The Change of Forces on Airfoil that is Above Water Surface (12cp)

Yuzhong Zhang – A17-081

Supervisor: Phuoc Huynh
Assessor: T. Thanh Nguyen
Major: Mechanical Engineering

Aerodynamics has been widely used in many areas including aircrafts, helicopters, wind turbines, automobiles etc. One of the most important applications of aerodynamics is the airfoil which generates lift forces when it deflects the airflow. There are already many studies on airfoils, but most of them focused on hard surfaces, i.e. concrete surface. Specific research of airfoils on flexible surfaces, for example, close to or above the water surface, is still rare. Nowadays, crafts over the water such as Wing-In-Ground (WIG) crafts and Ekranoplan, might experience a different aerodynamics in comparison with that over hard surfaces. For example, the forces acting on the airfoil may be changed dramatically due to deflection of the water surfaces.

To test the hypotheses that lift and drag forces of airfoils above flexible water surfaces are different from that above hard surfaces, we carried out this project with methods of software simulation and experimental measurements. Aerodynamics of airfoil under three situations, namely with an airfoil in "free" condition (not being near ground or water surface), near a hard surface (mimicking the ground), and near the water surface, have been considered. We used the software ANSYS Fluent to calculate aerodynamics of airfoil under various conditions in terms of airfoil shapes, wind speeds, distance to the surface, and angles of attack and obtained aerodynamics for the airfoils. Meanwhile, a wind tunnel apparatus was also built to conduct comprehensive experiments. Finally, results from experiment, computation and literature are compared and discussed.

Results of this study can potentially provide some useful advice for WIG and Ekranoplan crafts, aiming to optimize the aerodynamic design.

Study of Wind Forces on Airfoils Being Close To and Above Water Surface, at Different Heights between Water Surface and Airfoil - (12cp)
Jaehyung Kwon - A17-140

Supervisor: Phuoc Huynh
Assessor: Thanh Nguyen
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Team members: Duc Anh Khong –11578869, Yuzhong Zang –11247653, Jaehyung Kwon –11491521 and Liang Hou –11547433

The definition of aerodynamics is the study of forces and the resulting motion of object though the air. It has being used to a lot of areas such as car, bicycle, and aircraft. The airfoil is one of the essential components in aerodynamic applications, and it generates lift and drag forces when it deflects the airflow.
The aim of this project is to study the lift and drag forces on airfoils when it is being closed to and above the water surface. There are four different aspects in this test which are three different shapes of the airfoils, different wind speeds, different angles of attack, and different height to the water surface. In this project, I am going to figure out forces with different height to the water surface.
In this project, we are going to figure out forces by experiment using wind tunnel apparatus, which are built by our capstone members. We also calculate forces using ANSYS fluent software. The experimented results are compared with data from the literature.

Study of Wind Forces on Airfoils Being Closed To and Above Water Surface- (12cp)
Liang Hou - A17-149

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Assessor: Thanh Nguyen
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Aerodynamic forces have been used by humans for thousands of years in windmills and sailboats. Modern aerodynamic study have only hundreds of years of history but it has been widely used and is extremely important in today's life. It mainly focuses on areas include aircraft, motor vehicles and dynamic designs. Airfoils are normally used to test working conditions of airplane wings in air flows. There are a great number of studies on the airfoil models in the past, but most of them focused on airfoils in middle of air or above the hard surface.

In this project, our team need to investigate the lift and drag forces on different shapes of airfoil models when they deflect the airflow. Three situations will be considered: when the airfoil in "free" condition (not being near ground or water surface); when the airfoil near the hard surface (mimicking the ground) and when the airfoil near the water surface. The tests will be also conducted by different wind speeds, angle of attacks and heights. Our tasks will be comparing the experimental data we collect with the data from believable literature and simulations. We built a physical wind tunnel and measure system that suitable for testing our airfoil models. The software ANSYS Fluent has also been used to help us to simulate the tests.

This project aims future applications of WIG crafts (Wing-In-Ground crafts), it can also potentially provide conditions when crafts take-off and move in water area, which will help us to study how to improve the working efficiency.

Study of Wind Forces on Airfoils Being Closed To and Above Water Surface, at Different Angles Of Attack- (12cp)
Duc Anh Khong - A17-154

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Assessor: Thanh Nguyen
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Aerodynamics has several applications in different areas, such as aircraft and boats, rotors on helicopters, fan blades, sails on sailboats, and wind turbines. One of the essential components in every aerodynamic application is the airfoil, which generates the lift force when the airfoil deflects the airflow. There were many studies and investigations on airfoils in the past, however our team and supervisor notice that not many investigations on airfoil when it is being close to and above the water surface have been done. This study can potentially suggest most suitable conditions when an aircraft take-off and landing in the water area, to reduce its fuel consumption and improve its efficiency. Also, this project will investigate the primary application that I've envisaged for this project: WIG crafts (WIG = Wing-In-Ground, but most useful with crafts over the water).

This project aims to investigate the lift and drag forces and coefficients on airfoils when it is being closed to and above the water surface. Three situations will be considered: when the airfoil in "free" condition (not being near ground or water surface); when the airfoil near the hard surface (mimicking the ground) and when the airfoil near the water surface. The experiment will be conducted in different perspectives: three different shapes of the airfoil; different wind speeds; different height to the water surface; and different angles of attack. In the project, I am responsible for investigating when the airfoil is placed at different angles of attack.

The experiment will be physically tested on our self-built wind tunnel apparatus, and also being simulated by ANSYS Fluent. Hence, both experimental and computational results will be compared to the data from the literature. Based on our result, the most optimal condition will be suggested.

Enhancing Project Leadership Practice within Civil Construction Projects- (12cp)
John Ekechukwu - S17-185

Supervisor: Thorsten Lammers
Assessor: Dilek Cetindamar Kozanoglu
Major: Civil Engineering Major BBEBBus and BEBsc

Construction projects are one-of-a-kind undertakings with substantial global spending. Yet more failures are recorded than successes, often due to 'poor leadership' practice (Khan et al. 2015). And although research is beginning to pay more attention to project leadership, the industry itself has primarily focused on management, to the exclusion of leadership. Technological development within the industry is also heavily focused towards management, and thus the potential for digital technology to assist, in what appears to be an industry-wide 'leadership crisis', is yet to be realised. This research therefore aims to investigate digital transformation as a mechanism for project leadership development and/or enhancement within the construction sector. It uses a combination of literature reviews and critical analysis to construct a 'Six-C Model' of project leadership challenges; consisting of Character, Cohesion, Communication, Context, Culture and Control. Which is then validated within a live case study of a tier 3 civil construction company operating in Sydney, Australia.

Findings indicate, that digital transformation will have a positive influence on project leadership challenges and thus facilitate for project leadership practice and/or development. However, the magnitude of influence is segmented into two distinct modes; a direct influence on behavioural challenges of leadership (Character, Cohesion & Communication), and an indirect influence on situational challenges of leadership (Context, Culture & Control).

This research appears to be the first of its kind to investigate the potential of digital technology with respect to project leadership challenges within construction projects. It is therefore recommended that further research is conducted using the Six-C Model on a larger scale, to consolidate the applicability of 'leadership technology' within the construction sector.

Applying the TfNSW AEO Model to High Speed Rail on the Australian East Coast- (12cp)

Haran Delillo - S17-184

Supervisor: Ravindra Bagia
Assessor: John McCallum
Major: Civil Engineering Major BE and BEDipEngPrac

The delivery of a high speed rail network on the eastern coast of Australia would require a considerably coordinated approach to ensure optimum performance, efficiency and delivery of the network. Systems engineering offers significant benefits to managing the complexities of a project such as the high speed rail program. Accordingly, the AEO model, developed by Transport for New South Wales, is considered as a possible systems engineering model that may be applied to the high speed rail program.

This paper evaluates the extent to which the TfNSW AEO model is applicable to the high speed rail program and what modifications may be required to allow application.

This paper initially considers the structure and requirements of the AEO model and the requirements of the high speed rail program. It then evaluates the extent to which the systems engineering requirements and processes of the AEO model may be applied to the requirements of the high speed rail program. Lastly, it considers what modifications of the requirements would be needed to allow for a more tailored application.

This paper finds that the requirements and processes of the AEO model are, theoretically, applicable to the high speed rail program. However, they require modification to account for the more complex political and economic nature of the high speed rail program. In particular, the multi-jurisdictional influence of governments and authorities, the multi-staged integration of the network and the increased scale of effort required.

The research suggests further investigation into the inclusion and design of systems engineering practices for program management and delivery of high speed rail in Australia.

Kinematic Classification of Myosignals Exhibited During Elbow Flexion for Robotic Exoskeleton Control- (12cp)
Cameron Knox - S17-188

Supervisor: Marc Carmichael
Assessor: Sarath Kodagoda
Major: Mechatronic Engineering BE (Hons) Applied Physics BSc

Robotic exoskeletons are being used in a range of ever increasing applications such as assistive devices for people with disabilities and industry assistive devices to reduce risk of injury. Developing a control system for such a device is a difficult task. Interpreting a users' motion intentions is challenging and even more-so to generalise. The surface electrical potential generated by muscular activity is called a myosignal. This contains rich information to determine physiological kinematics and as a result has been a popular choice for the input signal for exoskeleton and robotic limb control.

This paper puts forward a method of collecting and processing myosignal data during static and dynamic elbow flexion for classification by a machine learning algorithm with the intention of controlling a robotic exoskeleton with the trained model. Though only elbow flexion is explored in this paper, the procedure is transferrable to studies of other limbs. A non-exhaustive search of literature determined that a Support Vector Machine (SVM) is an excellent choice as a controller over other architectures such as Artificial Neural Networks (ANN) due to its real-time computational advantages and lower requirements for amount of training data.

Raw myosignals are not ideal inputs to a system and a signal feature extraction is necessary. Continuous Wavelet Transformation (CWT) was applied to localise features in time and frequency domain and Principal Component Analysis (PCA) was used to reduce the high dimensionality of the wavelet transform. Prior to this, the signal was down-sampled to reduce the computational cost of training. Utilising this method, SVM classification rates exceeding 85% have been achieved for both static and dynamic elbow flexion, however the generalisation ability remains poor. This is expected to be due to inherent variation between data sets. Further development is required to effectively implement a functional controller in a real-time scenario.

Modernising Asthma Management; Personalised Asthma Action Plans (PAAPs) Using A Smartphone Application- (12cp)

Nikita Isaac - S17-178

Supervisor: Valerie Gay
Assessor: Ahmed Al-Ani
Major: Biomedical Engineering Major

Asthma is a chronic disease affecting one in nine Australians (Asthma Australia 2017). With symptoms such as coughing, wheezing and shortness of breath (Crosbie 2012) asthma can significantly impact a patient's quality of life. Asthma action plans are said to be one of the most effective asthma interventions available. However, in Australia only one in five people aged 15 and over, with asthma, have a written asthma action plan (AIHW 2016). Even less of which, refer to their plan. Upon conducting an extensive literature review, reasons for this underutilisation were found to be due to a common lack of understanding and knowledge regarding one's own asthma, combined with the inaccessibility of having the asthma action plans in a written form. In an attempt to mitigate these problems, this project focuses on the design and development of a smartphone application that can be easily downloaded and used, regardless of an asthmatics whereabouts or available resources. The application is currently a high-fidelity prototype that offers asthmatics a more appropriate referral medium for their asthma action plan. In addition to this conversion, the application incorporates aspects of the Internet of Things (IoT) whereby real-time data regarding environmental triggers such as temperature, humidity and pollen in asthmatics surroundings can be accessed from the app. This information is beneficial to asthmatics as these are common triggers of asthma flare-ups. Developments in mobile technology such as smartphones and the widespread, common use of smartphone applications could be the type of innovation required to combat the poor implementation and underutilisation of asthma action plans. The application ultimately aims to help asthmatics improve their health and quality of life by providing them, or their carer with the knowledge needed to better understand and manage their asthma when and where they need it.

Influence of Variable Wind Speed Conditions on Reliability of Different Wind Turbine Generators- (12cp)

Omar Alsaggaf - S17-187

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

With the continuous depletion of fossil fuel resources, and the exponential global increase of the energy demand, renewable energy has attracted more attention over recent decades for global energy production. Wind power is a free, abundant, and global source of energy, which has been utilised for thousands of years for local energy production. With the significant improvement of technology over recent decades, giant and efficient wind turbines have been designed to generate power and convert it to electricity using generators which have enabled the connection of wind power generated electricity to the global electricity network. One major factor that influences the operational efficiency of wind generators is the effect of variable and intermittent wind speed. Therefore, it is important to understand how different types of wind generators can respond effectively to the variable speed of wind.

A research on operational efficiencies of different wind generators under a wide range of wind speed scenarios is conducted. The main objective is to investigate the operational speed range of different wind generators and to discern the operational efficiencies of different wind turbine generators under different wind speed conditions.

Two main classifications of wind generators - fixed-speed and variable-speed - are studied. While fixed-speed generators are not efficient at high wind speeds, variable-speed generators have different operational efficiencies. Two different approaches to compare between operational efficiencies of different wind generators are considered. First, using the available empirical formula in the literature for each wind generator, efficiencies for specific wind speed distributions are calculated. Second, the experimental data available in the literature which represent power generation against wind speed in each wind generator are compared. Finally, a comprehensive table is provided which represents the flexibility and operational efficiency of each type of wind generator under various wind speed conditions.

Influence of Implant Geometry on Compressive and Torsional Load Bearing Characteristics of a Spinal Motion Segment Following a Nucleus Arthroplasty Procedure- (12cp)

Apoorv Parashar - S17-169

Supervisor: Ahmed Al-Ani
Assessor: Majid Ebrahimi Warkiani
Major: Biomedical Engineering Major BE and BEDipEngPrac

Lower back pain affects 70-80% of people on both a physical and emotional level. Back pain may originate from the intervertebral disc, which is an elastic structure between successive vertebrae consisting of two concentric layers surrounded by cartilaginous endplates. The outer layer is the annulus fibrosus which consists of collagen I fibres arranged in a ring like structure, which surrounds the inner layer, or nucleus pulposus, which is a proteoglycan-rich hydrated material intermixed with elastin, type I and II collagen fibres.

Disc herniation is one of the potential causes of lower back pain and occurs when degeneration in the annulus fibrosus causes the nucleus pulposus to protrude through the annulus. One of the treatments is to conduct a micro-discectomy procedure which involves the removal of degenerated nucleus material, in turn relieving pressure on the spinal nerve and thus reducing back pain. An injectable non-hydrogel based nucleus replacement implant can serve as a substitute for the lost material and can help restore stiffness to the spinal motion segment. This means that the endplates, nucleus, annulus, and the implant must interact in a more physiologically natural and healthy manner.

Cadaveric kangaroo lumbar spinal motion segments will be used as a model for the human spine as they possess similar vertebral body geometry, bipedalism, comparable adult body mass, and posture whilst also possessing intervertebral discs, which are most similar to humans compared to other animal models. The specimens will be tested in three different states: under-fill (-25%), complete fill, over-fill (+25%). The sample size for each group will be set at six specimens consisting of either the L3/L4 disc or the L5/L6 disc. The posterior elements will be removed leaving the vertebral bodies attached via the intervertebral disc and retaining the anterior longitudinal ligament and posterior longitudinal ligament. The specimens will be subsequently prepared and potted, after which they will be biomechanically tested in a six-degrees-of-freedom Bose Kinematic Spine Simulator in static axial compressions (500N, 5 cycles, 0.1Hz), static axial torsion (2Nm, 5 cycles, 0.1Hz) and dynamic axial compression (200N, 50 cycles, 0.5Hz, 1Hz, 2Hz).

It is envisaged that there will be a certain level of stiffness restoration within the specimens and that the implant geometry of the nucleus replacement implant will change based on the amount of biomechanical force applied on it.

Potential Benefits of Recirculating Municipal Solid Waste Leachate in Landfills for Renewable Energy Generation in NSW - (12cp)

Susan Fuentes-Torres - S17-008

Supervisor: Hadi Khabbaz
Assessor: Leonard Tijing
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Australia is one of the richest countries in the developed world, yet we send 20 million tonnes of waste to landfill every year. That is almost 1 tonne of waste annually per person. Although landfill numbers in Australia are decreasing, the average size has increased. As the population grows and cities expand, the isolated landfills are now being found alongside suburbia. Thus causing a hazardous risk to both the environment and the health of those who come in contact with landfill emissions. Landfills generate both liquid and gaseous emissions, leachate and landfill gas, respectively.

Over the past 50 years, Sanitary Landfill design has progressed to such a point where landfills are now engineered to allow the emissions to be used in a more cost-effective and sustainable manner. Bioreactor Landfills offer a faster waste settlement process consisting of moisture, nutrient, and microbe-induced biodegradation. In an anaerobic bioreactor landfill, leachate is collected and recirculated into the landfill to enhance the degradation process cutting the waste detention and settlement time from 50+ years to 15-30 years. The outcomes include improved leachate treatment, increased landfill space, reduced environmental impacts, enhanced gas generation, and reduced operating and maintenance costs. The increased gas generated is captured and used as renewable energy.

This project l focuses on how to optimise the municipal solid waste (MSW) landfill design in NSW by means of implementing Bioreactor Landfills. It explores implementation obstacles, and suggests reasons why NSW will benefit from Bioreactor Landfills. The end goal is to create awareness of the increasing waste problem that Australia has, and how it can be combated. A user-friendly calculator is created to demonstrate the waste retention capacity of landfill areas using the leachate recirculation, and the CO2-e gas generated by the waste, which can be used for energy production.

Analysis of Privacy Implications on the Internet of Things in the Home - (12cp)
Thomas Bruerton - S17-212

Supervisor: Ravindra Bagia
Assessor: John McCallum
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

Through the continual expansion of the Internet of Things (IoT), more and more connected home appliances and other 'smart devices' are becoming prevalent in peoples' homes. Connecting these devices to the internet provides the benefit of improving the experience of living in a 21st century connected world. With this benefit, the notion of privacy is being dismissed due to the lack in knowledge and awareness of the consumers' using these devices.
The absence of privacy policy regulation, controversial data retention laws, private-sector investment and underexposure of known risks, everyday consumers are unknowingly handing over their personal and private information to private organisations and government entities. This data is then stored and can be analysed, sold and distributed for commercial or political gain.
This project investigates the privacy risks of consumers using IoT devices in the home environment. By conducting research and a consumer consultation, it has been made evident that the technical and political complexity of IoT privacy regulation is shadowed behind the lifestyle benefits and simplicity of using the technology. The project identified that consumers are not aware of the privacy violations and risks that they are being exposed to and their current and future impact.
The intricacy of political and commercial reform required to protect consumers from the violation of privacy and risks of using IoT in the home is a significant challenge. The project has found the most feasible way to resolve these privacy violations and risks is to educate consumers on the real impact they may face, empowering them to fight for their right to privacy. By putting the power in the hands of the consumer, the current legislation and regulations will have to be addressed and adapted by governments and businesses to protect all who use IoT devices within the home.

Application of Techniques and Processes in Effectively Managing High Rise Construction Complexities - (12cp)

John Voudouris - S17-011

Supervisor: Emre Erkmen
Assessor: Ali Saleh
Major: Civil Engineering Major BBEBBus and BEBsc

A concept which has gained increased momentum and consideration within the construction sector is the added complexities that lie within high rise construction projects. The increasing competition for work and the demand from society to continue to build high rise construction, while still achieving and exceeding the triple bottom line of social, environmental and financial aspects has resulted in increased pressure for such organisations to identify techniques in which they are able to employ to effectively manage high rise construction complexities. High rise projects have a large degree of complexity that exists in areas as significant as time, quality and safety constraints. As a result, high rise construction companies must focuses their energy on developing and improving their current techniques and processes to enable complexities to be effectively managed. Forward planning and consideration for the corrected techniques and procedures to adopted on high rise construction projects can ultimately lead to a higher likelihood of project success. Without this, possible instability and project failure may be experienced due to overrunning of time, safety issues resulting in closing of sites and quality issues ultimately leading to an organisation reputation harmed.

