can experience over its lifespan and how these defects impact the render system. There appears to be a trend that render is used to cover up building defects, or as an excuse for poor building workmanship. I have conducted a survey in an attempt to gain a better understanding of industry perceptions on the issue of render failure particularly from builders and renderers.

The findings of this report will be valuable to a whole range of stakeholders. It will provide the engineering community, specifically the construction and remedial works industries, information on the varying failure modes of render. This research will also be valuable to the rendering community as they have very little protection when render fails, and they are often perceived to be at fault when the system does fail. Further, this research will be valuable to the wider community, informing building owners of the range of defects that can lead to the failure of a render system.
In very recent years, electric cars are becoming mainstream both on-road and in the racing world. A substantial contributing factor involved in the uptake of electric cars over those with internal combustion engines is the development of batteries with faster recharge times and higher capacities for travelling greater distances between recharges.

The electrical requirements of a battery for any individual electric car are closely related to the specifications of the system in terms of maximum required power, motor controller voltage and total energy requirements. High-voltage batteries in electric cars have requirements in terms of their physical properties as well, which need to be considered in their design, including being as lightweight as possible, the ability to disperse heat generated, and being robust and securely fastened to the chassis due to the inherently volatile nature of the contained high-density energy-storing chemicals. Safety in manufacture and storage of the battery, as well as in charging and running the powertrain, play an important factor in making design decisions. Careful consideration of these factors increases the expected lifespan of the battery, as well as reducing risk during both manufacture and driving of the car.

This report details the research, engineering design, and preliminary manufacture procedures involved in developing the powertrain of UTS Motorsports Electric’s first iteration of an electric FSAE car. The main focus has been on the development of the highly configurable custom-made 400V lithium ion battery, while providing a system overview for the components which the battery powers, addressing safety, storage and charging, and suggesting directions for future development in the FSAE car’s energy storage.
Use of Bamboo For An Engineered Application - (12cp)  
Timothy Spiteri - S14-104

Supervisor:  Rijun Shrestha  
Assessor:  Yangchen Li  
Major:  Civil Engineering Major BE and BEDipEngPrac

In the current global economic climate, rising areas of concern are based around environmental sustainability, and human rights and equality amongst all humans, not just people lucky enough to live in developed countries. This concept is strongly reflected from a Civil Engineering perspective, where materials used in construction need to be sustainable and environmentally friendly, as well as being accessible, especially in geographical regions that lack the resources for conventional construction materials. The idea of a bamboo engineered product has the potential to fulfill these two criteria, providing a sustainable solution to housing in regions that are unable to afford it. The analysis of this issue is two-fold.

Firstly this report examines the overall capacity of the bamboo when reconstituted into an engineered product. This is done through the fabrication and testing of 5 members, in both compression and bending. The results ascertained from these tests will be used to analyse the capacity of the member, and how this translates to the overall capacity of the member. The analysis will incorporate Australian Standards, in order to classify the member, and analyse overall applications.

Further to this, the overall feasibility of the product will be analysed within this report. It will examine various aspects relating to the overall feasibility of using a bamboo engineered product in geographical regions that have a strong need for an accessible and sustainable construction material. Some of the aspects that will be examined in this report include access to bamboo and the overall ability to construct the members with the constraints that may exist, such as limited resources and access to expensive materials.

This report provides a comprehensive analysis of the strength capacity of the bamboo member, especially in regards to their bending and compressive strength, and will further investigate the feasibility of using the product in geographical regions that could benefit from this material.
Development and Implementation of Hybrid-Electric Scooter Powertrain - (12cp)
Michael Steinkamp - S14-056

Supervisor: Holger Roser
Assessor: Paul Walker
Major: Mechanical Engineering Major BEBADipEngPrac

Conventional transport solutions are becoming less feasible due to rising fuel costs, environmental concern and the changing behaviour of society. Hybrid systems are increasingly becoming a viable option to replace the conventional Internal Combustion Engine (ICE). This trend is primarily driven by rising fuel costs, technological developments and an increasing number of cities implementing emissions restrictions.

