Diabetes Part-Task Trainer- (12cp)
Paul Benson - A18-137

Supervisor: Associate Professor Adel Ali Al-Jumaily
Major: Electrical Engineering major BE BEDipEngPrac

Across the world in medical training facilities, devices known as 'manikins' or patient simulators are used in place of humans in order to practice procedures and techniques which would otherwise be dangerous to practice. Manikins are used to replace humans when practicing techniques and procedures that would be harmful to a human, such as CPR.

Despite the expansion of manikins into other bodily functions, there are still many areas where these devices are unable to replicate a response that the human body could. One of these areas is blood glucose measurement, most commonly used to diagnose and monitor diabetes. This gap in the capabilities of manikins is important for two reasons. The first is that diabetes is a prevalent problem in many countries, including Australia where 1.7million people have diabetes and 280 people develop diabetes every day. The second reason is that blood glucose measuring involves 'lancing' or piercing the skin of the patient to gather a blood sample. This is obviously impossible to do in medical classes since it poses a health and safety risk for students to perform this procedure on each other.

In this project a prototype for a device which could be used in medical training facilities to simulate the procedure of taking a blood glucose measurement was produced. The device was produced from the ground up, including circuit design, printed circuit board design, 3D printing and microcontroller coding. The prototype consists of a series of modules which could later be embedded into a fake arm. The system can deliver a drop of simulated blood to the fingertip when the student performs the lancing procedure. This simulated blood looks authentic and will produce a blood glucose reading of the educators choosing on a clinical blood glucometer.

To Determine and Interpret Patterns in Human like Behaviour Using Vision Recognition Systems - (12cp)

Mohammad Azimi - A18-135

Supervisor: Dr David Davis
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

This report focuses on software intensive systems that detect and recognise human faces. These are often deployed in a variety of uses including security-oriented applications such as surveillance systems, biometric verification systems and biometric access controls. The project featured in this report has designed and implemented a prototype sub-system that mimics much larger systems that detects and recognises a human face against a dataset of profiles. The focus of the project is on biometrically controlled, user access, in a smart home environment that has been implemented in another project.

Software has been developed (python on a Linux platform) utilising the Raspberry Pi hardware which includes a camera module for detecting various facial images. Processing, control and storage has been implemented by the developed software. The prime purpose is to uniquely identify certain facial images that triggers a biometric access controller.

The software is divided into three part: 1. Detection/Classifier (reads and ensures facial images), 2. Training (pre-prepares the facial image data, ensuring it represents a human visage), 3. Recognition (to a database of known profiles). The system is complete and has been tested in a variety of scenarios that are described in the report.

Catenary-Free Tram System Upgrade: The Establishment and Implementation of Energy Harnessing, Storing and Distributing Techniques- (12cp)

John-Mark Merhi - A18-187

Supervisor: Associate Professor Dylan Lu
Major: Electrical Engineering major BEBBus BEBSc

The wire-free & on-board energy solution is an emerging technology for tramways currently being researched and experimented today within European organisations such as Siemens and Alstom. The technical, social and economic issues associated with overhead wires within cities pose a threat to the Australian environment and its people. This emerging technology will greatly improve the Australian cities – starting from Melbourne.

This design is a modified design that has taken account the existing solutions in Germany, France and Japan. It has been modified to suit the needs of future Australian trams considering Australian climate, load demands and cost, Australian terrain and cities. It also aims to enhance energy efficiency and consumption. The overall design consists of super capacitor and battery banks mounted on top of the tram and are interconnected through a range of DC and AC converters and inverters. The battery will supply the tram's appliances which include air conditioning, lighting, 240Vac power, and speakers. The super capacitor will supply power to the two 3-phase traction motors via a variable-voltage/variable-frequency (VVVF) drive that inverts and converts DC/AC. This system will also convert the regenerative braking energy to DC to be supplied to either the super capacitor, battery or back to the traction substation. The tram when stopped at a station, will be charged via the pantograph.