The project will consist of a combination of both construction techniques and processes in areas of construction, programming, safety and quality techniques in which will be presented through the completion of a theoretical review. In order to be able to relate this to a practical sense, interviews from a selected range of high rise construction contractors have been conducted, enabling a gap between theory and practice to be identified and an alignment of the concepts discussed within the theoretical frameworks researched and with industry process practice.

The studies ultimately endeavour is to give the reader an understanding of high rise construction complexities, firstly exploring these areas in a theoretical sense and then exploring five organisations in a practical outlook. It will provide an insight to the engineering and construction community in what is understood as best practice in the industry which overall achieves project success in these areas. The project findings have lead to identifying that the utilisation of the corrected techniques and processes are vital in effectively managing high rise complexities. Furthermore, the interviews findings have identified that the concept of high rise construction management and their complexities, is heavily depended on the experience, correct resourcing and forward planning of projects. The barriers preventing high rise construction organisations from implementing the corrected techniques and processes to effectively manage complexities, were identified as time and resource related factors. Through research findings and an analysis of the organisations interview responses, a technique and process action table has been developed in order to act as a framework for high rise organisations to employ.

The focus of this project is to enhance the reader's knowledge in areas of high rise construction complexities and explore the techniques and processes that can be employed by organisations to assist them in effectively managing high rise projects. The findings of this project are presented, drawing conclusions and recommendations for further research studies in this area.

Evaluation of Structural Systems in Slender Buildings - (12cp)
Patrick Walsh - S17-312

Supervisor: Ali Saleh
Assessor: Harry Far
Major: Civil Engineering Major BE and BEDipEngPrac

With the rapid population growth and increasing urbanisation in recent years, creating tall structures has become an increasing more relevant and viable option for both commercial and residential housing. With big cities today facing a growing need for housing, and a lack of developable space, the recent trend is not only to build tall, but slender as well. These slender structures are capable of maximising the floorspace that can be achieved from a relatively small building footprint.

This project investigates the different structural systems available for slender buildings and evaluates their structural performance and feasibility. Through examining how the different structural systems perform in buildings of varying height and floorplan, this project determines the most suitable structural systems for the new generation of slender skyscrapers.

Using several finite element analysis models, the capstone report compares which structural systems achieved the maximum developable floorspace under strict overall deflection limits. These competing superstructure designs were then also analysed in terms of their functionality, cost, and value proposition.

The evaluation of these structural systems in slender buildings, that has been undertaken in this capstone project, will be greatly helpful to the greater structural engineering community. Structural engineering firms are likely to receive increasing requests for these slender towers as developers seek to make the most of their expensive land purchases. Additionally, this project discusses the architectural, social and financial consequences of creating slender towers, benefiting architects, investors and developers.

Utilising Building Information Modelling Techniques to Optimise Design and Documentation of Structural Steel Connections - (12cp)
Nathan Aubrey - A17-034

Supervisor: Anne Gardner
Assessor: Harry Far
Major: Civil Engineering Major BE and BEDipEngPrac

Building Information Modelling (BIM) involves using software to design and document a project whilst also inserting vast amounts of information for future use. In construction projects, architects use these techniques to implement full life-cycle designs into the building from day one. Services consultants can use these techniques to host valuable information about plant equipment and life cycle maintenance requirements. Civil and structural engineers are increasingly finding that they must be competent BIM users to win new work on major projects and it is important that they take full advantage of the flexibility that it offers.

The purpose of this project was to determine whether BIM techniques can be used to streamline the design and documentation of structural steel connections such that changes take less time to make and errors are less likely to be made when compared to conventional approaches.

A widely used software package was adopted to design steel connections with in-built load capacities that would automatically update themselves in the model as the design changed. These connections were then used on an example project. The time taken both to firstly apply them and subsequently to fix them if the design changed was compared to more conventional methods of design and documentation.

It was found that structural steel connections that took advantage of BIM techniques were both quicker to place in the model initially and to correct if the design subsequently changed. Drawings were also less likely to be issued containing errors.

It was concluded that rather than simply using BIM software to remain compatible with other consultants, structural and civil engineers can and should take full advantage of the potential these systems offer. The potential of BIM software to change the way consultants approach projects is already widely known and used, however civil and structural engineers are in many instances not using it to its full potential. This project dealt specifically with structural steel connections but there is no reason why these methods cannot be applied to the design and documentation of many other structural elements.

Employing a Virtual Reality Interface to Enhance Large-Scale Infrastructure Inspection Capabilities - (12cp)

Joshua Henderson - S16-033

Supervisor: Gavin Paul
Assessor: Dikai Liu
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Major recent advances in inspection methods for large scale infrastructure have arisen through the use of remote sensing and robotics. Associated User Interface (UI) methods using 2D screens to view 3D information present a number of drawbacks including ambient lighting interference and other onsite environmental distractions. With the advent of cheaper Virtual Reality (VR) headsets in the past few years, it has become increasingly viable to use them in this application.

This project aims to create a VR environment to allow a more immersive user experience specifically for the detection of rust and other defects on internal structures of the Sydney Harbour Bridge. The creation of this Virtual environment utilizes 3D data captured by a climbing robot being developed by UTS.

An extensive literature review was conducted to determine the state of the art in terms of methods of locomotion and interaction within a VR environment together with intuitive menu design. Arising from this, a number of VR headsets were examined for suitability including the Gear VR and HTC Vive. In order to assess these headsets, a testing environment was created to examine various methods of interaction and navigation. This was then evaluated by participants against several criteria including time spent to navigate the virtual environment, level of discomfort experienced during the test and accuracy and completeness of various inspection tasks.

Results from this study and research confirm that Virtual Reality has the potential to overcome many of the problems with current UI methods in inspection applications. This project lays the foundation for further research into areas such as teleoperation of the robot from a VR environment and real time viewing of 3D data captured.

Reducing the Impact of Passenger Behaviour on Dwell Times along the Inner West Light Rail Through an Improved Passenger Guidance Program - (12cp)
Igor Mileusnic - A17-308

Supervisor: Michelle Zeibots
Assessor: Claudine Moutou
Major: Civil Engineering Major BE and BEDipEngPrac

The Inner West Light Rail has experienced unprecedented growth with patronage increasing some 250% since 2009. A sizable portion of this growth has occurred between 2014 and 2016, since the opening of the Lilyfield to Dulwich Hill extension and increases in service frequencies. The increased demand for services has created several operational and customer experience challenges as the network approaches capacity.

This study examines the dwell times now experienced at key stations along the route and how passenger behaviour can affect the duration and impact on operations. Analysis of data identified three key stations that regularly experience increased average dwell times — The Star, Pyrmont Bay and Convention. These stations have longer average dwell times and often experience dwell time 'blow outs' that increase end-to-end run times that negatively impact on customer experience and operational efficiency.

This project aims to develop several solutions that firstly minimise average dwell times at these stations and secondly, reduce the frequency and duration of dwell time 'blow outs'. This is achieved through the development of a Passenger Guidance Program (PGP) — a set of communications and actions intended to optimise passenger flow by helping individual customers to better navigate the service and so reduce the negative impacts of whole-group behaviour. Example solutions included within the PGP include:

- Announcements to help passengers board and alight from services more quickly
- Announcements to guide and remind passengers to move into the tram to increase capacity
- Optimising platform configurations to improve passenger flow and help ease movement
- Introduce marshalling staff at highly congested stations to help coordinate large crowd movements

Reductions in dwell times along the route would provide a significant difference in the daily operation of the network. By reducing the magnitude of dwell time 'blow outs', redundancy built into the timetable to accommodate problems can be reduced, enabling more efficient and reliable services to be provided to light rail customers.

Design and Development of a Cable Suspended Robot - (12cp)
Jeremy Loosli - A17-043

Supervisor: Jaime Valls Miro
Assessor: Shoudong Huang
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The Australian building and construction industry is one of the fastest growing but also one of the slowest to adopt new technologies and innovation. One of the most valuable developments in this space over the last decade has been the concept of Building Information Modelling (BIM). BIM is a virtual information package which contains technical drawings, design concepts and parametric information used in the design, construction and maintenance of large scale construction projects. Whilst in theory the implementation of BIM provides a wealth of opportunity to improve the efficiency and accuracy of construction projects, all too often there is a distinct lack of necessary data input to create a comprehensive model.

A key feature to improve the productivity of BIM has been identified as the ability to create faithful “as built” virtual models of buildings and structures as they evolve in the building site. Use of a cable suspended robot equipped with a 3D scanner to continually observe and track site progress can fill the data gap which exists. Additionally, current site intralogistics practice utilises imprecise methods of resource tracking and management. As a result, materials often become damaged, lost or misplaced on site and require the attention of multiple skilled and unskilled workers to rectify. The introduction of an autonomous cable robot to perform tracking, handling and distribution of materials on site could greatly reduce the cost overrun associated with more traditional approaches.

This project follows the development of a scale cable suspended robot to demonstrate the potential for a marketable product for the building and construction industry. The prototype features 3D camera sensing, a controllable gripper and four independently and wirelessly controllable winch motors. Utilising distributed hardware and software, a simple app has been developed to facilitate controlled manoeuvring, scanning procedures, and pick and place operations.

Renewably Powered Biorock Reef - (12cp)
Ryu Lippmann - A17-045

Supervisor: Terry Brown
Assessor: Bruce Moulton
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

This project has been undertaken to address and restore damaged and degraded coral reef ecosystems. These ecosystems add quantifiable benefit to human life through tourism, food and coastal protection. While there are existing methods of regrowing coral, the focus of this project is to do so whilst minimising adverse impacts, achieving an environmentally sustainable solution.

Working in response to a project with Gili Eco Trust, this project was primarily concerned with the powering of a Biorock reef solution. Powering a Biorock reef using renewable energy, preferably tidal, was the focus of this project. Research and analysis were undertaken in regards to system demands, requirements and environmental characteristics of the specific problem. Existing solutions were analysed, and a renewably powered location-appropriate design was explored. From this, an informed recommendation of key characteristics for effectiveness and efficiency has been made. The client expressed a clear intention of using a water turbine generator to power the structures, thus its use as a solution has been fundamental to the project.

A feasible generator for the demands of this project was sourced and recommended which circumvented the design and construction of a prototype. Further analyses regarding the financial breakeven point and sensitivity of the solution have been made. Analysis of world markets has been explored through mapping areas where there may be a demand for coral reef regeneration, as well as water current availability as a water turbine power source.

This research and analysis will allow Gili Eco Trust to create an environmentally and financially sustainable reef regeneration system. This system can be used as a benchmark and example for other projects in the area or with similar environmental conditions, as well as elsewhere around the world.

Aerodynamic Analysis and Diffuser Design for Formula SAE - (12cp)
Radoje Radovic - A17-051

Supervisor: Jon O'Neill
Assessor: Bruce Pearson
Major: Mechanical Engineering Major BE and BEDipEngPrac

Aerodynamics are a major part of any vehicle design process and it is important to understand the fluids interaction with the vehicle. This project focuses on the analysis and visualisation of the air flow around the UTS Formula SAE vehicle, an open wheel race car. By exploring the rules of the competition present by SAE International along with numerous texts on aerodynamic analysis and design, this project has been able to identify key components around the vehicle that contribute to lift and drag through CFD leading into the design and implementation of aerodynamic components to improve the vehicles overall performance.

The first stages involved were creating new models for the vehicle appropriate for CFD. This involved simplifying many components to reduce computational resources, improve mesh quality and allowed the simulation to be performed over more iterations. Key components contributing to lift and drag, such as the front wheels and chassis, generate large vortices that affect the surrounding airflow.

Using the design principles from vehicle aerodynamic texts components such as the barge boards, sidepods and floorpan with diffusers were designed and tested through CFD to validate their effects with each having a specific purpose. The floorpan create a flat plane on the bottom on the vehicle to separate the airflow from top and bottom and in conjunction with the diffusers assists in pulling air out from underneath the vehicle. This is the primary generation of downforce and has a minimal contribution to drag. While the barge boards and sidepods have been implemented to improve air flow above the vehicle with the barge boards generating vortices to direct the tyre wake away from the vehicle, and sidepods to improve airflow into the radiator.

The result is an aerodynamic package that improve the aerodynamic efficiency of the vehicle while minimizing the effects of drag. This in turn improves lap times, competition points and without having a negative effect on powertrain efficiency.

Guitar Playing Robot - (12cp)
Luke Coffey - A17-052

Supervisor: Sarath Kodagoda
Assessor: Marc Carmichael
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac| Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

There is a preconceived idea held by the general public that traditional engineering is not innovative or creative. The idea of developing a robotic guitar was seen as a way to engage the general public with a STEM related project that was outside the stereotypical realm of engineering. By developing a musical robot I hope to inspire the younger generations to pursue STEM studies. I decided to pursue this project as I believe that inspiring future generations to pursue STEM studies will encourage innovation and creativity, which hopefully will be directed to furthering technological development.

My capstone project, which I nicknamed LUCY, is a free-standing robot that was designed to play majority of guitar songs. Originally, I designed a single string system which I then replicated to create a 6 stringed robotic guitar. The single system also has the capability to be redesigned to create a multitude of other robotic stringed instruments. At the submission of my capstone my prototype version of LUCY can play some songs and a variety of different chords.

After my capstone submission I plan to reiterate the design of LUCY to develop a finished product. I will also be speaking to different organizations that have expressed interest in acquiring a robotic guitar. Through this I plan to develop more musical robots to showcase in exhibitions and exhibits. This in turn should allow me to continue engaging the general public with musical robotics. I also plan to take LUCY busking to further engage the general public. I will use this to get more feedback on LUCY's redesign so that the final product will be more appealing.

The Design and Optimisation of a Formula SAE Driveline - (12cp)
Michael De Palo- A17-284

Supervisor: Jon O'Neill
Assessor: Bruce Pearson
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

Formula SAE is a global student competition involving the design, manufacture and testing of a single seater race car. The University of Technology, Sydney has been competing in this competition for almost two decades, firstly with an internal combustion vehicle but more recently with an electric vehicle. The electric powertrain has a high potential for performance but requires carefully considered design work to maximise this potential. This project involved the design, manufacture and implementation of a single speed driveline for the 2017 UTS Motorsports Electric team. This design then provides a basis upon which optimisation can be completed for the team's 2018 driveline design. This second phase three key sub-stages: the justification of implementing a gear box, the selection of ideal ratios and both high and low-level design and analysis.

A simulator was developed to first justify the implementation of a gearbox and then determine the ideal ratios for specific electric motors. This comparison was made using a Formula SAE competition points analysis across four global events and determined both the ideal ratios and electric motor to achieve the most points in any given competition. The Emrax 188HV poly-phasic synchronous motor was the most ideal when combined with a two-speed gearbox with reductions of 9:1 and 6.6:1.

From this, a hybrid planetary-constant mesh transmission was designed to achieve these ratios given manufacturing, packaging and weight constraints with a belt drive to the rear differential. This combination provides the ideal balance between torque, top speed and efficiency for the vehicle in any given Formula SAE competition.

Post-Tensioned Concrete Design: Analysis of Sustainable Design Practice and Recognition within the Australian Green Star Certification - (12cp)

Jonathan Maude - A17-060

Supervisor: Anne Gardner
Assessor: Shami Nejadi
Major: Civil Engineering Major BE and BEDipEngPrac

Green Star Certification from the Green Building Council of Australia provides independent verification that a building or community project is sustainable. This is measured by achieving a specific amount of credit points across a range of fields. There are already specific credit points for reducing the amount of Portland cement used in concrete structures as well as sourcing the reinforcement from specified suppliers. Reinforced concrete is a composite construction material consisting of steel reinforcement encased in concrete. With a high tensile capacity the reinforcement compliments the compressive capacity of the concrete. Post tensioned concrete, an innovative approach to the design and construction of suspended concrete slabs, induces compressive stresses within the slab caused by the specific placement of steel cables as reinforcement. These internal forces balance the external forces which lead to a more efficient design.

This paper seeks to compare the material quantities for post tensioned concrete design and reinforced concrete design. Thus demonstrating that post tensioned concrete is a more efficient design method as it uses fewer materials. Therefore criteria for post tensioned concrete should be developed into a credit point(s) for Green Star Certification.

A suspended concrete slab with a constant span length is analysed by the different methods of post tensioned concrete design and reinforced concrete design. The quantity of materials required for each design is then compared to see which approach is more efficient. This analysis was repeated for different support layouts to demonstrate how different span lengths will affect the efficiency of each design method. Three industry- recognised engineering software programs were used to design the concrete slabs with the results being collated and presented clearly for analysis. The parameters for each concrete slab remained constant for both design methods to ensure that the only variables were the quantity of concrete and reinforcement used.

The analysis found that 20%-33% less concrete and 54%-66% less reinforcement is used by post tensioned concrete design when compared with reinforced concrete design. This reduction in material correlated with a greater span length between supports.

This study shows that when compared to reinforced concrete design, post tensioned concrete is a more efficient design method due to significant reductions in material quantities for the same slab. The reduction in materials is similar or greater than the current requirements for the concrete and steel credit points. This is a strong basis for recognition within the Green Star Certification credit point system and this project recommends the development of credit points that recognise the sustainability and reduced environmental impact of post tensioned concrete design.

Beacon-Based Indoor Localisation Solution for Android Smartphones - (12cp)
Kevin Casareo - A17-063

Supervisor: Zenon Chaczko
Assessor: Jan Szymanski
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

The indoor environments that we live and work in are complex spaces to navigate through and inspect. In a disorganised spaces such as warehouses, construction sites or even offices, it is intuitive for a human being to understand where they are, but not so for a computer system. The concept of utilising software to determine position is hardly novel – the Global Positioning System, for instance, is one such implementation of a localisation system that is used everywhere. The problem lies in finding an effective algorithm that could be employed by a software system to approximate the location of an object in an indoor space that will act as a suitable substitute for GPS.

This project aims to demonstrate a system that can act as an effective substitute for GPS indoors. To do this, consumer Bluetooth Low-Energy (BLE) devices (TI Sensortags) are employed as beacons and the ranging limitations and signal reliability are investigated when these devices are placed indoors. This is performed to provide middleware that other software developers could utilise to create applications that can localise a smartphone in an indoor space. The use of this middleware solution is demonstrated with a testing application.

Software that could pinpoint the location of a specific object, such as a smartphone application, would be valuable in places such as construction sites and mines, where it could be used to track the location of employees in those hazardous locations. It could also be incorporated in the robotics field, providing a means for pinpointing a drone whilst in transit to aid in the vehicle's navigation or for recovery in the event of catastrophe.

Concept Design of a Variable Compression Ratio Engine - (12cp)
Kendrick Cheng - A17-072

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

The internal combustion engine has been in use for over a century, and is in need of advancements to ensure it remains efficient and emissions friendly. Recently, variable compression ratio mechanisms have been developed to explore a fundamental aspect of the ICE to improve its performance and efficiency at all stages of loading.

The aim of this project is to explore the reasoning for the variable compression ratio, the different mechanisms currently available, and to develop a suitable model to visualise how it functions. The mechanism that was explored in depth was the multi-link mechanism developed by Nissan, which is also approaching final production.

It was found that the multi-link was most suitable due to the extensive development already performed by Nissan. In addition, the author's own analysis of the feasibility of the mechanism compared to the other available ones was found to be extremely positive for the multi-link design. The rigidity of the engine and combustion chamber integrity are unchanged from a regular engine, while the variation of the compression ratio is both accurate, and very controllable. However, the likelihood of converting a regular engine to VCR is very low, and there are somewhat increased mechanical losses and deteriorated crankshaft to piston kinematics.