In the past technological and social obstacles, such as battery technology and range anxiety have hindered the adoption of hybrid technology. These obstacles are becoming less of a concern as battery technology improves and hybrid systems become more capable. One such technology is the use of a Hybrid-electric system that is capable of running as a purely electric or as a hybrid-electric system. In this configuration the system is able to conform to zero emission requirements when required, and yet still have the capability to utilise the ICE for longer journeys, addressing range anxiety issues.

This project focuses on the development and implementation of the electric power train of a hybrid-electric scooter research platform. The UTS hybrid scooter research platform consists of a 125cc Scooter (Model: Kymco Like 125) converted from a 4-stroke petrol engine with a CVT transmission, to an electric power plant with modular range extender.

The project encompasses the following sub systems; traction motor and swing arm assembly and vehicle control system. This project reviewed existing designs, refined and implemented the electric powertrain. This process included extensive analysis of engineering constraints of the scooter frame and proposed components, FEA analysis and manufacture of components.

This project will assist in the completion of the electric scooter powertrain and allow for testing to be conducted. As a result this project has a direct impact on methods to package, implement and construct the electric powertrain for a Hybrid-electric scooter.
Around the world, the annual primary energy consumption is in an enormous increase due to the rising order for electricity that has become one of the primary necessities in the twenty first century. Conventional power sources and nuclear power plants have been supplying our world and meeting the power demand throughout more than 5 decades. However, the increasing environmental concerns and the economical advantages increased the interest in clean and sustainable energy resources. Among all of the renewable energy sources, wind power has experienced outstandingly rapid expansion. Accordingly, using wind turbines for the production of electricity is an established, competitive, and practically pollution-free technology extensively used in various places of the world.

There are two types of wind turbines which are horizontal axis and vertical axis, and each of the two basic configurations has its own advantages and limitations. The report will focus on highlighting the mechanical and electrical components of the wind turbine in form of subsystems; and will discuss the control systems in use. Additionally, the environmental impact of using wind turbines is analyzed where both advantages and limitations are discussed and taken into account.

Although wind turbines energy conversion systems have reached a mature stage, continuous improvements at both component and system level are still taking place in the aim of reaching the most efficient system function. The future of wind turbines is best analyzed by considering the expansion pace, expected development fields, and the foreseen challenges. Conducting this analysis helps clearly understand the level of enhancement that can be done to the system. Lastly, recommendations are made in the aim of enhancing the overall performance of the wind turbine systems, as well as actions that can be made to reduce the limitations.
Soft Calibration of an Inertial Measurement Unit (IMU) - (12cp)
Thuy Thy Van Tran - S14-131

Supervisor: Steven Su
Assessor: Youguang Guo
Major: Electrical Engineering Major BE and BEDipEngPrac

The roll and pitch angle outputs of an Accelerometer of the Inertial Measurement Unit (IMU) is based on the earth's gravitational field; however, the gravitational field varies around the world, although the earth's gravitational field is often stated to be 9.81 ms². In practice, the apparent gravitational field measured by an accelerometer varies by 0.7% from minimum to maximum over the earth's surface as a consequence of the earth's rotation, the earth's equatorial bulge and the effects of altitude. In addition, an IMU accelerometer output may be less accurate due to the physical misalignment between the sensor circuit and the final product packaging.

In order to provide the accuracy output of accelerometer, it requires a convenient way for calibration the accelerometer right on the spot of using.

Therefore, the aim of this capstone project is to design standalone software that provides the users two ‘Soft Cal’ options to calibrate the accelerometer conveniently right on the spot of using. Option 1 - ‘Easy-Cal’ does not require any equipment and the option 2 - ‘Precision-Cal’ only requires a smart phone with Euler Compass/Tilt Meter application.

The user can active the Soft Cal mode by pressing a button on the embedded board and the Soft Cal process will prompt the user to go over the Soft Cal calibration procedure. The Soft Cal parameters (gains and offsets) will be measured, calculated and stored in non-volatile Flash memory of the embedded microprocessor. These parameters are known as the good reference calibration parameters and will be loaded and used at every power-up after, until the user recalibrates the IMU or wish to the Hard Cal parameters.