Overall, the network will contain zero overhead wires and traction infrastructure to supply traction power via OHW. The only wires and infrastructure available will be that of charging stations that will initially charge both super capacitor and battery ready for service. The overall design also contains a charging/discharging management tool that will determine whether the super capacitor needs to be prioritised for charging or the battery and will be done so through regenerative braking. This design will be simulated into 8 configurations showing the charging and discharging of both energy storage devices at certain scenarios and will include a tuned PI controller for accurate results. Each product contained within this design have been heavily researched and can be purchased from Australian and international industrial partners/suppliers.

Granular Sound Morphing - (12cp)

James Dolphin - A18-249

Supervisor: Dr Eva Cheng
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Sound synthesis and signal processing have a broad range of applications including graphics & imaging, medicine, gaming, audio and military. The purpose of this project is to investigate sound morphing algorithms, specifically with granular synthesis, to measure them for effectiveness and computational cost. The research has been conducted using experimentation in Matlab, accompanied by a thorough literature review.

Sound morphing is the process by which two sounds are combined into an intermediary one. Granular synthesis is a growing synthesis method which involves creating sounds by taking tiny 'grains' of audio samples and applying various functions and attenuation to manipulate the output sound. In this project, granular synthesis parameters including Spray, Amplitude Modulation and Grain Density.

Since granular synthesis uses non-linear operations and uncommon modulation techniques, it can be difficult to find an appropriate intermediary sound; which maintains tonal features, aesthetic quality and characteristics from each of the input sounds. This makes the sound morphing process complicated with granular synthesis. In this project, complex methods of sound morphing including parametric morphing and energy spectrum morphing are explored. Both subjective testing and objective metrics testing are employed.

Improving Ventilation System in CNC Factory Using CFD - (12cp)

William Ching - A18-025

Supervisor: Associate Professor Guang Hong
Major: Innovation Engineering Major BE and BEDipEngPrac

Sufficient ventilation in an industrial factory is important to meeting the required thermal comfort and air quality of occupants in the building. Industrial environments experience extreme and unique conditions, specifically during hot days with pollutants in the air. Poor ventilation system will result in high internal heat loads from machinery and equipment which will produce uncomfortable indoor temperature and humidity affecting productivity and health of occupants. In addition, thermal expansion of machined products due to high room temperature can affect the overall dimensions of the product leading to high amounts of defects.

This project was aimed to solve a real-world problem, through improving the ventilation system at Challenge Engineering, a Computer Numerical Control (CNC) factory located in South Granville, Sydney. Currently, there is only natural ventilation occurring which makes use of thermal buoyancy and wind to circulate the air when the roller shutters are opened. With two CNC machines that are continuously in operation and significantly increases the heat loads towards the indoor environment, this creates a humid and unpleasant working environment during hot days as experienced directly during my engineering internship.

Computational Fluid Dynamics (CFD) is a tool used in engineering applications and allows the user to perform internal flow analysis through incorporating fluid mechanics and numerical analysis to solve problems defined by boundary conditions. Through utilising the software SolidWorks Flow, natural and mechanical ventilation has been simulated to design the most effective system through applying various air supply methods including mixing and displacement ventilation. The objectives are to reduce the room temperature, reach optimum relative humidity range and to provide adequate air flow for the factory.

Exploring Game Technology as a Tool for Children's Speech Therapy - (12cp)

Melisa Sachi - A18-201

Supervisor: Dr Jaime Garcia Marin
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Serious games – games with a main purpose other than entertainment – are an emerging field of technology that has provided numerous benefits to areas such as education and healthcare. Additionally, advances in technology such as speech recognition have allowed for more intuitive interaction with technology and improved data collection. As a result, games have become more immersive and have a greater capacity to capture and analyse an individual's actions, and hence have a greater range of potential applications outside of entertainment.

Speech therapy is one area where such games could have a considerable positive impact, especially due to how the repetitive nature of speech therapy exercises can cause patients to become frustrated and disinterested. This can lead to poor adherence and lack of motivation, especially when at-home practice is required. This is particularly true for young children, and yet it is vital for children with speech and language impairments to receive treatment early in order to prevent additional issues from developing.