The kinematic analysis performed through MATLAB and Monte Carlo analysis resulted in a variable compression ratio range between 7.98 to 13.74 (effectively 8:1 CR to 14:1 CR). The subsequent finite element analysis determined some critical points in the initial design that needed to be addressed, and after this was completed, the model was created through 3-D printing the components. To verify the mechanism, the engine was not considered to be operable under normal circumstances, and does not have lubrication or cooling capacities. As such, the results presented can be used to aid in the design of a fully functional variable compression ratio engine for production cars.

Improving the Level of service of the Sydney Inner West - (12cp)
Joel Smalley-S17-220

Supervisor: Michelle Zeibots
Assessor: Greg Southerland
Major: Civil Engineering Major BE and BEDipEngPrac

This report investigates the implementation of traffic signal priority to the Sydney Inner West Light Rail. By providing signal priority on Hay Street, customer travel and end-to-end run times can be reduced and trip-time consistency improved thereby upgrading transport services for the people of Sydney.

Light rail signal priority delivers a cost-effective solution to minimising run-time. Only operational changes are required with no new infrastructure purchases. Additionally, if end-to-end run-time of the Inner West Light Rail is reduced by four minutes, one less rolling stock and light rail crew can be used to maintain the current Level Of Service which also potentially improves farebox recovery.

This report examines the expected time saved when the Inner West Light Rail receives varying forms of signal priority on Hay Street, as well as assessing impacts to run-time, trip-time consistency, signal operations, road congestion and passenger throughput. Furthermore, operational changes will be proposed, including unconditional priority and signal phasing changes. For each proposal, benefits, risks and impacts to customers and operators, amongst other stakeholders, is identified.

A key finding of this investigation is that by providing priority signaling for light rail the throughput of people at intersections can be increased significantly because of the much higher carrying capacity of mass transit.

The outcomes and potential benefits of signal priority for the Hay Street intersection has implications for the other intersections along the on-street sections of the line.

An Investigation into the Effectiveness of Foam Pit Systems and Airbag Systems - (12cp) Trent Pickup - A17-089

Supervisor: David Eager
Assessor: Chris Chapman
Major: Mechanical Engineering Major BE and BEDipEngPrac

Foam pits were once exclusively used by gymnasts and action sports professional athletes. In more recent years they have become more accessible to the general public through recreational trampoline park facilities and indoor skate park facilities.

The primary purpose of a foam pit is to increase safety during dangerous manoeuvres. The injury data confirms that they nevertheless still pose a risk of injury to the user. Most users of foam pits are unaware of the dangers of incorrect use including head first falls and/or awkward falls from heights or a fall that allows them to penetrate through the foam to the bottom of the pit. Individuals using an incorrectly designed or filled foam pit can “bottom out” causing them to injure themselves on the hard foundation flooring beneath. Currently there are no national standards for the design, construction and characterisation of foam pits.

This project aims to assess the effectiveness of common foam pit configurations and air bag systems currently used within the trampoline industry together with alternative improved safety systems not currently in use. This involved testing various foam pit configurations from a controlled height and measuring the forces and neck extension experienced using an anthropometric dummy.

The results of this project will assist the both the general community, Australian health system, the trampoline industry, world-wide gymnastics and the engineering community. The method of testing the foam pits using test dummies and variable parameters will serve as a standardised way of testing. It is hoped that the results of this project, and others related projects, will led to an Australian Standard being published that ensures that a minimum safety threshold for foam pits is implemented across the country. This will ultimately result in a reduction in the frequency and severity of foam pit related injuries.

Investigation into the Impact of Ultracapacitors on Voltage Sag in and FSAE Electric Vehicle - (12cp)
Dylan Callender - A17-335

Supervisor: Jon O'Neill
Assessor: Peter McLean
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The ability to provide constant unmodified electrical power to the motor of an electric vehicle greatly effects reliability, drivability and performance. Voltage sag is a phenomenon that effects high discharge batteries under increased load where the overall battery pack voltage drops below its current charged voltage. In small battery packs such as in the UTS: Formula SAE Prototype Vehicle voltage sag negatively affects the ability to accelerate and reach peak rpm.
The aim of this project was to determine the viability of use of Ultracapacitors to replace or work in parallel with batteries to negate the effects of voltage sag. Viability is determined by cost, energy density and weight where these factors are compared to an average FSAE team's budget and design. Improvement in performance is evaluated in with an increase in competition ranking through a simulation of available points.

To test the effect of Ultracapacitors on voltage sag a static discharge apparatus were used to imitate real world discharge characteristics. Encompassed in this capstone was the design and prototyping of both a throttle imitation PCB as well as a Ultracapacitor mounting PCB. These allowed for the discharge of a single segment of the battery pack allowing visualisation of voltage sag modification with real world throttle application.

This project aims to establish the basis through which the UTS team can develop a parallel Ultracapacitor \ EV battery powertrain for use in the FSAE competition in 2018.

Heartbeat Monitoring & Patient Monitoring System - (12cp)
Bao Viet Vo - A16-139

Supervisor: Peter McLean
Assessor: Steven Su
Major: Electrical Engineering Major BE and BEDipEngPrac

The Internet of Things (IoT) is becoming a fast growing industry in this modern age. IoT refers to the general concept of gathering and collecting data around us and sending it to the Cloud where it can be processed and utilized for useful purposes. For the health industry in particular, many IoT products have been created in recent years and they have quickly gained popularity such as smart band, smart watch, and smart ring. However, most of these products are for personal use and it have not been developed for large system use such as in a hospital.

My aim with this project is to prove the IoT concept by developing an IoT application called Heartbeat Monitoring. The main function of this device is to transmit a patient's heart information to the Cloud and to display on a device such as a smartphone or PC. A prototype was developed to analyse different options of network model for the IoT concept. Based on the prototype, the model can be leveraged to a system called Patient Monitoring System. The main function of this system is the ability to monitor multiple patients at once with up to nine sensors. Patient data can be stored on a local network server and database. This data would be available for nurses, doctors and officers in-charge to monitor patient health.

The Impact of Climate Change on Energy Consumption of HVAC Services in Residential Buildings - (12cp)

Jason Gravanis - S16-089

Supervisor: Paul Walker
Assessor: JC Ji
Major: Mechanical Engineering Major BEBBus and BEBSc

The mechanical building services industry provides HVAC (Heating, Ventilation, and Air-conditioning) services to a large array of building sectors including residential, commercial, corporate as well as health and education. HVAC systems are typically designed around satisfying comfort and/or critical conditions. With an increasing trend in greenhouse gases, it is anticipated that surface air temperatures will continue to rise as well as extreme weather. Given this trend, it is assumed that HVAC systems will continue to see an increase in energy required to satisfy the same comfort and/or critical conditions.

This objective of this technical paper aims to explore the impact of climate change on the mechanical building services industry. The focus is on utilising known climate data to observe and compare the energy requirements of an average Australian in the last 37 years. The average Australian home has been modelled to meet minimum thermal resistance values using the 2016 National Construction Codes. In alignment with global greenhouse gas emissions, the decades 80's, 90's and 00's have been used for the investigated time periods. The model was built utilising industry-grade software CAMEL (Carrier Air-conditioning Method of Estimating Loads).

The CAMEL model has generated discussion as well as recommendations in how the issue of increasing energy requirements can be tackled. Recommendations look to explore on micro-levels such as whether the minimum thermal resistance values of housing materials should be increased as well as macro-levels, how climate change can be tackled. While having limitations, further investigation using this methodology could bring on sustainable solutions in the building services industry.

An Engineer'S Responsibility – A Theoretical and Practical Analysis into the Ethics of Engineering - (12cp)
Christopher Weston - A17-096

Supervisor: Jon O'Neill
Assessor: Terry Brown
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

The environment in which a modern professional has to operate within can be seen as relatively dynamic, particularly regarding the societal expectations for professional ethical behaviour.
But are engineers held to a different ethical standard than that of other modern professions, and what effect does this have on the decisions made by an engineer during the design process.

An in-depth analysis into the current state of ethics within the engineering community is best provided through a look at both the theoretical and practical components of engineering.

The theoretical analysis provides the history of ethics within the profession of engineering moving into the modern era, questioning what major events have led to the development of the modern codes of ethical conduct that all engineers must operate within. Beyond this, we look to address the question of whether an engineer is accountable for not only the safe and successful technical completion of their project, but also the potential outcomes of that project being completed in the first place.

The practical analysis into engineering ethics is designed to work in conjunction with the theoretical analysis, that being to question the accountability of a modern engineer when working on projects that society may question as ethical. The practical example in this case is a semi- to fully- automatic firearm conversion unit, a device that turns a legal weapon into one that that has the potential to operate in an illegal manner.

Overall, the intention is look into the future of engineering and the ethical requires that we will be expected to operate within. The expectations of society for all professionals, inclusive of engineers, have always been trending upwards, the question is whether the engineering community has taken enough steps professionally to keep up with society's standards.

Wearable Heart Rate and Activity Monitor that can be Centrally Monitored for Large Scale Deployments - (12cp)
Roshan Tillekeratne - A17-098

Supervisor: Peter McLean
Assessor: Jan Szymanski
Major: Electrical Engineering Major BE and BEDipEngPrac

Over the last few years, there has been a surge in the popularity of wearable technology, with a focus on fitness and health tracking. Most smart watches and fitness bands currently available include accelerometers for detecting movement, whilst a growing number of them now also include additional sensors for measuring metrics such as heart rate, blood oxygen concentration and temperature. One of the main downsides of most of these devices is that they were primarily designed to act as a companion device to a smartphone, limiting the potential applications of the devices.

One such application is the use of an inexpensive smart band as a large-scale health monitoring system, which could be utilized in both the health care and aged care industries. By eliminating the connection between the wearable device and a smartphone, instead directly connecting it to a network, an end to end system can be designed where multiple devices can transmit any data they have gathered to a central monitoring system, allowing all the devices to be monitored simultaneously from a single point. My thesis investigated the feasibility of creating such a system.

I have created a scaled down, end to end functional prototype of this system, which consists of two main components; the sensing device and the monitoring system. The sensing device obtains health data from an optical heart rate sensor, which is then processed and sent wirelessly to the monitoring system. Communications between the sensing device and monitoring system will occur over a Wi-Fi network. The monitoring system operates as a web application, allowing the sensors to be monitored using only an internet browser. The system has been designed such that the only requirements for operation are; the sensors, a web server and a Wi-Fi network.

Feasibility of Retinal Oximetry Using a Smartphone-Based Opthamology Imaging Tool and Application - (12cp)
Mathew Mason - A17-100

Supervisor: John Canning
Assessor: Mojtaba Golzan
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

Retinal oximetry is a non-invasive method of measuring an individual's blood oxygen saturation through the vessels located in the back of the eye. Beyond simple measurement, these results can potentially determine early symptoms of eye diseases such as glaucoma.

The project entailed designing and fabricating a smartphone-based ophthalmology imaging instrument. The focus was to measure oxygen levels in the eyes through spectral colour changes related to oxygenated haemoglobin. When oxygen is in the blood, absorption in the green spectral region increases relative to the red, offering a simple spectroscopic or colorimetric approach to its identification. It is in the basis of hospital oximetry used in surgery and in consumer smart band devices used to measure pulse rate. This project will demonstrate its potential in ophthalmology to produce a portable, low cost instrument which can be deployed in the field, including but not limited to, resource limited environments, as a health diagnostic.

The instrument is composed of low cost light emitting diodes (LEDs), which produce light in the red and green wavelength regions of the visible light spectrum, acting as the source of illumination for the imaging and colorimetric identification. These LED's are controlled by an Arduino circuit, which allows an operator to modify the lighting intensity. For high quality imaging over and above that of the smartphone alone, a bio indirect ophthalmoscope (BIO) lens is used to obtain focused images of the optic disc, located at the back of the eye. The entire setup is facilitated by a 3D-printed frame.

The results obtained show the method is feasible – a difference between red and green show clearly highlighted blood vessels as a result of the differences in absorption between the two LED outputs.

Recycled Asphalt in Road Pavements – A Focus on Local Government Applications - (12cp)
Dean Garroway - A17-102

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

The use of Reclaimed Asphalt Pavement (RAP) in Local Government is an ongoing issue which requires an ideal solution. With the commencement of each financial year, new road resurfacing, reconstruction and maintenance programs are funded to repair and rebuild existing pavements which are failing under heavy traffic loads. All the RAP which is removed from the surface of these roads is not utilised in the most economic and sustainable manner. As Sydney is in a significant growth phase at the present time and shows no sign of slowing down in the next decade, more road pavement materials will need to be sourced. The supply of common materials will be in high demand so it is crucial that an alternate solution is found immediately.

To investigate this constant problem, an industry analysis has been completed whereby seasoned professionals in the road pavement industry were interviewed and asked a series of set questions. This process formed the basis for the experimentation phase of the project which assessed and analysed the ability for RAP to be compacted to satisfy Australian Standards whilst keeping the engineering integrity of the materials intact.

Common practice in modern pavement engineering is to replace virgin aggregates in new, conventional asphalt mixes with recycled asphalt which has seen some success though not in an overwhelming capacity. This process is time-consuming and expensive. The findings of this report indicate that RAP does indeed have the ability to perform to the required standard in multiple alternate methods which is an advantage to the industry. This would provide a substantial cost saving for the governing body. It would deliver projects in a shorter period of time and keep all stakeholders involved in each individual project satisfied.

Construction on Polymerase Chain Reaction - (12cp)
Patrick Huynh - A17-324

Supervisor: Quang Ha
Assessor: Ricardo Aguilera Echeverria
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

PCR (Polymerase Chain Reaction) is a technique that has emerged a long way since 1970 and now become standard practice in clinical and research laboratories. It is a technique used to amplify DNA sequences so the information and details on the DNA samples become much more readable, allowing further study. This practice has never become much more relevant in the field of modern biology under fields such as pathology, environmental microbiology, virology and many more. The applications are many but include diagnoses and monitoring of infectious diseases, DNA profiling for genetic fingerprints for forensics and detection of degrading organisms in pollutants. Currently the standard method of applying this technique is through rapid heat control.

The equipment used to drive this reaction is known as a thermal cycler and its primary role is to rapidly heat and cool the DNA samples so that the reaction with the enzymes may take place. It is very important that the temperature control is accurate yet fast for reliable results. However, standard thermal cyclers cost around $6 000 for a good brand quality. This makes it not accessible to researchers of third world countries or rural areas who cannot afford laboratories with a regulated temperature. Thus, the main aim of this project was to develop a thermal cycler which is much more affordable but have similar performance characteristics.

This report will focus on temperature results which outline how fast it rises as well as the accuracy of the control achieved. This temperature control is achieved with a Peltier, a thermoelectric device, which can heat up or cool the surface depending on the direction of the applied current. The results are that the temperature control requirement can be achieved however the temperature ramp is found to decrease as the heating block's temperature increases. Additional heating elements are required to be integrated into the design to increase temperature ramp. Further work on the promising development will be introduced.

Active Perception for Pome Fruit Detection - (12cp)
Luke Hammond - A17-108

Supervisor: Robert Fitch
Assessor: Alen Alempijevic
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

This capstone presents the system integration and evaluation of the ADAM system which is designed for the purpose of actively perceiving and detecting apples. Pome fruit harvesting remains one of the few agricultural tasks that lacks any form of effective widespread automation. This is due to the difficulty inherent in the tasks of programmatically segmenting desired objects within This is a great opportunity as new forms of object recognition allow for significantly improved accuracy even without reliance on color based image segmentation.

The ADAM system is designed to leverage these new developments by integrating two currently researched methodologies into an effective apple harvesting system. This is done via the application of a depth sensor and Gaussian process implicit surfaces using geometric priors to fit recorded point clouds to shapes based on expected geometries. Utilizing this methodology it is possible to better segment spherical objects such as apples from cluttered environments with greater accuracy. This process is combined with the FREDS motion planning code that utilizes pre-built databases to optimize robotic arm movement within known environments. The goal of this capstone project is to successfully integrate these repositories and evaluate the effectivity of the resultant system to best determine the focus of future development.

The ADAM system was subjected to a number of simple harvesting situations and found to perform adequately for the task of apple picking. The system is notable for its high accuracy in object detection, being capable of discovering fruit occluded behind foliage. This was tempered however by lackluster harvesting accuracy and the chosen depth sensor's inability to work in direct sunlight. Overall the methodology presented in the ADAM system shows great promise and with further work focused on solving implementation issues, ADAM can provide a viable first step into wider automation of agricultural harvesting practices.

A Study of Radiant Heating and Cooling Hvac Systems in the Australian Climate - (12cp)
Jordon Galpin - A17-111

Supervisor: Ali Altaee
Assessor: John Zhou
Major: Civil Engineering Major BE and BEDipEngPrac

Within any building envelope in Australia there is a requirement for an effective HVAC (heating, ventilation and cooling) and dehumidification system to be active. These systems aim to create an ideal thermal comfort zone as well as high quality indoor air circulation for all occupants. With Australian's spending approximately 90% of their lifespan indoors, optimising thermal comfort is a necessity and epitomised engineering feat.

The current Australian heating and cooling market is dominated by traditional air conditioning system. Like all systems, they are not perfect and there is potential for improvement. Radiant designs have become the engineering norm in parts of Europe where the technology has been recognised as beneficial in terms of comfort levels, cost and energy consumption. These systems are perceived by the Australian industry as niche and inefficient due to our extremely dynamic climate as seasonal variance.

This report analyses and evaluates the performance of both radiant and air systems in the Australian climate as a primary objective. The practical findings within this detailed analysis illustrate the potential for radiant systems to perform to the required satisfaction levels of occupants whilst meeting economic, environmental demands and the nature of the Australian construction industry.

Information about the system performance was collected from local engineering consultants in Australia, modelled under different operating conditions. A questionnaire study was performed on a sample of 50 students to ascertain preferences and temperature comfort zones that should be considered in building design.

Design and Implementation of an Alternative Drive System for Tilt Industrial Designs Skylights - (12cp)
Harry Sherwin - A17-123

Supervisor: Marc Carmichael
Assessor: Terry Brown
Major: Mechanical Engineering Major BE and BEDipEngPrac

With the ever-increasing need to maximize space within urban areas, Tilt Industrial Designs Skylights aim to give people access to rooftops and terraces while also increasing natural lighting without the need to add additional height to a property. Furthermore, Tilts Skylights offer this with a distinct market feature of being able to integrate a Building Code of Australia (BCA) standard staircase for access. Competitors use either ladders or non BCA conforming staircases. Tilts Skylights are the only repeatable product and as such, requires continual research and development making it more efficient, reliable and the ability to offer a variety of size options for an expanding market.

The current design is limited to a maximum physical size dictated by the actuators running at maximum load opening and closing the skylight. This required a holistic systematic analysis of the skylight design.

This project needed to be consistent with Tilt Industrial Designs core values, to balance aesthetics, function and commercial needs. Following a systems engineering approach that covered all aspects of the Skylight design providing specific recommendations on a number of focus areas. The majority of which was focused on an optimization of the Skylights drive system. This optimization; reduces the load on the actuators, decreases the opening time and maintains geometry and bracket details of the drive system across numerous size option. Geometry and bracket details are maintained for fabrication and manufacturing simplicity and thus offers Skylight design standardization across a range of different sizes and also maintain design aesthetics.