With this Soft Cal embedded in the IMU system, the user can calibrate the IMU accelerometer anytime, anywhere conveniently right on the spot of using.
Implementation of a High Rate Covered Anaerobic Lagoon Design at an Australian Abattoir - (12cp)
Bradley Tombleson - S14-196

Supervisor: Hokyong Shon
Assessor: Leonard Tijing
Major: Civil and Environmental Engineering Major BE and BEDipEngPrac

In 2014 CST Wastewater Solutions Services (Principal Contractor) began construction of the first of its kind high rate covered anaerobic lagoon (high rate CAL) wastewater treatment plant. The primary function of the project was to collect biogas after anaerobic digestion of industrial effluent produced by an Australian Beef abattoir. This plant was the first covered anaerobic lagoon water treatment plant that both the Principal Contractor and Designer had ever constructed.

The purpose of this paper is to review the application of high rate CAL technology in Australia and what construction aspects of the plant should be carried over to future projects along with potential design applications should be improved upon. This paper will discuss anaerobic water treatment and its benefits along with what makes the high rate CAL design different from other anaerobic wastewater treatment designs. However, this paper is not intended to be a comparison for the basis of considering this high rate CAL design over other wastewater treatment designs. The focus of this paper is to highlight and discuss ways to improve the implementation of this high rate CAL technology and other wastewater treatment facilities. Thus giving a review to help improve the delivery time and cost required for the construction of future high rate CAL wastewater treatment facilities.

This paper is written from the perspective of the Project Engineer for the Principal Contractor, therefore will not justify the process design of the high rate CAL design. The validity of design will be limited to areas of instrument and equipment selection and layout. The overall process design will not be discussed in this paper. The observations and analysis will include the construction of two High Density Poly Ethylene lined lagoons, mechanical installation of plant equipment, electrical installation and requirements, material selections, equipment and instrument layout and legislative requirements and approvals.
Stabilisation of Expansive Soils through the Use of Chemical Additives - (12cp)
James Tricker - S14-124

Supervisor: Behzad Fatahi
Assessor: Hadi Khabbaz
Major: Civil Engineering Major BE and BEDipEngPrac

In the construction industry, highly reactive soil is problematic as it often results in an inconsistent and high movement foundation material. Highly reactive clay soil will swell as it gathers moisture and shrink as it dries out, this is a recurring issue in Sydney due to commonly encountered high plastic clay material. The purpose of the chemical additives (hydrated lime and fly ash) in this situation is to minimise the shrink/swell effect and this is what the project shall quantify and compare.

The project aim is to quantify and compare the stabilising effect that particular chemical additives have on the reactivity of expansive soil, I will be performing a number of laboratory tests on highly reactive clay sample material in order to determine and compare the additives effects. This project shall prove beneficial to the engineering community as it will show a direct comparison of readily available chemical additives at different concentrations and there effects on a common highly reactive clay soil sample, improving knowledge on this matter allows engineers to make more informed decisions and/or recommendations.

My second block of engineering experience was as a geotechnical engineering intern and I am now continuing to work in that field throughout the remainder of my studies. In my short time working in the geotechnical engineering industry I have witnessed the negative impacts that expansive soils can have on foundation quality, often reducing safety and increasing costs related to projects. There is currently very limited information available in regards to stabilisation of expansive (Sydney) soils in regards to shrink/swell potential, this was the major influence towards me pursuing this topic.
Solar Energy Used in Households - (12cp)  
Ahmed Tuwalah - A15-059  
Supervisor: Huu Hao Ngo  
Assessor: Wenshan Guo  
Major: Electrical Engineering Major BE and BEdipEngPrac  

The challenges that face solar energy in Australia range from technological to economic, logistic and political as well as environmental. Developing a strategy that meets these challenges is a priority and vital in the development of solar energy use in the country. The foundation and the fundamentals that have made the use of the technology in the current time and that will form the basis for the future state of solar energy have called for an analysis of where the country is, where it is headed and the general situation of this form of energy. The question on whether to push through with the adoption of solar energy as the main form of energy is a foregone conclusion as the climatic conditions show that fossil fuel use is not sustainable since it’s not renewable source of energy, and it is toxic to the climate. Using solar energy as an electrical power will benefit the community in terms of electricity which can be done by using solar panels suitably. The conversion process can be done successfully by using enough materials and methods and knowing the solar panels applications carefully and how it works properly.