Exploring the Concept of a Smart Service Business - (12cp)
Ivy Tan - A17-124

Supervisor: Zenon Chaczko
Assessor: Jan Szymanski
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

With the increasing rise of innovative technologies many workplaces have begun to utilise new technology into their business to help improve management, efficiency and customer flow.
This project's goal is to develop a mobile application prototype that can integrate different technologies which are readily available in the market to create a smarter environment that is aware of its immediate surroundings which can help with streamlining workflow and processes. The app is adapted to a car service type business incorporating and interacting with three core technologies; cloud, mobile and beacon technology.
The Estimote beacons are placed in the environment and send contextual information such as temperature and push notifications to the users when they enter within range via low energy Bluetooth. Google Firebase has a range of different applications from handling user authentication to realtime cloud database storage to provide users with real-time updates and notifications via the application. The app can also provide useful analytics on the users and their activities via Google Firebase analytics.

The development of the prototype can be used as a platform to further incorporate other smart technologies such as light, air-conditioning or robotics. The APIs can be integrated with the application to enable it to use beacon's data to automatically adjust light intensity, temperature or interact with customers based on its surrounding environment.

Investigating Gene Expression Profiles of Karyotypically Distinct Leukaemias - (12cp)
Julia Down - A17-341

Supervisor: Dominik Beck
Assessor: Gyorgy Hutvagner
Major: Biomedical Engineering Major BE and BEDipEngPrac

Understanding the biology of a disease is crucial for the development of novel personalised treatments. Bioinformatics analysis of massively parallel sequences has been successfully applied to pinpoint highly specific oncogenes which can be further implemented into prognostic, diagnostic or drug targets for precision medicine. The aim of this capstone project is to implement a bioinformatics pipeline to quantify, analyse and model several million short ribonucleic acid sequences from normal blood stem and leukaemic cells. In particular, we aim to apply data modelling to eliminate technical replication of sequencing and thereby significantly reducing experimental costs. We will also contrast the transcriptomes of normal blood stem and leukaemic cells to pinpoint oncomirs that can be further explored as prognostic or therapeutic targets.

Effect Slope on Seismic Performance of Structures Considering Soil- Foundation – Structure Interaction - (12cp)
Ali Samimi Haghighi - A17-127

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

The effects of seismic soil interactions on performances of high rise building have caused significant problems for Civil engineers and structural designers who design tall structures. These effects in addition to the existence of the different types of slopes have caused major catastrophic failures after earthquakes. Hence further analysis of the structural behavior is required in order to identify the main failure reasons during an earthquake, especially when these structures are located next to slopes.

In this project, a numerical modelling that is composed of a fifteen stories building sitting on clayey soil reinforced with sixteen piles near slopes is conducted using three dimensional finite element method. Nonlinear behaviors of the soil medium, is considered in this model. The Northridge Earthquake acceleration time history record with fifteen seconds of duration has been applied and lateral deflections, shear forces, inter story drifts, rocking angle and response spectrum have been predicted.

The results show that dimensions and stiffness of the pile system have direct effects on predicted displacements and deformations of the whole soil-foundation-structure system and the seismic responses of the soil and structure including displacements, deflection and the shear forces will change accordingly. In other word, the pile system has significant role on the stability and strength of the building at the time of earthquake. In addition, it is concluded that distance of building from the slope can influence the predictions notably.

A Numerical Investigation to Improve Construction Practices of Non-Engineered Buildings in Rural Nepal - (12cp)
Anuradha Seneviratne - A17-129

Supervisor: Harry Far
Assessor: Ali Saleh
Major: Civil and Environmental Engineering Major BE and BEDipEngPrac

Nepal is situated on the Alphide belt where some of the devastating earthquakes occur due to the tectonic plate movement. The April 2015 earthquake in Gorkha, displaced many lives due to structural collapses of housing and other infrastructure under the Ms 8.1 earthquake. Numerous investigations post-earthquake identified that majority of the damaged housing stock were unreinforced masonry structures such as mud brick, rubble stone, and non-engineered brick and mortar structures.

The construction of these unreinforced masonry structures is often conducted by either the land owner or masons who do not consider the resilience of the structure during a large seismic event. While there are programs targeted by various non-governmental organisations and the federal government, there is little impact on the communities because of the costs attached in implementing these life-saving strategies. The purpose of this study is to create a bridge to encourage masons in rural areas of Nepal to adopt simple earthquake resilient construction practices. This numerical study has focused on two common structural shapes (circular and rectangular) constructed as housing stock in Nepal where it was determined that the height to floor area was key in resisting seismic forces in unreinforced masonry structures. In addition, the study also looked at bamboo as a low-cost reinforcing method and identified that for all structures horizontal bamboo reinforcement is better suited at negating seismic forces.

Automotive Monitoring and Control Can Bus - (12cp)
Angas Torrance - A17-331

Supervisor: Peter McLean
Assessor: Ha Pham
Major: Electrical Engineering Major BE and BEDipEngPrac

Modern vehicles have become increasingly reliant on electronics to provide new features. These features improve the safety, comfort and convenience of the driving experience. A network of distributed sensors and body control modules forms a system that monitors and controls a range of functions within the vehicle. However, there are many older vehicles still on the roads that lack the useful features available in modern vehicles. While these vehicles are mechanically operational, the driving experience would be greatly improved by the addition of monitoring and control features.

In many cases, these modern features can be added without affecting the operation of the vehicle. This allows them to be retrofitted with minimal effort. This project is focused on designing a distributed system of sensor and control nodes that provide the driver with detailed information about the operation of the vehicle, along with features commonly found in modern vehicles such as automatic headlights. As the predominant automotive network standard, the project will implement a Controller Area Network (CAN) bus to communicate between modules. The design must consider the harsh automotive environment that the modules will be operating in, as well as meet the international standards that govern automotive electronics such ISO 11898, ISO 7637-2 and ISO 16750.

The project resulted in an operational CAN bus system which was designed, manufactured and programmed from the ground up. Each node performs as designed and together they successfully form a functional system. This demonstrates the technical feasibility of an aftermarket monitoring and control product. The project has significant potential for future expansion, refinement and commercialisation.

Improvement of Information Flow in Facilities Management Using Building Information Modelling and Image Classification - (12cp)

Jian Zhan - A17-141

Supervisor: Shoudong Huang
Assessor: Sarath Kodagoda
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Building Information Modelling (BIM) is a multilayered methodology used in building and construction industry, commonly being referred as the use of shared digital model with rich information of built objects. Some benefits of BIM include facilitating the collaboration between interdisciplinary parties, reducing loss of information and decreasing cost. As a part of Facilities Management (FM), the inspection-repair process can also benefit from utilising BIM. Moreover, application of image classification can render this process automated.

This project aims to develop a system that improves the information flow in the process of inspection and repair, involving three main roles of users, namely inspectors, managers and repairmen. This project mainly concentrates on the construction of BIM knowledge repository, the application of image classifying algorithms and the development of graphical user interfaces (GUI).

This system is built as plugins based on a BIM application called Autodesk Naviswork. By implementing Naviswork API, the system can access items in 3D models and their properties. These properties, together with images and text files, forms the knowledge repository. Separate GUIs are developed for different users with C# and .NET framework. Image classification is applied when images are uploaded to the knowledge repository, allowing images to be sorted according to their content automatically. ZXing library, Image Processing Toolbox and Computer Vision System Toolbox in MATLAB are used to conduct the image classification.

With this system, users are enabled to collaborate effectively using the same model. It also allows the users to upload images without manual classification. In comparison with the conventional inspection-repair process, this system improves the information flow between users by associating the process with digital 3D model, GUIs and knowledge repository. Furthermore, it reduces information loss by storing all records, images and other information to the repository, which can be conveniently reviewed and referred in the future.

Design of Algae Panels For Buildings –A Structural Engineer's Perspective - (12cp)
Jianfeng Chen - A17-303

Supervisor: Paul Stoller
Assessor: Roger Hadgraft
Major: Civil Engineering Major BE and BEDipEngPrac

An algae façade panel, as one of the emerging technologies in the built environment, has attracted attention from the building industry stakeholders due to pharmaceutical and environmental benefits for an algae end product. The panel, upon successful design, will be used as an exhibiting prototype to monitor the algae growth. Whilst conventional façade manufacturing technology is preferred for maximum resource utilisation, the effect of placing algae liquid into the panel was investigated.

Conventional façade design procedure was adopted to design the components against nominal wind actions, hydrostatic pressure as well as long-term material durability. Relevant Australian Standard section from AS1170 - Structural Design Actions and AS1288 - Glass Selection for Buildings were complied. To ensure the algae panel can be securely positioned, the scope of the project also include designing a supporting steel frame to AS4100 – Steel Design. The design include a finite element analysis (FEA) with non-standard components and a stress analysis for the glass panel using commercial FEA software.

The investigation is consisted of a 1m by 1m insulated glass unit panel supported on steel frame and two durability testing tanks. The former glass unit panel attempts to address the manufacturing assembly, connection detailing and pressure gauging questions, while the later testing tanks attempt to address the long term corrosion and durability issue. The concept selection of the glass panel and testing tanks has undergone a research questions importance ranking for resourcing.

Multi-disciplinary system engineering approach was adopted in the investigation. Regular communication with the façade manufacturer was maintained on a weekly basis to ensure the easy assembly, economical use of material and safe design. Architect planning and hydraulics engineering aspects are considered, in collaboration with other designer colleagues.

Experimental Investigation into Methods to Reduce Bike/Pedestrian Road Casualties through the Design and Implementation of Radio Technology - (12cp)
Tom Southey - A17-161

Supervisor: Jinchen Ji
Assessor: Guang Hong
Major: Mechanical Engineering Major BE and BEDipEngPrac

In Australia, motorcycle riders make up around 4.5% of all Motor Vehicle registrations, but account for almost 15% of all road deaths, and an even higher proportion of serious injuries. Motorbike riders, cyclists and pedestrians are all at higher risk of serious injury on our roads as they are not surrounded by the protective chassis of passenger vehicles.

This project is aimed at designing a standalone device that can proactively help increase awareness of these higher risk parties when in close proximity to passenger vehicles, especially when they are not visible. This project explores the use of radio technology as an effective form of communication between vehicles.

In most road collisions, usually two or more parties are involved. Many other proximity devices on the market require both road users to carry a transmission/detection device, this project explores the possibility of using radio technology due to the abundance of radio receivers already installed in passenger vehicles and an increase of 9.7 million people listening to commercial radio in Australia each year.

This study has resulted in the development of a functional revised prototype device, in-depth analysis of its real-world applications and detailed insight into future improvements. This report details the research, methodologies and designs used to achieve this.

The hope is that the developments made in this project can be explored further and the device can be brought into the current market for safety equipment to reduce preventable road casualties.

Design and Development of a Sensor Suite for Sound Source Localisation - (12cp)
Lawrence Warren - A17-166

Supervisor: Teresa Vidal Calleja
Assessor: Shoudong Huang
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

Sensors are used in a wide range of applications and are important in allowing robots and other autonomous systems to interact and engage with the world. Sound source localisation (SSL) and simultaneous localisation and mapping (SLAM) are fundamental applications of robot sensing. There is a lot of research being undertaken in the field of robot audition into the use of microphone arrays of different configurations and designs, as well as the use of a variety of different algorithms and techniques.

The aim of this project is to design and develop a sensor suite for use in robot vision and audition. This sensor suite will be comprised of a 2D/3D camera, a microphone array, and an IMU. As part of this project, a sensor suite was devised and manufactured to integrate the three sensors in a single platform. Once the sensor suite was completed, it was used to collect data from the camera and the microphone array. A general calibration procedure was designed and executed which allowed the 2D/3D camera and microphone array to be calibrated with respect to one another.

A calibrated sensor suite, comprising of the sensors specified, can be used in conjunction with a range of robots and systems; it can also be used to test or explore SSL and SLAM algorithms or in other applications. A pre-built, pre-calibrated sensor suite simplifies this process for researchers by minimising the effort needed to use these sensors in combination. It is envisioned the sensor suite will be used by researchers in UTS: CAS to investigate algorithms for robot vision and audition.

Advancements in Reinforced Soil Walls - Construction Methodology - (12cp)
Joshua Steel - A17-168

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

Reinforced soil walls (RSW) are a composite structure involving the interaction between both select granular backfill and reinforcement. It is a more recently developed type of structure as opposed to more traditional methods such as cantilevered retaining walls which implement the use of a large concrete footing. This reinforcement material used within a RSW can consist of either metal strips or mesh, as well as the use of more modern material such as high tensile geo-synthetics which can be manufactured in grid-like patterns in sheets. The combination between the reinforcement and soil allows for these structures to possess significantly improved properties and maintain strength over increased wall heights that would be otherwise deemed impractical by any other type of wall.

While the modern type of RSW was developed in the 1960s, it has only been used commonly in industry in the past 30-40 years. As a result, while there are current construction methodologies on how these walls are built, they are very broad and do not cover specific details that would be expected to be seen in the construction. For a recently graduated site engineer working in the field, this can be a daunting and confronting experience particularly with sub-par preparation in common practices and the general procedure involved when constructing a RSW.

For this reason, this report aims to not only describe the methodology involved, but use relevant industry experience to describe the potential lessons to be learned, as well as future recommendations from previous developments, to provide a more comprehensive methodology. Additionally, this report will help prepare new site engineers to build these structures productively and with minimal errors, while also providing guidance to the expectation of their role and responsibilities in the industry.

Combined Effects of Alkali Silica Reaction and Corrosion on the Residual Strength of Concrete Structures - (12cp)

Anthony Arruzza - A17-170

Supervisor: Shami Nejadi
Assessor: Nadarajah Gowripalan
Major: Civil Engineering Major BE and BEDipEngPrac

Alkali silica reaction (ASR) is a chemical reaction that takes place within the concrete matrix and leads to subsequent deterioration of concrete structures. It occurs when the hydroxide radicals in the pore solution of concrete react with silica or silicate minerals to form a silicate hydroxide complex at the surface or within the mineral structure. The negatively charged silicate hydroxide complex combines with the sodium and potassium ions in the pore solution to form a sodium and potassium silica hydrate gel. In the presence of sufficient moisture, this gel forms an expansive hydrate with sufficient swelling pressure to disrupt the concrete matrix. This results in cracking of the concrete and an increased level of porosity of the concrete matrix, which leads to increased corrosion levels and affects the long-term residual strength of concrete structures.

ASR is a concern in today's engineering society as a result of the effects that it is having on concrete structures around the world, particularly those in environments that are exposed to water or high levels of moisture. In New South Wales, the Roads and Maritime Service who governs road infrastructure has identified this to be an area of concern and as a result has provided funding to the University of Technology, Sydney, to investigate the effects that ASR has on infrastructure's long-term durability and structural performance.

This capstone investigation undertaken had the specific objective to identify the 'Combined Effects of Alkali Silica Reaction and Corrosion on the Residual Strength of Concrete Structures' through the use computer modelling. This was achieved using ATENA, which is a computer computational program for finite element analysis of reinforced concrete. The modelling process involved the loading of three beams with different reinforcement configurations and ASR severity at their serviceable load and 50% of their ultimate load, in order to assess the effects on the structure. The results of the computer modelling assessed the relationships between crack width, deflection and loading in relation to the ASR severity applied, in order to determine a model to assess the residual strength.

The methodology developed as a part of this investigation and the subsequent results can be used to model the combined effects of alkali silica reaction and corrosion on the residual strength of concrete structures. It also has the capability to be adjusted and adopted to be used to examine and model different structures and severities of ASR, based upon geometry and available concrete properties and characteristics.

Numerical Modelling of Ballasted Railway Track: Two-Dimensional Approach - (12cp)
Rebekah Fulthorp - A17-174

Supervisor: Sanjay Nimbalkar
Assessor: Hadi Khabbaz
Major: Civil Engineering Major BE and BEDipEngPrac

Railways are one of the most common forms of public transportation, and within New South Wales are a vital part of the public transportation network. The railway track that trains run on needs to be constructed and maintained properly to avoid potentially catastrophic failure. Despite this, the analysis of railway tracks down to subgrade is yet to be fully resolved, and as such there are a variety of empirical models currently being used in the rail world.

This thesis determines a numerical methodology that enables rail, sleepers, ballast, capping, and subgrade of a railway track to be simulated resembling in-situ field conditions. A two-dimensional (plane strain) numerical model of railway track consisting of superstructure and substructure is implemented in the finite element program, Optum G2. Various practical scenarios related to track substructure conditions are modelled and elastoplastic analysis is considered. A parametric study of stresses, strains, and deformation in various track layers is undertaken to cater for different cases of loading (existing passenger trains vs. proposed high-speed rail passenger trains in Australia) and different substructure conditions (stiff vs. soft soils, and various depths of subgrade).

The aim of this study is to analyse the mechanical behaviour of track under certain traffic conditions. By determining the most critical substructure parameters for existing passenger trains, it becomes apparent which areas of the track system need to be a focus for good track design and maintenance. By determining the most influential substructure parameters for high-speed passenger trains (on existing passenger lines), it would be possible to emphasise important areas for track maintenance and optimization of a maintenance program. This has the potential to substantially reduce future costs of track maintenance and rehabilitation. A comparison of the two could be a step towards converting existing passenger lines into high-speed rail lines, should that be a viable option for Australia.

A Comparative Analysis of Weekend Passenger Travel Behaviour on the Sydney Trains Network Using Opal Card Data - (12cp)
Ramen Awraham - A17-178

Supervisor: Michelle Zeibots
Assessor: Garry Glazebrook
Major: Civil Engineering Major BE and BEDipEngPrac

In recent years, there has been a rise in congestion levels throughout the Sydney Metropolitan Area with weekend traffic experiencing delays as much as weekday traffic. Australia is a relatively car dependant nation, and even though Sydney has the highest mode-split to public transport for journeys-to-work in Australia, the high concentration of traffic moving in and out of city centres during peak hours is causing an increase in congestion. Building new roads and expanding existing ones are not always the best solution to congestion as the faster travel times can attract additional traffic. This paper will focus on public transport service improvements as an alternative solution to weekend congestion.

With the introduction of the Opal card ticketing system, information on travel patterns for all trips by public transport can now be recorded and analysed in much more detail than was possible before. This data shows that passenger demand on the heavy rail network is much higher on weekends than previously thought and needs improved planning to work alongside the road network to curb congestion problems in Sydney.

The objective of this project is to investigate options for improving and optimising weekend heavy rail services and developing a long-term solution to ease traffic congestion in Sydney. This has been achieved through an analysis of weekend demand levels using Opal data and investigations of ways to improve Level of Service of the current customer service offering, as well as a literature review and a customer opinion survey. Using this information, possible solutions, as well as their limitations, were assessed and their viability discussed.

With the current poor utilisation of the NightRide service, having it replaced with heavy rail services on Friday and Saturday nights would allow for twenty-four-hour access to trains, however, further analysis is needed regarding whether the demand is sufficient enough to make the change justifiable. The analysis recorded a growing demand for heavy rail services during the weekend, leading to the conclusion that adjustments to train routes, including frequency and number of stops, would need to be made to focus on customer travel patterns during different hours of the day.

Functional Relationship to Examine the Effect of Demographics on Motor Vehicle Crashes and Casualties - (12cp)
Jane Ngo - A17-182

Supervisor: Xiaobo Qu
Assessor: Nicholas Surawski
Major: Civil Engineering Major BE and BEDipEngPrac

An estimated $27 billion AUD contributes to the social cost of vehicle crashes in Australia per annum. With increasing crash trends, road collisions present a major concern on individuals, communities and the national economy. Applicable preventative measures in the analysis of road crashes have the potential to reduce these figures and increase safety on the road network. The demographics of a location can play an important role which contributes to the frequency and severity of crashes and through thorough examination of their relationship, functions can be derived to propose and incorporate solutions in improving traffic safety on NSW roads.

A functional relationship between crash and casualty statistics and demographics of a LGA was proposed through the usage of statistics provided by Transport for NSW and The Australia Bureau of Statistics. Correlation and linear regression analysis will examine the trends and patterns in relation to the demographics in the respective LGA and deduce attributes that instigate high amount of crashes. Spatial analysis was undertaken through the usage of Geographic Information Systems which enabled the generation of classification and hot spot identification maps, providing a visual representation of the existing crashes and casualties per LGA.

The potential applications and limitations of this function have been further discussed in addition to its overall accuracy and resourcefulness as a new indicator into the analysis of current engineering crash prevention and safety assessments per LGA.

Thermal Modelling Of Thick Concrete Elements in Australia and the Use of CIRIA C660 - (12cp)

Adam Woods - A17-187

Supervisor: Harry Far
Assessor: Jun Li
Major: Civil Engineering Major BE and BEDipEngPrac

Early-age concrete experiences significant temperatures due to the exothermic reaction of hydrating cement. Excessive temperatures can cause early-age thermal cracking and risk Delayed Ettringite Formation. One of the most common tools in Australian practice to predict the temperature developed in concrete is the UK-based CIRIA C660 - Early-age Thermal Crack Control in Concrete Temperature Spreadsheet.

There are a number limitations to CIRIA C660; the temperature spreadsheet can only conduct a one-dimensional thermal analysis, heat produced by the cement is based on UK-cement properties and a limited choice of formwork materials. For this capstone project, a spreadsheet was created in Microsoft Excel, specifically using Visual Basic that allows the everyday structural engineer to easily conduct a thermal analysis of a concrete element. This spreadsheet amends the limitations of the CIRIA C660 temperature spreadsheet and provides greater functionality. Improvements include:

a) The ability to conduct a two-dimensional thermal analysis;
b) Incorporation of the thermal properties of Australian cementitious material using Riding et al (2012) model;
c) Allows for the insertion of data from a 'hot box' test into the thermal analysis;
d) A greater choice of formwork materials and stripping times for each face of the concrete element.

The capstone spreadsheet was compared to the CIRIA C660 temperature spreadsheet using hypothetical scenarios and temperature recordings from site. Results showed that the one-dimensional analysis used in CIRIA C660 can overestimate the concrete temperature, primarily leading to unnecessarily site practices to control the temperature. Incorporation of Australian cements into the model yielded accurate temperature predictions whereas the UK-based cement properties used in CIRIA C660 yielded severely over-estimated temperature predictions.

Air Conditioning in Hostile Environments - M5 Tunnel Equipment Room Cooling - (12cp)
Andrew Ghattas - A17-195

Supervisor: Guang Hong
Assessor: JC Ji
Major: Innovation Engineering Major BE and BEDipEngPrac

Computer equipment cooling has become a focal point for the Heating, Ventilation and Air Conditioning (HVAC) industry in recent years. HVAC in tunnel equipment rooms is especially difficult to manage due to the conditions being hostile to clean air circulation. Crucially, this report will undertake an investigation into how the current approach to the situation can be significantly improved.

Approximately eighty equipment rooms populate the M5 East Tunnel, wherein tunnel operators utilise numerous 'split' air conditioner units to cool each of the equipment rooms. A unit is installed in the equipment room, and the outdoor unit, or condenser, has been mounted at high level within the tunnel, meaning air from the tunnel is drawn into the condenser. Due to the particulate matter and chemicals in vehicle exhaust fumes, this air has significant fouling properties aberrant from what is normally drawn through a condenser unit. As a result, the condensers require replacement at a vastly lower lifespan than recommended in manufacturer specifications. This exercise costs tunnel operators an estimated $1,900 per year, per unit, when the cost of the unit, labour to install it and traffic management costs are taken into consideration.

This report reports the investigation of the causes of condenser fouling and its effect on air conditioning equipment within the tunnel, the method by which the design conditions of the tunnel were established and a proposed solution to address this issue.

Recommendations
The analysis found that the best way to resolve the issue was the use of a hybrid air scrubber and indirect evaporative cooler system in conjunction with the existing air conditioning units. This solution effectively addresses the condenser fouling issue, and is even able to achieve the required cooling capacity in the room with greater energy efficiency than the current equipment.

Investigating Operating Procedures on the Inner West Light Rail to Improve Level of Service - (12cp)
Opinderjit Samra - A17-196

Supervisor: Michelle Zeibots
Assessor: Garry Glazebrook
Major: Civil Engineering Major BE and BEDipEngPrac

Within public transport systems, the Level Of Service delivered to commuters is dependent on the configuration of the physical system infrastructure and the operating procedures used. Improvements to Level Of Service can be delivered through infrastructure upgrades and/or changes to operating procedures. But whilst transport infrastructure is static and must be physically altered, transport operations are conceptual and can be reconfigured using existing infrastructure. In Sydney, the need to improve public transport efficiency is evident as fare revenues only cover 22% of operating costs (IPART 2016). The remainder is funded through state tax revenues which could be otherwise utilised to fund government initiatives or the expansion of public transport services. This can be addressed through low cost improvements to transport operations.

This report investigates the pressures and constraints on Sydney's Inner West Light Rail (IWLR) and identifies how operational changes to the existing infrastructure can lead to improved service outcomes. A range of options were identified and considered using a least cost planning approach, and the decision was made to investigate the viability of implementing alternate stopping patterns on the IWLR, targeting areas of high patronage.

A method was developed using Opal data and the service timetable to calculate service passenger loads on the IWLR. Patterns in the patronage levels were observed to identify periods and locations of high crowding along the line. In response, a series of timetable options were created with alternate stopping patterns targeted to address the high demand areas on the line and better utilise the system. The Opal data was reanalysed with the alternate timetables to calculate and compare the level of crowding relief.

This method can be further applied to monitor crowding levels on the IWLR without video or physical surveys. It can also be used in conjunction with dwell time data to determine the relationship between crowding and dwell time on the IWLR to inform operational strategies for dwell time reduction.

Android Application for the Management and Monitoring of Security Guards - (12cp)
Dilan Johnpulle - A17-197

Supervisor: Tom McBride
Assessor: Asif Gill
Major: ICT Engineering major BEBE (Hons) BBus, BEBE (Hons) BSc

This project encapsulates the work performed by Dilan Johnpullé in prototyping an Android Mobile and Django Web Application for the Management and Monitoring of Security Guards for submission as part of Capstone B Spring 2017.

The recording of security incidents by guards in a journal is standard practice across the industry in line with legal obligations so as to provide management and venue operators with an overview of the risks and threats facing their premises.

At present many providers make use of PC based logging solutions for this purpose. I have come to believe this is a practice that can be eschewed in favour of one that yields greater data integrity and reliability through the use of cloud and mobile technology and digitisation.

Due to the fact that most security roles are shift based, spontaneously covering individual employees tends to be a rather difficult endeavour for most providers. This often results in a need to keep guards out patrolling instead of calling them into security offices to log reports after incidents.

As such this results in a time delay between when incidents occur and when they are finally logged in a system, usually at the end of said guards' shifts or when they are next able to come in from patrolling. This time delay of course impacts upon the reliability of input data.
Through personal experience I have observed many guards make use of paper based solutions as a temporary measure to record their interactions initially which are then transferred later to their official report.

This project therefore provides a prototype system that makes use of Android powered devices carried by guards to log incidents as and when they occur. This prototype also includes a Django powered supervisor web application which enables supervisors to review and approve logged incidents.

Predicting the Performance of Elite Swimmers - (12cp)
Bronte Thompson - A17-199

Supervisor: Ahmed Al-Ani
Assessor: Valerie Gay
Major: Biomedical Engineering Major BE and BEDipEngPrac

With the rise of data collection capabilities in athletic performance, numerous measures are now recorded from elite swimmers including quality of sleep, level of fatigue, type of training and a myriad of heart rate variability statistics. The resulting quantity of data available has indicated a need for the development of new techniques to predicting swimming performance.

In the field of sports science, coaches and trainers alter an athlete's training to generate an assumed change in performance based off subjective measures supported by years of experience combined with their skills and knowledge in the field. This approach is outdated and difficult to quantify. The aim of the project is to utilise the intersection of machine learning and sports science fields to improve the process used to predict the performance of elite swimmers.

The project produced 2 models using MATLAB and KNIME software. Firstly, a classification model built using a random forest algorithm achieved acceptable accuracy of 78.1%. Secondly, a regression tree model was implemented providing impressive statistics with a 0.99 R2 value.

The purpose of this project is to address the wide range of data available within the sports science field and integrate this with the computer science and machine learning fields. By implementing data analytics models, the problem of data excess is minimised whilst providing a tool to trainers and coaches. This tool may act as an additional source of input to consult when making changes to athletes' training procedures and could invoke more specific improvements or enhancements.

Exploring the Application of Agile Working in an Engineering Workplace - (12cp)
Matthew Campling - A17-200

Supervisor: Anne Gardner
Assessor: Timothy Aubrey
Major: Civil Engineering Major BE and BEDipEngPrac

Engineering workplaces have traditionally utilised enclosed private office environments where employees are assigned a desk and are categorised by their line of work. A developing trend in an 'agile' workplace model (aka hot-desking) is being adopted by the engineering industry. A review of literature suggests this workplace model can be associated with cost benefits, workplace efficiency, knowledge share and increased collaboration. However, more general workplace studies note how employee satisfaction can be compromised when privacy and ability to focus are compromised over collaboration incentives.

This project explores the practicality of agile working in an engineering workplace, specifically by analysing the impact it has on an anonymous private engineering company and their employees.

Surveys were distributed to a controlled group of engineering employees in both pre-agile and agile office spaces to draw correlations over what factors contribute to their satisfaction or dissatisfaction, as well as identifying any other changes to their styles of working. Interviews with employees through the engineering hierarchy helped gage whether an agile office space suited engineering needs for individual and collaborative work. Transect walks further validated the data, by observing how engineers adopt or reject agile practices.

Results found a decrease in satisfaction amongst almost all aspects of an engineer's work, and although increased interactions resulted in increased knowledge share, it also saw a rise in interruptions and a decline in ability to concentrate. The results also discovered that the success of an agile model to an engineering workplace heavily rely on its implementation and support IT services.

Fundamentally, the way engineers work individually and amongst their teams should be supported rather than changed. When adopting agile practices, engineering companies should consider how a push for collaboration incentives can directly impact an engineer's ability to perform individual focused work, and hence a balance should be sought.

Robotic Sensing and Perception for Collaborative Environments - (12cp)
Yujun Lai - S16-172

Supervisor: Gavin Paul
Assessor: Alen Alempijevic
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Robots are becoming an increasingly ubiquitous part of our everyday lives. Interactions with robotic systems are more prevalent amongst the economic and domestic scenes as robotics is continually developed and introduced to the differing sectors. Conventional robotics, such as those in economic industries like manufacturing, have favoured and obtained speed and precision at the cost of physical human contact with the robotic systems.

Collaborative robotics aims to introduce humans into robotic workspaces due to the complementary skills to improve capabilities of robotic cell, a workspace where robotic systems and humans collaborate to produce discrete outputs. This has spurred research into state-of-the-art framework developments for collaborative robotic cells and have already been heavily tested in applications where complex tasks require the dexterity and adaptability of humans with the support and precision from robots.

Environmental awareness is key for a robotic system to attain versatility and autonomy. Our everyday lives and tasks rely on our inherent perceptual abilities to realise actions developed by our brains, allowing collaboration with other people. The pertinence in perception has motivated this project to explore current perception capabilities, integrate perception implementations in robotic systems, and develop a framework to overcome a current perception limitation.

Basic implementation of two prominent computer vision libraries, OpenCV and Point Cloud Library (PCL), were performed, demonstrating a few applications of their outputs. From the works, a gap in occlusion handling in Deformable Linear Object manipulation was identified and a new framework was developed to tackle the issue. The probabilistic framework merges Bayesian Committee Members (BCM) to complement capabilities of Gaussian Process regression models. Two revisions of the experiment were conducted and results were compared against each other and ground truth data.

Autonomous Fluid Changes for Large Haulage Trucks - (12cp)
Benjamin Terracini - A17-208

Supervisor: Sarath Kodagoda
Assessor: Shoudong Huang
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The mining industry is a major player in the Australian economy, contributing approximately 6.9% of Australia's GDP in 2015-16 (DIIS 2016). Mining technology is developing to combat increasing labour costs and comply with environmental regulations. Rio Tinto currently operates a fleet of autonomous ultra-class mining trucks, dubbed the AHS (Autonomous Haulage System) in Western Australia which consists of Komatsu 830E-4AT and 930E-4AT models. Despite the trucks being autonomous all the servicing, including refueling, oil changes, tyre changes and general maintenance are all done manually by service personnel.

There has been some progress made in automating services in this and other industries. The Scott Automation Robofuel™ system serves as an almost fully autonomous refueling station, requiring only the truck operator to activate the system using a touch screen device within the truck. Other patents have been registered for devices and systems to undertake autonomous maintenance on cars and aircraft but none has sought to automate the changing of oils on mining trucks.

This project aims to develop a preliminary design for a device to autonomously and simultaneously change the engine oil and hydraulic oil of a Komatsu 830E-4AT (autonomous) or 830E-1AC (manual) truck. These trucks are equipped with a quick-fill service centre on either side. The design revolves around the use of a robotic arm equipped with sensors to detect the location of the quick-fill service centre and connect necessary hoses. The device then evacuates the old oil from the tanks and refills it with fresh oil. The goal is to reduce the working time for these oil changes from six man hours to half a man hour.

Application of Robotics in Social Contexts - (12cp)
Denis Draca - S16-224

Supervisor: Jonathan Vitale
Assessor: Benjamin Johnston
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Robots are slowly but consistently appearing in public spaces such as shopping centers, airports, hospitals and train stations. Thus, developers are asked to identify new robotic applications focusing around human interactions and social aspects, as to help ease the integration of robotics into society. In this work I provide a solution for a problem commonly found in complex public spaces, namely that of providing human-like directions to reach landmarks within the considered environment.

This project proposes to solve this problem using existing path planning algorithms coupled with a natural human language generator. Specifically, by generating a path using the A* path planning algorithm, the solution can follow along this path, look for landmarks and points of interest and attach natural language that would lead the user past these landmarks. There are already many navigation solutions on the market, but they mainly deal with constrained maps such as road navigation where streets are used. There are none that work within complex environments such as shopping centers, this project aims to bridge this gap.

Across the three scales of a quality path (path accuracy, path speed, path simplicity) it was found that the proposed solution performs admirably across all three. There is very little deviation in the quality of each of the scales as compared to human generated paths as seen by other humans. There is less than a 1σ deviation from the mean across all three scales. Given the small sample size this cannot draw any definitive answers, it does however show that it is worth increasing the scale and performing the same testing with a much larger sample size.

Performance Evaluation of Supervised Machine Learning Algorithms Using Functional Near – Infrared Spectroscopy (fNIRS) Signals - (12cp)

Somaia Ahmadi - A17-211

Supervisor: Rifai Chai
Assessor: Steve Ling
Major: Biomedical Engineering Major BE and BEDipEngPrac

This project is constrained to my analysis and evaluation of the classification of Functional Near – Infrared Spectroscopy (fNIRS) signals. More specifically, these classification methods include but is not limited to Support Vector Machines (SVM), Linear Discriminant Analysis (LDA), K – Nearest Neighbours (KNN), and Artificial Neural Networks.

The accuracy of a classifier model directly impacts the performance of the particular application that the model is an input of. A primary application of fNIRS signals are in conjunction with Brain – Computer Interfaces (BCI). fNIRS based BCI's have a wide potential for rehabilitation or as a means of communication for highly disabled patients.

The results were derived from the binary classification of an acquired dataset containing fNIRS signals from the following activities: the execution of mental arithmetic tasks and a baseline resting phase. The features utilized for this task were the oxygenated haemoglobin, deoxygenated haemoglobin, and total haemoglobin concentration levels.
The highest performing classifier in terms of accuracy was Artificial Neural Networks with a maximum accuracy rate of 94.5%, sensitivity of 0.97 and specificity of 0.92. The subsequent top performing algorithms were Complex and Simple Classification Trees with an accuracy rate of 92.0% and 90.5%, sensitivity of 0.89/0.93 and specificity of 0.90/0.83 respectively.

The attained results from this project are yet another confirmation for the potential integration of fNIRS signals with BCI's as well as paving the way for yet more refinement of the classification methodology.

Seam Identification and Simulated Separation of a Primal Cut of Poultry Carcasses Using an RGBD Camera and Robotic Manipulator - (12cp)
Matthew Clout - S16-180

Supervisor: Alen Alempijevic
Assessor: Gavin Paul
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Automation of meat processing industry in Australia aims to improve the efficiency and quality of meat cuts whilst optimising yield, and ensuring consistency. Due to the varying nature (size, shape, and deformity) of poultry carcasses, automation within the industry requires sensing, and dexterity to identify, manipulate and separate the primal cuts from the carcasses.

This project aims to analyse and identify key features located around the drumstick of the chicken carcass. These features are used to generate a cutting trajectory to be actuated by a robotic manipulator to demonstrate the separation of the whole chicken leg, a primal cut. Datasets of several chicken carcasses were collected using RGBD cameras to produce 3D point cloud models used to develop and perform the identification.

Feature extraction techniques applied to the point cloud data include point cloud segmentation, principal curvatures, identification of surface normals and Euclidean cluster extraction, from the Point Cloud Library (PCL). The trajectory along the seam of the chicken's hip joint is derived by conducting principal component analysis on the key features identified, and their respective locations.

Subsequently, identification of the carcass location relative to the RGBD camera and the manipulator ensures the path planned is actuated at a selected, safe distance away from the seam. Using a laser to point along the seam simulates a physical demonstration of the separation of the primal cut.

Using the techniques above, it can be seen that areas around the drumstick can be located when viewed from specific angles within a controlled environment. Performance and visualisation is enhanced by utlising graphic processing units (GPU) to acquire data at near real-time (~1hz@500msec delay). This project has demonstrated the potential for these techniques to be applied in real-world applications.

Potential Application(s) of Additive Manufacturing in Load Bearing Structural Members - (12cp)

Philippa Easling - A17-310

Supervisor: Ali Saleh
Assessor: Harry Far
Major: Civil Engineering Major BE and BEDipEngPrac

The capabilities of additive manufacturing, commonly referred to as 3D printing, continue to develop and their commercial applications are widening. Originally developed for rapid prototyping, 3D printing and other techniques are now finding adoption in industries such as aerospace, medical, dental, automotive, defense and consumer goods. The technology continues to develop both in terms of printable materials and manufacturing systems. With this development, there exists an opportunity to investigate the potential benefits with respect to the construction industry. To date, the construction industry has seen limited implementation of the techniques primarily due to the sheer scale of construction projects.

This project aims to identify a point of justification for the development of additive manufacturing technology capable of printing load bearing structural members. A numeric analysis of Universal Beam section properties was conducted in order to identify quantifiable measures of efficiency. Once geometric relationships and material efficiency of the existing sections had been determined, it was attempted to develop new geometries that improved on the performance of a selected existing section. The geometries were modelled with finite element software and optimised in terms of overall mass, flexural stiffness, bending stress and buckling behaviour.

It was found that a material saving of 10% could be achieved whilst satisfying strength and deflection criteria and improving upon buckling tendencies for a chosen section. These results demonstrate potential viability for future development of additive manufacturing in the construction industry. The successful adoption of this practice would depend on many complex factors including the risk-averse nature of the construction industry as well as the development of machines capable of manufacturing load bearing structural steel members.

Sydney Trains: Investigation of Passenger Behaviour - (12cp)
Veronica Thorpe - S17-217

Supervisor: Michelle Zeibots
Assessor: Claudine Moutou
Major: Civil Engineering Major BE and BEDipEngPrac

This study investigates passenger usage and behaviour patterns on the Sydney Trains - T1 North Shore, Northern & Western train lines in order to identify how this might contribute to overcrowding that can lead to operational challenges and reduction in service to customers. These challenges frequently occur at CBD stations Wynyard, Town Hall, Central and Redfern.