Australia has the highest potential for solar power with most of its parts being arid and semi-arid. Development of better PV cells technologies and incentives given by the government have led to an increase in the number of households that have installed PV cells and that feed the excess energy back to the grid for redistribution by utility companies. Uptake in solar power use by homesteads has however faced several challenges that range from technological capabilities to logistical and grid problem. Not only materials are included to elaborate the uses of the solar panels but also a case study for the use of central park solar which will be further detailed in the report.

The use of solar electricity reduces bills and also makes it possible for the owners to reduce their utility bills as the power meter rewinds when they feed back their energy to the grid. Challenges with grid overload, effects of solar parks and the lack of political will to promote solar energy have, however cast a grooms picture on the use of this renewable energy. The challenges can be addressed through the increase of the capacity of energy storage technologies, improvement of the PV cells, and the change in the business models that utility companies use. Improving the state and the capability of small renewable energy companies is one of the options that will address the challenges that renewable energy faces. The advances made by the households due to a reduction in the price of the PV cells and provision of better storage technology indicate an upward trend in the coming decades with pressure mounted by climatic changes likely to lead to accelerated adoption of renewable energy. Solar energy has proved the potential to reduce the harmful effects of some other sources of energy such as oil as it doesn’t produce any harmful products to the environment. The fact that the environment is a natural system means that the view of role and impact of solar energy on the environment has to be healthy as well and the cases where it is harming the environment noticed.
Evaluating the Impact of Household Electrical Device Optimisation - (12cp)  
Michael Watson - S14-108

Supervisor: Edward Langham  
Assessor: Youguang Guo  
Major: Innovation Engineering Major BE and BEDipEngPrac

As electricity prices in New South Wales have risen it has put additional financial pressure on Australian households leading to 70% of Australian’s worrying about being unable to pay their next electricity bill (EY, 2013). At the same time the Australian Bureau of Statistics estimates that 57% of Australian adults are concerned about climate change (2011-12). These factors, among others, have resulted in 89% of Australian’s taking steps to limit their residential electricity use (ABS, 2011-12) by implementing lifestyle changes, getting rid of old electrical appliances or making efforts to conserve energy. On a market level, as residential households have become more conscious about their electricity use this has resulted in the level of domestic electricity consumption decreasing annually since 2010 ultimately forcing electricity producers and retailers to try to identify how low residential electricity consumption could go in order to adjust their business models accordingly – but how low could residential electricity demand go?

To enable the electricity industry to identify the impact that electricity conscious households could have on the level of domestic electricity consumption I created a model that compares a household’s actual consumption pattern with the household’s consumption pattern if their electrical device usage had been optimised to either reduce their electricity bill or environmental impact, in the same way that a household could be motivated to save electricity. The project employed high resolution metering of a sample household’s electricity consumption at the individual electrical device level as a foundation of the model. By analysing each major electrical device’s general use case and operation a generalised electrical device model was developed to serve as a platform for evaluating potential optimisation opportunities across a range of typical households Australian households. When evaluating potential electrical device optimisations, such as the elimination, minimisation, substitution or shifting of electrical device usage, the model factors in the optimisation goal (bill or environmental reductions), the household routine, the household’s propensity to implement optimisation activities, the household’s current electricity billing information and the appliance use case before deciding whether or not to implement an optimisation activity. If an optimization activity does not align with the optimisation goal, requires the occupants to implement major changes in their routine or if the effort required to implementation the optimisation activity is too high then the model would not implement the proposed device usage optimisation. The model can be used to either evaluate a specific scenario or can be used to compare and contrast the impact of lifestyle factors, demographic and economic on the optimisation potential. When applied to a representative dataset this model has the potential to be used to evaluate the impact that emerging smart devices and home automation technologies can have on the electricity grid and quantify their demand response potential.
An Innovative Solution to the Manufacturing Process of Custom-Shaped Seating Inserts with Affordable 3D Scanning Techniques - (12cp)
Stuart Wheatley - S14-206

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Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

Pressure Ulcers (PUs) significantly burden the health care system and greatly impact quality of life. PUs cost the Australian health care system an estimated AUD$285 million per annum (Mulligan 2011) and the majority of these may be preventable (Hibbs 1988, Downie 2013). Limited mobility and decreased sensation, typical of people in wheelchairs, increase the risk of PUs therefore prevention methods that redistribute pressure are necessary.