Several reasons for crowding have been recognised in other investigations including time of day, station layouts and operational problems along with performance indicators such as on time running, dwell time irregularities and stopping patterns. These investigations neglected to look at passenger behaviour and incorporate how customers utilise station facilities and train assets.

In my research several approaches were used to measure and observe passenger activities including general behavioural observations at peak and off peak periods, observed interaction with station facilities and recorded passenger movements on and off trains and platforms. The observational data revealed common travel patterns such as progressive loading/unloading through the CBD and was used as the basis for comments and assumptions relating to passenger behaviours and to explain reasons for crowding.

The analyses of the anonymous Opal data corroborated overcrowding problems and revealed unexpected results such as high volumes of short trips between CBD stations and high numbers of taping on/off at the same CBD station during peak periods. Analysis of the greater T1 lines displayed popular travel patterns through the CBD, a magnitude of passengers using T1 stations and significant numbers of passengers transferring between the T-line services during peak periods.

Investigating passenger behaviour and travel patterns were important factors in determining the way the system is used. Observational figures of passenger activities showed that they rarely had an impact on train operations and an increase in some services would likely alleviate crowding on both the trains and the platforms.

Investigating Improvements to Model Fitting in Photogrammetric Processing - (12cp)

Kavin Miranda - S16-181

Supervisor: Jack Wang
Assessor: Shoudong Huang
Major: Mechanical Engineering Major BEBBus and BEBSc

This Capstone Project Aims to investigate improvements to the repeatability and efficiency of model fitting algorithms primarily used in Structure from Motion (SfM) and Visual Odometry (VO). A partial model of the UTS Campus, was first processed to better understand the limitations of current photogrammetric techniques and identify areas of improvement.

A major part of any SfM or VO pipeline is the implementation of a model fitting and outlier rejection algorithm. Upon further enquiry, Random Sample Consensus (RANSAC) was identified as a widely-used inlier estimation algorithm. An alternative to RANSAC, Purposive Sample Consensus (PURSAC) will be used to accelerate the estimation of inliers and tune the model, improving repeatability for the estimation of the model.

All SfM and VO pipelines suffer from several shortcomings these include its susceptibility to noise present in the dataset, due to the randomness in sampling method the iterative process can be time consuming and inconsistent over several runs and finally the estimation may be influenced by features close to the vanishing point.

The proposed solution utilizes a statistical method to further reduce the effect of noise by removing nose sensitive feature points around the vanishing point in a set of images, as well as some additional approaches. This method is tested on VO, which requires a very high level of repeatability and consistency. Implementing an outlier rejection scheme allows for minimal effect on the processing speed while providing a consistent modelling result, this is contrasted with RANSAC based algorithms that can be detrimental to the speed.

Further improvements/solutions to VO drift and accumulation of error are also discussed for future implementation of the PURSAC algorithm, including the potential of improving the intrinsic parameters of a camera. The magnitude of vectors will be assessed for their proximity to the vanishing point and be disregarded from the final estimation of the extrinsic parameters of the camera.

Reasons for Inaccurate Earthwrk Quantities in Road Infrastructure Projects and their Impact on Cost Overrun - (12cp)
Robert Woodchuck - A17-220

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

With Australia's expected population growth to be 30 million by 2030, there is an expectation that the road network will be able to support demand and manage the urban traffic that is progressively growing. In order to do this, costing of projects need to be accurate or there is a high chance of overrun that will result in a lack of funding for other infrastructure projects. Flyvbjerg (2003) conducted a study into the cost overrun of transport infrastructure projects globally, and noted that over 258 mega-projects, 90% of them overrun in cost by more than 28% of the total value of the project. Smaller projects have a 50% chance of cost overrun by a total of 4-9.5% of the value of the project. To combat this excessive cost overrun, this project investigates the refining of two topics within Roads and Maritime Services Specification R44 – Earthworks to determine if they have significant impact on the costing of a project.

This project is separated into two components, the first being the analysis of Roads and Maritime Specification R44 – Earthworks for its definition of topsoil and the management requirements of excavated topsoil quantities for the construction of road infrastructure projects. It determines if there is any benefit in separating the total topsoil quantities into their 3 separate layers. The second area of investigation is into demonstrating the feasibility of having reduced allocated stockpile sites by undertaking the earthwork design through the construction staging. This will have benefits in minimising the amount of property that may need to be leased temporarily.

The findings of this study revealed that it is beneficial for topsoil layers to separated. However, it is recommended that the Roads and Maritime Services/contractor implement a topsoil management strategy on a project to project basis. The methodology for determining stockpile size requirements is a worthy exercise to be implemented in urban projects where there is limited space.

Development of a Program to Assess the Pressure Distribution onto Buried Structures under External Loads - (12cp)

Emma Lucas - A17-227

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

The demand for residential, commercial and industrial development in Sydney has grown significantly over the past years and it has become increasingly common at Sydney Water to see developers applying to build closer to underground assets. Due to the increase in the value of property in Sydney, it has become financially viable to build near and engineer around buried structures in a way that has not been seen before. These developments can place additional loads and stress on the buried structures and increase the risk of failure. Sydney Water currently has need for a computational tool that can assess the vertical and lateral pressure distribution from complex external loads on buried structures to aid in their assessment of these development proposals.

The literature relating to the current numerical load distribution methods have been compared and analysed to determine the most appropriate techniques for use in the computational tool. Further literature providing and comparing experimental results to those of the numerical methods has been used for the validation of the numerical methods and has aided in the determination of the numerical methods to be used in the computational tool.

A computer program which incorporates these numerical models has been developed using excel. The programs ease of use has been ensured by limiting the amount of input and information required from the user by programming the computational tool to make decisions in the background. A parametric study and sensitivity analysis has been undertaken to recognise how the parameters impact the outputs of the program.

The computational tool will allow engineers in water utility industry to efficiently assess the types of pressure distribution expected on a buried pipe and determine whether the anticipated loading is acceptable and whether the pipe will need additional protection measures in place to reduce the risk of failure.

Learning from the Past to Explore Improvements and Lessons Learnt for Australian Tunnel Construction. - (12cp)
Declan McKeegan - A17-235

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

In the engineering and construction community improving on current practices and learning from the past is how project failures can be avoided. By learning from past mistakes and successes engineers are able to explore new construction methods and technology to deliver projects more efficiently, at lower costs and safer.

This report reviews the historical tunnel construction methods, identify current practices and methodology. Furthermore, this project identifies emerging technologies being introduced to make tunnel construction safer, faster and as a result potential cost savings. Research is undertaken from published and discussions with current industry professionals as sources to understand the nature of failures in tunnel construction projects launched both in Australia and overseas. This is complimented by interviews undertaken with professionals involved in some recent Australian projects to obtain some insights into the reasons for success and failures on projects and some of the lessons learnt.

This research is used to prepare an interactive reference guide of knowledge gained from past failures. The objective of the reference guide is that it can be used as a tool to inform engineers so that they can learn from past failures and be better informed as to the potential risks they may face in their project and factors to be considered.

The reference guide is not intended as an exhaustive tool as circumstances may change from project to project and site to site, its value will be as an information source to alert the user to potential challenges that may arise from specific site conditions.

Recognition of Maturity in Fruits Using Intel Realsense - (12cp)
Radhakrishna Alwar - A17-321

Supervisor: Beeshanga Abewardana Jayawickrama
Assessor: Ying He
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

The current avenue for monitoring farms to judge if the fruits are ripe are labour intensive and alternatives available in terms of surveillance prove to be quite pricey. This project is intended to provide an automated solution based on current technologies as an alternative.

The project is focused on taking current image recognition principles, algorithms and applying them to the goal of identifying if a chosen fruit is ripe. For the purposes of this project the chosen fruit will be an orange although principle used for the development of the algorithm can be also be applied to other fruits or vegetables.

The algorithm will be built making use of the depth features and where possible the current modules found in the Intel RealSense Camera. The algorithm is based around using 2 factors to determine if the fruit is ripe. The idea is that for a given photo of the chosen fruit, based on the average ratio of red to green pixels found in the fruit (which is compared to a similar avg ratio of pixels in a ripe fruit of the same kind) and the size of the fruit we can determine if it is ripe.

The current implementation and prototype will be working under the assumption that only one fruit will be present in the photo at a time and that the background will be of a single colour (controlled environment).

This project can prove extremely beneficial as a monitoring system for large farms. If it is attached to the drone it can be used as part of a regular time monitoring system and thus saving money and resources in form of reduced manual or electronic surveillance.

Design and Development of A Resistivity Measuring Device for Structural Health Monitoring - (12cp)

Sathira Wickramanayake Mudalige Don - A17-311

Supervisor: Sarath Kodagoda
Assessor: Lasi Piyathilaka
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

In ageing civil infrastructures, structural health monitoring plays a major role in maintaining proper standards. Some of the main factors that affect the strength and the durability of concrete are chloride ion permeability, rebar corrosion and the moisture conditions. There is a strong correlation between the aforementioned factors and the surface resistivity of a material. Therefore, analysing the resistivity of a concrete structure is a quick and a non-destructive method to evaluate the health of the concrete.

Several methods of measuring resistivity of a surface were investigated for civil applications, and the Wenner probe methodology was found to be the most consistent and reliable method of measuring surface resistivity. This project will aim to design and develop a non-destructive system to measure the resistivity of concrete. This system will be based on the Wenner probe principle, which uses four electrodes. The basic working principle of this method is to inject an alternating current on to the surface using the outer two electrodes whilst measuring the electrical potential difference from the inner two electrodes. The injected current and the potential difference measured, along with some other factors can be used to compute the electrical resistivity of the material.

The electrical resistivity of a material is also influenced by the rebar cover of the concrete. To produce consistent results, this system will have the ability to vary the frequency of the injected current to control the penetration depth of the current to take the rebar cover in to consideration when measuring the resistivity.

The data obtained from this system can be used to evaluate the structural properties of the concrete. Some tests revealed that higher concrete resistivity depicts a lower moisture content in the concrete while low values of resistivity shows a higher concrete moisture content. It was also apparent from the tests, that there is a significant influence on resistivity values from the extent of concrete corrosion and the rebar cover of concrete. These properties can be analysed to monitor the structural integrity of concrete.

The Sixth Sense: A Navigational Assistant Based On 3D Camera Vision to Aid the Visually Impaired Demographic - (12cp)

Manujaya Kankanige - A17-252

Supervisor: Beeshanga Abewardana Jayawickrama
Assessor: Ying He
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

The project looks at a mechanism to make up for limitations in sight, faced by the visually impaired demographic in their day to day lives. “The Sixth Sense” system provides a medium for its users to move around freely without the hassle of white canes or walking dogs. Instead, understanding what lies ahead of them is performed in greater detail via technology present in the proposed system. “The Sixth Sense” system makes use of 3-dimensional camera vision and audio feedback to deliver real-time awareness of the surrounding.

This concept utilises depth sensing functionality to detect the presence of obstacles that lie in the vicinity of a visually disadvantaged individual. The proposed system merges camera hardware with embedded software engineering, to generate an effective solution. The principle of Root-Mean-Square averaging used in the field of autonomous robot navigation has been compared against an optimised algorithm for improved accuracy in estimating the presence of obstacles. In addition to recognising obstructions, corresponding voice commands are conveyed to the user, enabling deviation from collisions.

Consequently, the final real-time system is capable of assisting users to clearly grasp information regarding static or moving obstructions present within the field of view. A working model of the application capable of demonstrating aforementioned functionality has been designed and implemented. A combination of an ordinary laptop, in-built speaker audio and Intel’s RealSense camera have been employed to successfully construct this prototype.

Not only does “The Sixth Sense” system provide a mean for bridging the gap between the visually disabled population and the real world, it also illustrates possibilities of utilising advancements in technology to support people in need.

Design and Testing of a Multi-Purpose Refrigeration System - (12cp)
Abdullah Aldehaim - A17-257

Supervisor: JC Ji
Assessor: Dongbin Wei
Major: Mechanical Engineering Major BE and BEDipEngPrac

Refrigeration systems have a considerable impact on the human life, and nowadays refrigerators and air-conditioners are an indispensable part of the modern life. The vapour compression refrigeration system is the most popular type of refrigeration systems. Vapour compression refrigeration systems, nonetheless, have harmful impacts on the environment due to the effect of refrigerants on the ozone layer depletion and the production of the greenhouse gases that are responsible for global warming. Therefore, considerable efforts are made to use environmental-friendly refrigerants that are less harmful to the environment. In the current project, a multi-purpose refrigeration system with heat recovery unit is theoretically designed and investigated for refrigeration, air-conditioning and providing of hot and cold drinking water. For this purpose, three conceptual configurations are studied assuming that the systems utilise the R134a refrigerant. Theoretical investigation demonstrates that the inclusion of the heat recovery unit enhances the performance of the system considerably, especially in countries with very hot climates, like Kuwait. Furthermore, the effect of utilising different refrigerants is analysed computationally. It is observed that R152a and R600 will improve the system performance by about 8%. Furthermore, their utilisation results in a substantial decrease in the required mass flow rate of the refrigerant. Effects of the different system parameters are also analysed regarding the system performance. It is observed that decreasing the condenser temperature as well as increasing the degree of subcooling improves the performance of the system considerably. Furthermore, it is observed that increasing the degree of superheating enhances the system performance, but its effect is not as considerable as increasing the degree of subcooling. A prototype of the system, designed with a single evaporator, is built in Kuwait by a local manufacturer and used for the experimental investigation of the system. The obtained experimental data demonstrates the feasibility of the system and the validity of the theoretical studies.

Control Rotors - (12cp)
Zachary Dowling - A17-259

Supervisor: Guang Hong
Assessor: Paul Walker
Major: Mechanical Engineering Major BE and BEDipEngPrac

In Australian coal fired power stations, the steam turbines are designed to operate at 3000rpm. When a steam turbine operates beyond the designed speed the unit is at risk of catastrophic failure which leads to major financial and safety risks for plant owners. Toshiba steam turbines are equipped with over-speed protection devices that shut-down the steam turbine once over-speed conditions are reached. One such device implemented on Toshiba steam turbines are the emergency governors on the control rotor. When a Toshiba steam turbine operates at 3300rpm the emergency governors expand and send a signal that shuts down the turbine.

As the emergency governors are a critical component of the steam turbine, the response of the emergency governors is required to be tested during power station outages. However, at Toshiba International Corporation there is no dedicated device to test the response of the emergency governors and alternative test methods need to be undertaken.

In this report an over-speed testing device is designed to accurately test the response of emergency governors on turbine control rotors. As part of the design process, research was undertaken to understand the current testing methods, the mechanical principles of the emergency governors as well as the principles of motor speed control. The designed testing device also features an oil injection system that simulates on-line oil injection over-speed testing.

The result of this capstone is a comprehensive design report that Toshiba International Corporation can use to manufacture an emergency governor testing device.

Investigating the Role of Disc Degeneration in the Progression of a Spondylolytic Defect at L5 to Spondylolisthesis: A Biomechanical Study - (12cp)

Vivek Ramakrishna - A17-260

Supervisor: Ahmed Al-Ani
Assessor: Terry Brown
Major: Biomedical Engineering Major BE and BEDipEngPrac

Low back pain (LBP) will affect 70-80% of individuals at some point in their life to the detriment of their emotional and physical state. Diagnosing and treating the cause of LBP is a significant challenge facing clinicians, as less than one in five cases of LBP can be attributed to a specific cause.

Spondylolysis is a fracture to the pars region of the lumbar vertebra which affects nearly 6% of the general population. Progression of spondylolysis to spondylolisthesis (or vertebral slippage) is a painful condition that occurs in nearly 80% of the individuals with a pars fracture, however, reasons behind this progression are not well understood.

Radiographic analyses have highlighted that degeneration of the intervertebral disc is often associated with both vertebral slippage and the pars fracture. In the absence of quantitative analysis, however, it is unclear whether disc degeneration is the cause or consequence of progression to vertebral slippage. The aim of this project was to clarify the role of disc degeneration in the progression of a pars fracture to vertebral slippage using finite element (FE) analysis to provide a quantitative, biomechanical perspective.

Five FE models were generated from segmented computed tomography (CT) scans of the lumbosacral spine, representing a range of intervertebral disc degeneration severities. When simulated in forward and backward bending motion, results indicated that a segment is more prone to anterior slippage when in a state of mild disc degeneration, rather than severe. Consequently, cases of severe disc degeneration observed in spondylolisthesis are likely to have progressed to slippage in a mildly-degenerate state before the slippage induced further degeneration of the disc. Radiographic validation of these findings is necessary before guiding the course of clinical treatment.

Determining and Implementing Distance Based Sensors for Assistive Robotic Systems - (12cp)
Eashwinder Deharput - A17-265

Supervisor: Marc Carmichael
Assessor: Teresa Vidal Calleja
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Human-robot collaboration is a growing research field that is anticipated to result in fascinating developments in many fields, including materials handling, manufacturing, robotic surgery, rehabilitation and more. . However, having systems that either assist humans for work for humans, need to have assurance of reliability and safety, as these are the two main deciding factors for collaborative robotic systems to be adopted. One of the main methods to achieve a reliable and safe system is through sensing which gives an autonomous system perception, similar or greater than, of a human, and enables it to react and behave in certain conditions.

This thesis explores different types of sensors, that are relatively inexpensive, to be implemented on an upper limb robotic exoskeleton. The Jexo is a 5 degree of freedom robotic arm, in the Centre of Autonomous System. Currently the Jexo system utilises a pressure sensor implemented near the elbow joint to measure contact with a human user, allowing it to follow their arm motions. This project looks to replace that component with a non-contact distance based sensor, so a user would not have to apply pressure for the Jexo to follow their motions.

The sensors would have to be sourced, tested via experiments, analysed to determine which are suitable based on speed, accuracy and range, and then integrated into the existing Jexo system to replace the current pressure sensor. From analysing the data from the experiments, that tested the range, speed and accuracy, a time of flight sensor, Sparkfun VL6180, was chosen to be the most suitable for implementation, as the other sensors were lacking in performance. Further tests were performed for calibration, once the sensor was successfully implemented into the Jexo system, however, more testing was needed for accurate calibration.

Portalised Steel Trusses vs Portal Steel Frames for Long Span Industrial Buildings - (12cp)

Hussein Haydar - A17-268

Supervisor: Harry Far
Assessor: Ali Saleh
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Portal frames and portalised truss structures are emerging as two of the most cost effective and sustainable structural commodities for utilisation in the design and construction of long span industrial buildings. Although the application of both steel cladded structures may be heavily implemented across Australia, particularly within the health and industrial sectors, it may be assumed that there is enough information to provide solutions to unpredictable queries that may arise. However, due to frame complexity and variation of frame types there has yet to be a source that provides a comprehensive investigation on the concepts of portalised trusses and portal frames for use in single story buildings that exceed spans greater than 30 meters.

This study has examined the behaviour of a portalised truss configuration in contrast to a pitched portal frame for use in long span industrial buildings that exceed 30 meters and has considered the weight, costs and time for construction. This study entails a numerical investigation that utilises SAP2000 a computer program to model and structurally optimise the member properties for both portal frame and portalised truss configurations.

Consequently, from the results obtained from the investigation, the portalised truss configurations were found to be lighter, cheaper to fabricate and construct due to the smaller sections used in comparison to the pitched portal frame that established a shorter time for construction. Ultimately, it is recommended that a portalised truss configuration should be utilised in lieu of a pitched portal frame for applications that require a light weight and low-cost alternative. Whereas the pitched portal frame is recommended for applications where there is a limitation on construction time, this however would result in a more expensive structure.

Motorcycle Suspension Data Recorder and Tuner - (12cp)
Myles Savage - A17-271

Supervisor: Terry Brown
Assessor: Jonathon O'Neill
Major: Mechanical Engineering Major BE and BEDipEngPrac

Most motorcycle suspension (front and rear) have multiple settings riders can adjust including preload, compression and rebound. Suspension changes can be dangerous, difficult and expensive without optimal settings for various riding environments. Settings can significantly alter performances and tyre grip through the suspension's ability to keep the wheels in contact with the road which may also impact the handling characteristics, safety and comfort for the rider.

Through investigating suspension issues, I've identified opportunities for further research/ experimentation and determined affordable ways of creating useful indicators for riders to change their suspension settings, reducing the guess work and improve safety in an affordable and intuitive way.

I have 25 years' experience riding motorcycles, I did not have much experience in suspension analysis. I developed my understanding through library research, internet websites, forums, seeking advice, identification and investigation of key suspension theories.
Equipment selected considered budget and time with a goal to produce data and analyse outcomes during track day conditions. Equipment was incorporated on the motorcycle through various design iterations as per my design criteria, with consideration for safety and the motorcycles mechanical operation. I systematically researched, investigated, selected and installed equipment in a logical process to understand, analyse and produce suspension optimising indicators from the data logging and analysing system I designed.

My system interpreted the physical suspension movement into raw numerical data. I then used excel to analyse the suspension system and produced information on displacement, velocity and histograms supported by mathematical arguments. I overcame glitches through innovative designs. Experiments included street, pillion and race-track rides to investigate cause and effects of techniques and hardware. Suspensions analysis techniques gained through experiments include free, bike and rider sag, dynamic sag, rear anti sag, suspension average travel and velocities and fork bottom out information.

The data analysis indicators assist a rider to understand the critical parameters of their motorcycle suspension system showing variable mechanical conditions best suited to the riding environment. The system is relatively simple and affordable compared to consumer data logging equipment. I have successfully developed a robust tool for suspension setting optimisation for motorcycles.

Human Activity Recognition with Deep Learning Using Smartphone as a Sensor - (12cp)

Ali Kutlu Omeroglu - A17-274

Supervisor: Andrew Zhang
Assessor: Forest Zhu
Major: ICT Engineering major BEBE (Hons) BBus, BEBE (Hons) BSc

Our everyday devices come packed with embedded sensors. Smartphones and wearable devices are one of the best examples of this as they include various sensors that consistently collect data about our usage, location and movements. The data collected from these devices is usually processed using some sort of machine learning algorithm to solve various domain challenges. In this project, a deep learning algorithm was employed to solve the challenge of human activity recognition.

As a result of the recent rapid developments in AI and the trend of open source software, machine learning algorithms are available to public through open-source software libraries. In addition to these libraries, data collected in previous research is often made publicly available. The aim of this project is to utilise these resources to build a model to predict human activities from the data collected using an application developed for android smartphones.

The project comprises of two subsystems; a data collection application and a machine learning model for human activity prediction. The first sub-system is an android application, which was built to collect data from IMUs that are embedded in our smartphones. The collected data is then uploaded to a cloud storage server to be processed on the server-side. The second system is a server-side python application which includes the necessary features to feed the retrieved data into an LSTM recurrent neural network. The model created was trained using an online dataset allowing it to predict the human activities based on the accelerometer data collected by the android application developed. Prediction accuracy of up to 94% was achieved on the test data derived from the dataset. The prediction accuracy of the algorithms was also cross checked against the data collected to ensure that model generalises as intended.

Investigating the Impact of Workplace Cultures of Modern Engineering Organtisations - (12cp)

Maria Sawiris - A17-175

Supervisor: Anne Gardner
Assessor: Timothy Aubrey
Major: Civil Engineering Major BE and BEDipEngPrac

The profitability and productivity of an engineering organisation relies heavily on the engineering decisions and behaviours of employees and managers. Engineers are required to abide by industry codes of practice and it has been found that the workplace culture of an organisation can play a major role in an engineer's ability to do so. Workplace cultures incorporate many different elements which help to shape an engineer's decisions and behaviours. This research aims to explore these different elements of a workplace culture and the impact they have on engineers and consequently the success of the organisation.

The purpose of this research is to investigate the impact of workplace cultures on modern engineering organisations. For this research, data was initially collected through a literature study on this topic to inform my research, and this literature study analysed a range of sources including textbooks and peer-reviewed journal articles. The primary data source for this research however, came from interviews with practicing engineers in the Australian industry. These interviews were coded in order to identify recurring themes that were supported by the literature study. A document analysis was also conducted on the organisational codes of conduct to identify any impact these had on the interview participants' experiences.

The findings validated the importance of the factors that were identified in the literature review in regards to their impact on workplace culture. The interview findings also confirmed that there were relationships between aspects of workplace cultures and engineering decision making.

Investigating the Role of Structural Engineers in Sustainable Development - (12cp)
Erin Beckefeld - A17-194

Supervisor: Anne Gardner
Assessor: Roger Hadgraft
Major: Civil Engineering Major BE and BEDipEngPrac

In the Australian market, the green building movement has aimed to integrate key concepts of sustainability within the design, construction, and operational practices of the built environment to minimise social, economic, and environmental impacts of the construction sector. Engineers are relied upon to assist in and lead the delivery of projects underpinned by sustainability agenda, and are often required to work beyond the traditional scope of their work in order to do so. The key objective of this research is to define the role of structural engineers in sustainable development, within the Australian market.

A case study analysis was undertaken to explore how the role of engineers on green building projects differed from conventional building projects. The International House project in the Barangaroo precinct was selected due to its notability and striking use of engineered timber, with three structural engineers interviewed in order to investigate their roles within the context of the International House project, and timber structures in general. The interviews were transcribed and analysed in order to identify and investigate key themes related to their respective roles.

The role of structural engineers was found to have extended beyond the traditional scope where engineered timber was implemented, primarily due to an industry wide lack of knowledge related to the use of timber as a building material. Furthermore, engineers are required to collaborate with developers, architects, and contractors, due to a distinctively higher level of coordination associated with timber structures. Whilst engineers should act as personal advocates for sustainability, they must also support architects where necessary, in order to deliver projects that capture the needs of communities and building occupants. However, engineers are influenced by the dynamic environment within which they operate, meaning other project stakeholders may either influence or limit the extent of their contribution to sustainable building projects.

A Preliminary Investigation into Field Hockey Face and Head Protection Systems - (12cp)
Gabrielle Harradine - A17-107

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

Field hockey is a sport that is accustomed to injuries to the head and face, sustained through contact with either the ball or a stick. However unlike sports with similar head injury mechanisms, head or face protection in hockey is not compulsory, and is not required to be made to any standard, or tested to performance standards. The efficacy of the current head and face protection systems is questionable and is yet to be the subject of a major study.

This thesis investigated current interventions which reduce the likelihood and severity of facial and head injuries suffered during a field hockey match. It is hoped that the findings of this report will assist the hockey community in ensuring player safety for the future of the game.

A test rig was developed using an automated hockey ball firing machine which shot balls at the mask whilst it was attached to a headform. Testing was performed on face masks currently available on the market. An in depth literature review, survey of a portion of the hockey community, and an analysis of protection in other sports was also conducted.

The investigation showed that the masks performed in a manner not adequate for face and head protection from hockey balls travelling at high speeds. The deformation and fracture of masks, and the potential for injury to the face under this impact, was surprising and concerning. The comparison to other sports and the survey highlighted the need for the development of standards.

The findings from this investigation suggest that the generation of an Australian standard for face masks is crucial, in order to improve player safety in field hockey. Field hockey must follow the lead of other sports by conducting further investigations into their equipment and the benefit this protection has for athletes.

Investigate Methods of Increasing Knock Resistance of High Performance Turbocharged Engines - (12cp)
Nicholas Davies - A17-180

Supervisor: Guang Hong
Assessor: Yuhan Huang
Major: Mechanical Engineering Major BE and BEDipEngPrac

For turbocharged engines, high intake temperatures are one of the major factors attributed with engine knocking. The issue with high intake temperatures is that they are difficult to control. As a result engine design and operation parameters need to be adjusted to prevent internal damage caused by engine knock. The engine control unit (ECU) alters parameters such as; ignition timing, air/fuel ratio and on forced induction engines, boost pressure. On high performance engines this is not tolerable and so other methods must be exploited to increase the knock resistance of an engine.
Driven by my personal interest in internal combustion engines to address the above issues, I converted the original engine in my Subaru Liberty to run safely on ethanol based fuels and conducted testing on a chassis dynamometer to replicate normal running conditions. I designed a heatshield and insulation to lower the engine bay temperature to prevent heat soaking of the intake system. An aftermarket Water/Methanol injection system was sourced and temporarily installed on the car.
This report includes detailed comparison of the mentioned systems used to reduce intake charge temperatures and investigation of sourcing and determining the correct method of installation. These methods have been comparatively tested considering all advantages and disadvantages of running each system and their overall effectiveness. All tests were conducted on a chassis dynamometer in realistic running conditions. The results showed conclusive findings.

World Solar Challenge: Long Distance Driver Fatigue in Lightweight Vehicles – Objective Evaluation and Monitoring Of Seat Discomfort - (12cp)
Anna Lidfors Lindqvist - S17-189

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

The University of Technology Sydney is aiming to compete in The World Solar challenge competition in 2019. The competition requires a vehicle using solar energy as its only power source, meaning the vehicle will need to be extremely lightweight. The low weight makes the vehicle more prone to excessive vibrations, which is transmitted straight onto the driver via the seat. As such, selecting a seat to be used in the solar car will require an evaluation of the effect of vibration on the user.

The objective of this project is to find a method to record seat fidget movements as an objective evaluation of seat discomfort, by designing and evaluating a seat sensor system. The sensor system consists of Force Sensing Resistors (FSR) that are wired in an array of Voltage Dividers. Data was then collected and compared to cumulative vibration in the form of VDV (Vibration dose value).

For the purpose of testing and evaluating the prototype data acquisition arrangement, a vehicle seat was mounted to a small shaker in a laboratory environment, five volunteers sat in the seat for a duration of two hours. Due to the low number of participants, no correct statistical analysis could be made. Although, the raw data displayed that the system is able to pick up on movement of the seated participants, and an increase in fidget movements was demonstrated for participants over the duration of the tests.

However, the sensors were found to be dependent on their placement, showing more movement for areas under less pressure which indicates that the system may be missing fidget data under areas that experience a higher level of pressure. Therefore, the chosen system is not suitable for picking up on smaller movements such as fidgeting.

Investigation of Fuel Injection Control in a Ni Electronic Control Unit for Experimental Research on Internal Combustion Engine - (12cp)
Nicholas Millar - A17-070

Supervisor: Guang Hong
Assessor: Steven Su
Major: Mechanical Engineering Major BE and BEDipEngPrac

Most Electronic Control Unit (ECU) systems are manufactured by a small amount of companies and supplied mostly to engine manufacturers. Motor vehicles with Electronic Control Units are designed to maximize the performance of their internal combustion engine. Whilst undertaking research work on internal combustion engines, it often becomes necessary to study important control aspects of the engine such as fuel injection duration and valve timing to determine how each aspect influences the performance of the engine. This project arose because the University of Technology, Sydney wanted to perform research on an engine using an ECU. However, Electronic Control units are expensive and complex pieces of hardware to set up and configure. A solution to this problem was the use of a National Instruments CompactRIO (ECU) which is a cost and time effective solution. This project was aimed to investigate the ECU and to ascertain whether or not the ECU is suitable for experimental research on internal combustion engines. To understand whether the ECU is suitable for research, the project main aim was to focus on the control of fuel injection and whether this was possible or not using the CompactRIO.

All hardware and software aspects of this project had been previously installed and configured by a previous capstone student named Alfred Royce De Leon. The software that is compatible with the CompactRIO is called LabVIEW. National Instruments had provided a functioning LabVIEW program to control a fuel injector. However, this program did not have the ability to adjust the timing of the injector upon a varying signal and all input to the injector was based off static input variables from the user.

A function generator was used to provide a varying square wave signal to simulate a vehicles engine speed. I developed a program using National Instrument LabVIEW software to read in the frequency from the generator, convert the frequency into RPM and then to provide the engine speed to the NI injector control program. The injector timing and duration could be increased or decreased based on the varying signal from the function generator. Upon completion of this project, the National Instrument ECU was successfully able to control a direct fuel injector and it was determined that the NI CompactRIO is a suitable ECU to perform research on an internal combustion engine and its components.

Surf Life Saving Water Craft Competitor Emergency Safety System - (12cp)
Adam Atkins - A17-136

Supervisor: Terry Brown
Assessor: Marc Carmichael
Major: Mechanical Engineering Major BE and BEDipEngPrac

There is currently a need in the Surf Life Saving Sport to ensure water craft competitor safety. This need has arisen due to catastrophic and tragic events where three competitors lost their lives at the national level competitive event, The Australian Surf Life Saving Championships, over a period of 20 years. High level investigation has identified a need for improved safety measures. The recommended measures such as helmets and lifejackets were not well received by the sport.

The aim of this project has been to design a proof of concept device which would be worn by each competitor that could monitor their condition. In the unfortunate event of their incapacitation it would activate an alarm mechanism which would alert officials and nearby competitors to an incapacitated individual and aid in locating them for rescue. This would reduce response time to the detection of the emergency and aid in the implementation of the rescue.

Various factors of the competitor and their immediate environment were considered for their potential to be quantitatively assessed. These factors include ambient pressure, movement, position (via GPS) and heart rate. These were also considered against my relevant experience and the available technologies in microcontrollers and sensors. Final design incorporated an Arduino Uno and an electromyography (EMG) sensor.

It was determined that this device does have potential for further improvement and potential marketability to the intended target market of Surf Life Saving as well as many other water based sports. These improvements have been outlined in the report.

LED Constant Current Driver – Load for Phase-Cut Dimmer - (12cp)
Shamsher Dhanju - A17-143

Supervisor: Dylan Lu
Assessor: Yam Siwakoti
Major: Electrical Engineering Major BE and BEDipEngPrac

Standards play an important role for the product development and ensure that goods and services are performing the way they intend to perform. Standards are developed, updated and changed from time to time depending upon the needs. Anyone can propose the development or revision of the standard or technical document by following the process put in place by the regulatory body (like Standards Australia).

Standards are also used by test labs so that they can follow standards and procedures to check that products are safe and as intended. The government of the country rely on the standards to protect citizens from unsafe products.

Standards could vary from country to country. Companies/manufacturers need international standards (International Technical Commission -IEC) so that they are able to sell their products globally. International standards contain all the information companies need in order to find the difference between individual countries the company would like to sell their products. This helps companies to save time and money and can produce products that operate in predictable way anywhere in the world.

The role of IEC is to facilitate the complicated of reaching agreement among the many experts from countries all over the world who volunteer to prepare the rules, specifications and terminology that allow manufacturers to build devices that work together, safely and as expected. IEC provides a platform where representatives from industry, government, universities, research and companies can meet. It also publishes consensus based International Standards for electrical, electronics, processes and technologies – collectively known as electrotechnology.

During my internship at Legrand and being the company highly involved in LED design, IEC approached Legrand and asked them to volunteer to design a circuit and check its performance so that it can be used as a benchmark for LED dimmers. This will help in standardising a product. Based on this I used this topic as a capstone project so that I can research about the LED, its design, operation, functionality and comparability. This project reflects on LED technology and describes that how in such a short duration of time there has been so much research involved in this technology and the reasons behind it.

World Solar Challenge Vehicle Project UTS Team - (12cp)
Enoch Zhao - A17-184

Supervisor: Paul Walker
Assessor: Terry Brown
Major: Mechanical Engineering Major BE and BEDipEngPrac

The University of Technology Sydney has collaborated with RMIT, QUT, Curtin University, and UNISA to participate in the World Solar Challenge in 2019. The competition involves developing a solar-powered vehicle to race from Darwin to Adelaide. The solar-powered vehicle is therefore designed with the foremost consideration in optimising energy efficiency.

The main concern of solar-powered vehicles is their weight. Commercially available steering systems weigh too substantially to be beneficial for the World Solar Challenge competition. The aim of the project is to resolve the weight issue by developing a custom light weight steering system that will satisfy all the project parameters with considerable advantages over sourced counterparts. Subsequent to this, various types of steering systems utilised by modern conventional vehicles were explored. As a result, the rack-and-pinion steering mechanism was chosen due to its reduced complexity, less space required, and ease of construction characteristics (Borse at el., 2016).

The resulting achievements of this project include developing two possible steering rack design concepts. Upon further assessment one particular design concept, Mark II, was determined to have advantages over the other and was clearly the better design. This design was equal in strength as its pre-successors, was theoretically more durable, and required less material in production. A selection of durable and lightweight materials such as aluminium, titanium, and Polytetrafluoroethylene (Teflon) was considered in the design concept. Finally, Mark II weighs approximately 4.72 kg, which satisfies the project parameters. Therefore, Mark II is proposed as the ideal design to be incorporated into the lightweight WSC solar-powered vehicle.

Further development of the system could include optimising design variables with consideration of component structural strength, and possibly experimenting with alternate lightweight materials.

Communications Driver for Proprietary Refrigeration and Building Management System Protocol - (12cp)

Stuart Johnston - A17-293

Supervisor: Peter McLean
Assessor: Ying He
Major: Electrical Engineering Major BE and BEDipEngPrac

Modern refrigeration and building management systems provide a wealth of data to their installers and operators. By observing the operation of the system as a whole, valuable insights can be made to improve the efficiency of operations, reduce operating costs and decrease the impact of these systems on the environment. Unfortunately, these targets are often complicated by the undocumented proprietary communications protocols that are employed. The use of proprietary protocols helps to enforce vendor lock-in and prevents owners from receiving the most competitive services and support.

It is frequently possible to examine the network traffic containing protocol messages and, through investigation and analysis, determine the meaning of the data being sent. This project aims to examine one of these proprietary communications protocols, decoding its constituent elements so that a thorough understanding of the system can be found and enabling the platform to open for other uses. A practical application involving the development of a communications driver for this protocol for the Tridium Niagara controls platform is also included in the scope. This will allow owners to access information provided by these systems and issue control operations from a much wider range of systems and contractors, enabling them to receive the most competitive service.

The outcome of this project was very successful. The basic protocol structure, almost all basic operations and several advanced operations were fully decoded and understood. A driver module for this protocol is in active development. It is currently in use in industry to collect data for efficiency analytics purposes, with further interest expressed from third party distributors for wider use.

Wireless Charging System for Electrification - (12cp)
Hoang Minh Tan - S17-176

Supervisor: Ha Pham
Assessor: Ricardo Aguilera Echeverria
Major: Electrical Engineering Major BE and BEDipEngPrac

In the recent years, the development of Electric Vehicles (EVs) has risen since the lack of Fossil Fuel Energy around the world. This development has pushed the innovation of all related electrical/ electronic technology in this EVs industry including charging technology. The conventional plug-in charging system, in spite of its efficiency and reliability, has shown many disadvantages in common usage. As a result, Wireless Power Transfer (WPT) systems were widely developed to solve this charging problem.

The most developed WPT technique is Inductive Power Transfer (IPT) technique. Currently, this system provides EVs with the most efficient and reliable charging method in the Industry. IPT is not a brand new technique but has been developed for hundred years. However, its functionality and capability have not been totally explored. Many researches and experiments have been conducted to maximize the capability of IPT system and hence, increase the productivity of EVs industry.