Megalong Positioning Service (MPS) provides custom-shaped inserts for wheelchairs and beds as passive PU prevention. Custom inserts are more effective (Tasker 2014) than generic inserts as they enable more even distribution of body weight. MPS’ current manufacturing process is limited by the high cost of current scanners, so one scanner is transported to all clients. Moreover, inefficient data manipulation has a negative impact on the overall manufacturing process. Hence there is a need for more affordable scanning and production techniques to reduce costs to consumers and expand services to remote areas.

This project developed a customized approach to scanning and processing data, replacing current scanning systems with open source software and commercially available 3D sensors such as the Xtion Pro. The developed solution provides a 3D modeling system that reduces cleaning and manipulation time significantly. It also reduces file size while achieving suitable accuracies for manufacture. The outcome of this project provides a significant operational advantage with considerable price reduction per sensor allowing expansion of services without increasing consumer expenses. Utilising these low cost sensors, MPS is now able to distribute scanning equipment to occupational therapists (OTs) local to clients, saving travel costs by emailing scans to MPS for manufacture rather than travelling one sensor to client locations.

MPS is currently studying integrating the proposed methodology into their business model with further discussion of funding a refined final scanning package for distribution to OTs.
Sustainable Design of Residential Buildings – Material and Cost Aspect - (12cp)
Elizabeth Williams - S14-123

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In Australia, since the early 1990s there has been a growing emphasis towards sustainability. This emphasis has been particularly evident within the construction industry, especially in the residential sector. This has seen new regulations being introduced into the Building Codes of Australia for residential buildings to meet energy efficiency requirements, and further the introduction of BASIX which is a recent tool now required for all new residential buildings. It is commonly believed that building a house designed to meet these requirements will cost a lot more to build than a standard brick house.

This thesis aims to explore frequently used techniques in residential buildings to achieve a sustainable house in accordance with the principals outlined in BASIX and considers some alternative sustainability options. It also aims to analyse the cost component associated with each technique and the benefits associated with that technique in relation to reducing greenhouse gas emissions, price and societal benefits.

Some of the techniques that are reviewed include solar panels, rain water tanks, material choice and house orientation. A computer aided program was used to mark up the sustainably designed house which encompasses these techniques. The program also assesses the house design for its’ potential energy efficiency.

The results highlighted that including some sustainable design techniques does not always necessarily result in a greater upfront cost. Further to this, where up-front costs were higher, the expected number of greenhouse gas emissions reduced by such a large amount, that from an environmental perspective, one might see it as economically viable.

Keywords: Sustainable, Design, Energy Efficiency
Emission Minimisation for Off-Road Heavy Vehicle Machinery - (12cp)
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In the recent years, scientists and manufacturers focused on reducing the emission of light and heavy transport vehicles. In meanwhile, the off-road heavy vehicles were missed from this environmental innovation where they exist at every single construction and renovation project in the metropolitan or regional areas. Thus, this capstone project addresses the issue of the emission coming from the off-road heavy machineries. It compares the ADR legislation, specifically EURO standards. Furthermore, it provides suggestions for having a friendly and green environment, free of air pollution.

The engineering community were able to control the emission by introducing the electrical, hydrogen and/or the hybrid systems. For off-road heavy vehicles, the outcome will have less efficiency where the cost will be expensive for the manufacturers as the consumers might not adapt with it. Currently, the government organisations are giving credit for the companies who provide friendly environmental equipment and it became considered by individuals and business consumers. This project aims to have an in-depth study in the process and chemical contents that cause the air pollution and provide recommendations to reduce it at a low cost. Moreover, the reduction process may also include upgrading for an exciting part or applying new application with likely cost of $1,400 to $9,900.

This report also includes a summary of a study tour being conducted to local manufacturers and suppliers in Sydney. The purpose of this tour is to handle a list of questions about emission controlling system that is applied to new engine products. This report discusses the data collected and analyses it.