This report is going to demonstrate a new bi-directional IPT system which can be installed on Electric Wheel, a device that turns traditional bicycles into Electric Bikes. This IPT system can both charge the Wheel's battery and supply the grid with energy from the battery. By doing so, the bicycle parking station is turned into a small powerplant for a building, a mall or furthermore, a smart city. In order to handle the capability of a small powerplant, the proposed IPT system must transfer Power in kW for each Bike. This power must be transferred in a proper airgap to maintain advantages of WPT technique. Finally, the size of the IPT system must be minimized to ensure its installation's ability within a normal bicycle wheel.

The system presented in this project is shown to be able to transfer 1.5kW within 3mm airgap distance with 97.2% efficiency. This is done by providing a 400 AC voltage at 85kHz through a transmission topology constructed by two E- ferrite coils.

Construction Enterprise Information Management: Information Integration at Project & Organisational Levels - (12cp)
James Fleetwood - A17-117

Supervisor: Julie Jupp
Assessor: Rob Jarman
Major: Civil Engineering Major BBEBBus and BEBsc

Globally, the construction industry has awoken to the importance of real-time, data-driven decision support. In a select number of Australian Tier 1 and 2 organisations, general contractors are pursuing a holistic approach to systems integration that encompasses all aspects of business – implementing digital platforms to support Enterprise Information Management (EIM). Against this backcloth, this research project investigates this growing shift in the Australian construction industry and considers the impacts of recent advances in Building Information Modelling (BIM) on the integration requirements of architectural, engineering, construction and operation (AECO) data and information. The research utilises findings derived from the literature and two original case studies implemented using a qualitative research method. Semi-structured interviews and a follow-up survey were implemented The findings of the case study analysis describe the aims and objectives of the strategies underpinning each organisation, contrasting the traditional approach with a 'radical' and potentially disruptive digital innovation strategy. The case findings document the capabilities and challenges of implementing digital enterprise platforms relative to the maturity of seven core aspects of EIM systems, namely (i) systems integration, (ii) workflow and process management, (iii) quality and performance management, (iv) knowledge and information management, (v) data lifecycle management, (vi) governance and (vii) human factors. The case study analysis is also considered relative to the customisation of "off-the-shelf" platform solutions versus internal R&D initiatives being undertaken by general contractors to develop bespoke, in-house platforms. The findings suggest that robust change management backed by top down organisational support, bottom up engagement, and middle out management is required to successfully implement digital enterprise platforms that transverse all three levels of activity. Further empirical research on supporting systems engineering methods and transformation of traditional business models are needed to address the unique characteristics of a contemporary digital construction ecosystem.

Autonomous 3D Concrete Printing by means of Industrial - (12cp)
Jarred Renneberg - A17-090

Supervisor: Gavin Paul Shami Nejadi
Assessor: Shami Nejadi
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

With the progression and advancements in technology, the implementation of robotics and automated solutions have become increasingly common in industrial applications. Modern industries, particularly manufacturing, have embraced the advancements of robotics and the benefits in efficiency and safety that they provide. For the construction industry, particularly in highly labour-intensive applications, the acceptance and incorporation of technological advancements, like robotics, tends to be quite slow in comparison. The process of mixing and laying concrete in desired formations takes considerable time and can be quite strenuous for workers to perform. With an autonomous implementation, the time required to setup and lay concrete could be significantly reduced and add a whole new level of efficiency to this common but vital construction process.

Recent advancements in additive manufacturing processes continue to highlight its viability in commercial and research applications. In contrast to subtractive manufacturing, additive manufacturing relies on building desired components layer by layer through means of extrusion (or similar). An example of this, 3-Dimensional Printing (3DP), is a widely used process which uses the extrusion of filament material to build up components in layer increments. Each layer is determined by a pre-programmed toolpath which the extruder follows. Applying this concept with the extrusion of concrete through a pre-programmed 6DOF robotic arm has yielded interesting results. Path planning is created using customised software which uses a combination of resolve motion rate control and damped least squares methods to form smooth trajectories while working in tandem with various delivery systems.

The content of this report will detail the implementation and progressive development and design of the hardware and software components that make up the robotic system and demonstrates how the system works. Supported by an initial literature review, which examines the viability of the system, and printed results recorded over the course of the project, an evaluation will be conducted on the system. This will then be summarised with the intended future works for the project and what areas need future research in order to improve the system's viability in practical applications.

RavenWorks – All-in-one Framework for Rapid Internet of Things Development (6cp) - (12cp)

Xu Lian - A17-148

Supervisor: Steven Su
Assessor: Rifai Chai
Major: Electrical Engineering Major BE and BEDipEngPrac

The E-Nose project aimed for detecting and analyzing the chemical composition in air, is developing by Steven Su et al. at University of Technology Sydney. It is proposed to replace the traditional sniffer animals and enhance the quality and quantity in the chemical detection and analysis for various areas such as examining grade and freshness in food industry, diagnosing the potential illness such as cancer from patients in heathy and pharmaceutical field and detecting potential threats in customs. The primary goal of this capstone project is to help the on-going E-Nose development on the end-user software design and development. This will enable the E-Nose a broad range of accessibility with ease-of-use on modern personal computing devices such as smart phone and tablets.

Although there are existing end user applications for monitoring and analysis the received reading from the electronic noses, they are not modern, cloud and Internet of Things ready, across platform, and ease-of-use up to today's standard. This project focuses on providing an all-in-one solution to address the listed issues on IoT and end-user softwares of existing applications.

RavenWorks, the final product of this project, has achieved its viable state. It is composed of embedded middleware framework, cross-platform end-user software scaffolds and cloud services. The middleware framework that providing device control, data sampling and secure networking and communication accelerates the development cycle of the embedded software of the IoT hardware. The cross-platform Desktop, Web App and Mobile (iOS and Android) end-user software scaffolds provide a quick-n-simple development entry point and stay-finished foundation. The cloud services link the IoT devices and their users and applications across the globe. Thus, RavenWorks is the all-in-one framework for rapid Internet of Things development. The E-Nose project at UTS that adopted RavenWorks will reach a broad range accessibility with ease-of-use on modern personal computing devices in the foreseeable future.

Effect of Limestone Mineral Addition on Sulfate Resistance of Concrete - (12cp)
Jeremy Carnovale - S16-193

Supervisor: Vute Sirivivatnanon
Assessor: Kirk Vessalas
Major: Civil Engineering Major BE and BEDipEngPrac

The addition of limestone mineral into Portland cement has the capability of lowering the embodied carbon of the cement. There has been some concern that using more limestone mineral in cement than what is allowed in AS3972 can reduce the binder's sulfate resistance, thus causing expansion of the concrete and consequential loss of strength and elastic properties, resulting in an adverse effect on the concrete's durability.

This experimental dissertation studies the influence of the addition of limestone mineral into Portland cement at differing quantities, and with 20% fly ash replacement of cement in each of the different levels of limestone mineral addition. Results of research carried out by Irassar et al. (2011) have shown that limestone mineral addition under 10% causes no significant changes in the sulfate resisting ability of Portland cement, but a higher composition (over 15%) may have an impact. Additionally, results of research undertaken by Hooton and Thomas (2016) have shown that the addition of fly ash may prevent the influence of limestone on sulfate resistance.

Mortar bar samples measuring 25 mm x 25 mm x 285 mm and cube samples measuring 50 mm x 50 mm x 50 mm of a 0% limestone content Portland cement mix, an 8% limestone mineral addition Portland cement mix and a 17% limestone mineral addition Portland cement mix were prepared. Directions were followed as per the recommendations given under ASTM C1012-04 Standard Test Method to replicate conditions in the relevant literature and emulate real-world conditions. Following standard curing procedures, compression tests were undertaken on the cube samples to ensure sufficient strength was achieved prior to sulfate penetration. Following sufficient strength development of 20 MPa, to emulate real-world conditions, the samples were kept in a sodium sulfate solution at room temperature for the duration of testing. The length of the bar samples were taken on a weekly basis to assess the expansion of the samples over time. The different rates of expansion were the basis of assessing the relationships between limestone mineral addition and the potential for sulfate attack.

The results thus far have correlated with current literature to demonstrate that the greater the level of limestone mineral addition, the greater the level of linear expansion. In addition, each of the mixes containing fly ash demonstrate less expansion for equivalent limestone mineral content, potentially as a result of the decreased permeability of the mix leading to increased resistance against sulfate attack.

Brain Computer Interface- fNIRS Signals - (12cp)
Meenal Sharma - A17-169

Supervisor: Rifai Chai
Assessor: Steve Ling
Major: Biomedical Engineering Major BE and BEDipEngPrac

Brain Computer Interface (BCI) enables the use of brain activity to control computer or other source of medium of external devices. It is an extraordinary and powerful tool that has the capacity to bypass the individuals' peripheral nervous system to provide a more proficient means of communication for those patients suffering from motor disabilities. There are several types of signals that can be put to target within BCI; however within this project the main focus is on fNIRS signals which is an advances neuroimaging technology that is non-invasive in monitoring brain activity.

The data was gathered from BNC database which is of 8 participants' whose hemoglobin response patterns has been collected during the performance of a mental arithmetic task. A wave system is created to analyse the oxygenation level within their brain which measures the changes in oxy, deoxy and total hemoglobin. The purpose of this study is to investigate the fNIRS signals by inputting it through various stages in order to determine its performance. Initially the data underwent preprocessing stage, followed by a number of features were extracted for efficient filtrations of signals such as mean, standard deviation and skewness. Then classifying it with various different classifiers such as Support Vector Machines, Linear Discriminant Analysis (LDA) and K-nearest neighbors algorithm (KNN) which helps determine the accuracy and success rate of the model. The validation of the model was tested minutely based on individual 52 channels as well where Fine Gaussian SVM resulted in an average accuracy of above 90% for all oxygenated, deoxygenated and Total Hemoglobin. Other forms of performance for the signals were determined based on the confusion matrix and ROC curve which on average gave the AUC of above 0.85. On the other hand KNN Coarse did not perform well on any of the channels with resulted in accuracy below 60%.

Overall, the classification conducted resulted in promising outcomes that holds demand for utilizing new and unique systems to be built as it holds strong potential to be applied in future for neurorehabilitation and neurofeedback applications within Brain Computer Interface. Thus, this project holds great potential for new great advancements in the engineering community through a novel algorithm system.

Development of a High-Speed Eye-Controlled Communication Tool for Physical Disability - (12cp)
Nicholas Temple - S16-102

Supervisor: Steven Su
Assessor: JC Ji
Major: ICT Engineering major BE (Hons), BE (Hons) DipProfEngPrac

In Australia, a significant percentage of the population is affected by a physical disability. Of these individuals, many are challenged with a high-level physical disability limiting their ability to communicate. For many people with disabilities including cerebral palsy and locked-in syndrome an individual's eyes can be one of the only muscles that person can reliably control. Many eye-controlled communication systems available today take advantage of this but are limited in speed by the method of gaze interaction.

The aim in developing a high-speed eye-controlled communication tool is to utilise modern eye-tracking hardware and software methods to create a system that will allow faster eye-communication compared to traditional dwell-based practices. The proposed system includes a method of eye-controlled typing that only requires dwell-based interactions for the first character in the original word of a sentence, if no mistakes are made. To handle human error, error-correction is built in and dictionary suggestions are available for each typed word to provide the ability to correct mistakes.

This system utilises an SQLite database for storing and querying the dictionary database of words. A pattern mechanism was designed and implemented where gaze samples are hashed into data representing the shape of the gaze trail. This shape hash method is a notable achievement as it provides the ability to avoid hovering over characters that are in-line with each other and minimises reliance on dwell times.

This system has been fully developed and tested in user trials where trial participants have shown that performance can reach up to 23 words per minute (WPM) in a single 45-minute session. Improvement over time was observed, and informal trials have shown that the system can allow a user to perform up to 40 WPM.

Molecular Machines And Nano-Computers - (12cp)
Jacob Rowland - A17-185

Supervisor: John Canning
Assessor: Robin Braun
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The 2016 Chemistry Nobel prize for molecular machinery brought to light significant developments with regards to the concept of nano-scale technologies. Nano-technology, a science that recognizes interactions on small lengths scales that may not occur on macro dimensions, is continually evolving. It has incredible potential particularly in precision fields like medicine and engineering. The current trend of fabricating smaller technologies ultimately requires smaller building blocks.

The two literary reviews focus on separate concepts in an attempt to identify common themes. The first literary review focuses on existing molecular computer architecture and their varying degrees of success. The second review focuses on existing molecular machines and their likeness in function to the electronics required to make logic circuits. A novel aspect of this report is the translation of chemical properties across into electronic inputs and outputs, the basis for designing new functional molecular devices.

The broader aim of this project is to attempt to visualize a computer consisting entirely of molecular machinery. An investigation into molecular logic approaches led to a proposed theoretical transistor, 4 nm in length that utilizes electron blockades to lower the conductance of a molecular structure acting as an inverted transistor. As demonstrated, these transistors can be used as the fundamental component to larger logic gates, flip-flops and multiplexers. The system is powered and kept in time entirely with UV light, such as that obtained from the sun. An optically excited motor provides a square wave oscillation frequency of up to 3 MHz. By combining these new logic circuits and the square wave oscillator, the functionality of a clock is achieved through binary-coded decimals.

Although the nano-computer has a maximum clock rate 1000 times slower than a commercial performance CPU, it would draw 1000 times less power, entirely from UV light. Its standalone capability would allow it to perform as an auxiliary ‘brain’ to other mechatronic systems without affecting form or weight. This would be particularly useful in dangerous or delicate environments.

Evaluating LIF and HPT Technologies at a Petroleum Contaminated Site - (12cp)
Justin Chan - S17-223

Supervisor: Robert McLaughlan
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There are over 160,000 contaminated sites across Australia – a number of which are polluted with non-aqueous phase liquids (NAPL) such as petroleum. Traditional approaches to site characterisation involve taking samples and analysing in the laboratory, while innovative approaches involve in-situ measurements that are more cost-effective and provide near-continuous data as opposed to data from large intervals. The innovative technologies Laser Induced Fluorescence (LIF) and Hydraulic Profiling Tool (HPT) offer insight regarding the distribution and extent of NAPL contamination throughout a site. One such site, located at a service station in Western Australia, requires analysis of data provided by CSIRO before remediation activities may commence. Through interpretations of data by graphical regression and visual detection of patterns, comparisons between LIF, HPT and core data were made, for the validation and improved understanding of these technologies.

This project focused on three central themes: comparison of soil total petroleum hydrocarbon (TPH) concentrations to LIF Reference Emitter (%RE) values, comparison of soil TPH to LIF %RE by the alignment of peak values, and regression between LIF and HPT soil electrical conductivity (EC). Internal and external factors that potentially affected the data and its interpretation were considered, including date/distance proximities between partnered data samples, rainfall, and conversion of point data to averages.

While there was no correlation for the most current data samples, a strong overall correlation was identified when peak values were aligned. This suggests that both core and LIF tools can accurately represent the shape and extent of NAPL, but there may be a discrepancy in depth. Furthermore, %RE was found to be inversely proportional to EC, and NAPL based on %RE was generally located in sand instead of clay. This reveals the nature of NAPL in the subsurface, which prefers flow-paths of low EC material (sand) rather than high EC material (clay).

Prototype of Phase Shift Controlled Inductive Coupling Wireless Power Transfer for Smart Wheel (6cp) - (12cp)

William William - A17-177

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Global warming has been the main issue these years. The carbon emission from the burnt fossil fuel for transportation has been the leading consumer. Numerous electric vehicle (EV) technologies have been developed to minimise the fossil fuel consumption. Since EV is one of the most promising options that could replace conventional internal combustion engine (ICE) vehicle in the future. The further development of the EV technology will be massive in consideration of the carbon emission reduction that agreed by most countries on Paris Agreement. The existing technology for EV still has several major issues related to the charging efficiency and charging duration. In particular, the wireless power transfer (WPT) technology. Since, the current WPT technology for EV is dependent and influenced to the air-gap and misalignment. The most popular WPT technology nowadays is Inductive Power Transfer (IPT) that utilized inductive coupling as the transmitter and receiver. Even though IPT is not a new technology, yet due to its reliability, and efficiency, it becomes the most mature option on WPT technology.

Therefore, in this Capstone, I design a prototype and investigate the optimisation configuration based on the controlled phase shift on the inverter for inductive coupling. It is designed based on the dual active bridge (DAB) topology that popular nowadays. The objective of controlling the switching phase shift is to generate a soft-switching on the inverter that minimises the switching ripple and reduces the power loss. The proposed technology will combine the conventional analog inverter on transmitter and receiver side with the FPGA as the controller. Furthermore, the U-shape magnetic core is utilized for the inductive coupling due to the reliability and efficiency of high power transfer as the prototype is examined on high voltage (400V DC). Based on the experiment, the WPT prototype reaches an efficiency of 97.2% with 3 mm air-gap with 1.5 kW power output on operating frequency of 85 kHz.

The Electronic Nose System with Data Acquisition System and Machine Learning Algorithms Analysis - (12cp)
Yuzhen Wang - S17-172

Supervisor: Steven Su
Assessor: Youguang Guo
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The electronic nose system as a major gas detect device that has been widely applied in many industries and developed rapidly in past decades, it is a technology that used to detect and measure the specific ingredients of the odours or through the analysis of the ingredients of an odour to classify the gas type. On the other hand, the electronic nose system is still a new technology compare with other experienced electronic devices which has the shortage at easy to be influenced by the environmental condition, such as temperature and humidity. Therefore, the research of the electronic nose system is very valuable for the future development and studies.

In this capstone report, it is going to explain the process of building an integrated electronic nose system which is aimed to detect the combustible and explosive gas. This system containing a hardware circuit which is built by the gas sensor array (MQ2, 4, and TGS2602), temperature sensors and power supply module, a data acquisition system which based on the LabVIEW software to collect the gas sample data, and the application of the machine learning algorithms which depends on the MATLAB software to analysis and identify the gas sample data in order to check the overall performance of the electronic nose system. The detailed description of each step has been present in this report, and the most challenge parts are applied the machine learning algorithms to classify the two gas samples.

Finally, the algorithm- support vector machine (SVM) and neural network (NN) has been representing in this project and successfully classify the two-sample gas. The results of this project are meet the requirements of the objectives with a high accuracy and efficiency which could be able to provide a great reference for the further research.

Investigation of Significant Movements Associated with Concrete Pavements and Related Legislation to Mitigate Movements, with Respect to Terminal Ends - (12cp)
Caleb Hayde - A17-086

Supervisor: Kirk Vessalas
Assessor: Rob McLaughlan
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Concrete road pavements are becoming progressively more important to the future of major transport infrastructure development in NSW. Expenditure on new road infrastructure projects and on maintenance operations has never been higher, and concrete is an increasingly more attractive alternative to asphalt for transport authorities.

Concrete road pavements are subject to excessive and potentially damaging movements if not accounted for in the initial design. Continuously reinforced concrete pavements (CRCP), for example, are subject to large internal and external stresses, which build up along the extents of the rigid concrete pavement and these stresses are alleviated at the terminal ends as significant movements.

Current pavement design practice assumes the concrete pavement is in full contact with the subbase layer at all times. However, the cyclic movements of concrete both theoretically and upon visual inspection indicate this is not the case.

This report aims to investigate the most significant causes of these movements and their impact on the concrete pavement's contact with the subbase layer, critical to the overall performance of the pavement. A preliminary investigation of the effect of temperature changes on vertical and horizontal displacements, the magnitude, locations and rates of change in vertical displacements, and the effect of joint type selection on displacements is included. Additionally, accountability of the impact of significant movements by current relevant Australian legislation is assessed. Particularly regarding both the construction of new concrete road pavements and maintenance operations of existing infrastructure.

A preliminary set of guidelines are recommended for inclusion in local concrete road pavement design specifications and maintenance operation guidelines, based on comparison of best practice from other transport authorities.