In conclusion, this study could recommend the best way to upgrade existing engine process to what is best for the environment and the stakeholders.
Time Dependent Effect of Microorganisms on Small Strain Properties of Improved Soft Clay - (12cp)
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Soil stabilisation is the process of changing soil properties to improve its engineering performance, in particular increasing the strength and reduce the settlement and construction cost. Due to vast amount of soft soils in coastal areas in Australia, finding an efficient ground improvement method for infrastructure projects can have significant benefits.

There are many available methods to improve soft soils using mechanical and chemical approaches. Mechanical stabilization is the physical process changing the physical nature of native soil using vibration, compaction or incorporating other physical processes. Chemical stabilisation depends on the chemical reaction between soil and cementitious or pozzolanic material to improve soil properties. The most commonly materials in ground improvement projects are cement and lime.

This project focuses on the biochemical stabilization of soft clay by using Microorganisms and cement. The selected microorganism is to change the soil properties due to the reaction between soil and bacteria. This project is aiming to examine how the shear modulus of the improved soil changes with time, and determine the extent of improvement. To achieve these objectives bender element tests have been conducted. Samples with 10%, 15% and 20% cement contents as well as 0%, 0.5%, 1%, 2% and 5% microorganism have been prepared. The laboratory measurements have been obtained for more than 60 days, The results of this research show that in long term optimum microorganism content can improve stiffness of the improved soil significantly.
Soil and Groundwater Sampling - Environmental Site Investigation At Former Alexandria Waste Transfer Station - (12cp)
Ningye Zhang - S14-157

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Recently, the world has been aware of the ‘waste crisis’. However, there are only limited focuses on the former municipal waste transfer, storage or treatment sites on their environmental impacts. Due to the dramatic expansion of modern cities, these sites can potentially end up as the residential/commercial properties located close to or even within the human living clusters. Hence, the closure or redevelopment of these prior waste related sites should be considered and investigated with extra care.

The objective of this project is to provide and demonstrate the soil and groundwater sampling methodologies. The intrusive methods in terms of different sampling techniques for a particular media (soil or groundwater) will be described, analysed, and then compared. A further consideration will be discussed on how the sampling program is designed from a holistic view (non-intrusive method) and in compliance with the guidelines applied in New South Wales area. The theoretical knowledge, rationalities, and assumptions will be justified in conducting an environmental site investigation at the former Alexandria waste transfer station site. The assessment should include but not limited to the site identification, historical information search, site walkover, soil and groundwater study, sample testing and results discussion. A conceptual site model can be developed based on the results achieved. This model could be utilised in the future investigation and decommission of a waste transfer station, waste storage and waste treatment sites to raise critical considerations from environmental land contamination perspective.
Exhaust gases from vehicles are a major contribution to air pollution, the depletion of the ozone layer and climate change. Electric vehicles have a high potential in replacing conventional combustion vehicles. Different battery chemistries and energy storage devices are being tested to determine if it can endure mechanical and electrical loadings in driving conditions.

The aim of this particular project is to subject lithium iron phosphate (LiFePO4) batteries to various electrical and vibration tests according to standards set by the Society of Automotive Engineers (SAE). The electrical tests were performed according to the standard SAEJ1798: "Recommended Practice for Performance Rating of Electric Vehicle Battery Modules" and the vibration tests were performed according to the standard SAE J2380 "Vibration Testing of Electric Vehicle Batteries".

The testing stage was split into three phases: Phase 1 - electrical tests, Phase 2 - vibration tests and Phase 3 - electrical tests. Phase 1 and Phase 3 electrical tests were identical and were used to compare battery performance before and after vibration. The vibration tests were designed to simulate vibrations encountered driving.

Three types of electrical tests were performed, the static capacity test, charge retention tests and charge acceptance tests. The static capacity test simulates sustained periods of discharge. The charge retention tests subject the battery sustained periods of inactivity to measure the battery’s ability to hold charge. The charge acceptance test measures the battery's ability to accept charge whilst standing in various temperatures.

The report contains test methodology, equipment setup, results, comparisons, conclusions and future improvements to testing procedure for obtain better results.