The gamification of children's speech therapy exercises could help to resolve this issue, encouraging children to actively participate in therapy exercises while also gathering data on the players' performance and progress. This Capstone project was aimed at investigating the gaps in existing research and solutions, with the primary goals of investigating the feasibility of using off-the-shelf game technology to deliver gamified speech therapy exercises and of collecting data during gameplay to assess player performance and progression. The resultant game achieves these goals through short, voice-controlled minigames where the player's performance scales with the accuracy of their articulation and through tracking overall performance and progress over time.

Wireless Energy Monitoring System - (12cp)
Le Nguyen Khang Nguyen - A18-074

Supervisor: Dr Ha Pham
Major: Electrical Engineering major BE BEDipEngPrac

There are so many units of electronic power controller devices lying around your home While you could buy just one smart Power Controller device that contains all the features of the current product with less cost and convenience to use. Wireless Energy Monitoring System (WEMS) is a modern micro-processing technological electronic device that helps the household and office monitoring and improves the power consumption

Currently, there is so many Power Controller available for sales on the market, but each had limited the features and high cost per units. Using Wireless Energy Monitoring system (WEMS), the user can check how much energy you are using and how much it cost you, also the user can check the power consumption. Base on that information, the user can change the time schedule of their electronic device to reduce the electricity bill, saving energy and reduce the greenhouse gas emissions.

Nowadays, the electricity prices usage on the electric bill depends on the time frame. But with the existing Power Controller devices could not auto adjust the electricity cost values go through the whole day with respect to the electricity peak hour price times and off-peak price times

The purposes of this project are combined all the features of the current Power controller devices on the market into one Wireless Energy Monitoring System device. Along with the developments of data storage system inside and auto adjust power consumption function with respect to the electricity peak and off-peak times

Developing a Tool that Enables Nightlife Venues to Collect and Analyse Data about their Business - (12cp)

Hadi Ayoub - A18-088

Supervisor: Associate Professor Kaska Musial-Gabrys
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Data analysis has been a critical component in the success of online business. Even seemingly straight-forward decisions, like what text to display on a "call-to-action" button, are made solely based on data collected from users, highlighting measurable differences to the desired outcome between one piece of text over another.

In the physical world, for brick and mortar businesses, data as detailed as what's available for online businesses just isn't as easy to collect. For most businesses, the only data they have available is how much money is being made. While ultimately this is the most important piece of data, it doesn't allow for worthwhile analysis which could be used to fine-tune aspects of a business.

The difficulty with acquiring data for brick-and-mortar businesses is that the data which is important to each business changes across different industries. For example, a gym may find that knowing how much time is spent by members at the pool vs the workout room is crucial for influencing decision making, whereas a nightclub might be less interested in the physical presence of its patrons, but more interested in how they reacted to each DJ.

This project focused on the nightlife industry, which in Sydney, has been facing hard times for several years since the introduction of the controversial 'lockout-laws'. The project set out to build a tool which would allow venues to collect and analyse data. This eventually took the form of a mobile application for data collection and a dashboard for venue management and analysis.

In addition to detailing the design, development and integration of the delivered application, dashboard and other behind-the-scenes components, this project also explores how software features can be designed to give information about real world interactions for the purpose of data analytics for brick-and-mortar businesses.

Mobility Assistance Exoskeleton for Muscular Dystrophy Patients - (12cp)

Aron Turner - A18-252

Supervisor: Dr Marc Carmichael
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Muscular Dystrophy (MD) is a debilitating disability that manifests in children at a young age that results in the progressive breakdown of muscles. A variation of the disability known as Duchenne Muscular Dystrophy (DMD) affects 1 in 3500 boys worldwide and is the most common form of MD. Late stages of the disease often leave the patient wheelchair bound at an early age and for some, leaves them without the ability to eat and drink without assistance. Recent research of the muscular signal strength of late stage DMD patients suggests that the potential for exoskeletal assistance is a distinct possibility.

This project details the planning, development and testing of a prototype mobility assistance exoskeleton with the aim to design a cost-effective solution with the future potential for commercialisation. This design task was undertaken with the intention for the complete development of all mechanical (excluding motors), electrical (schematics and PCB) and software (embedded systems programming) components from scratch. The final objective of this capstone is to develop a prototype that can perform basic activities of daily living (ADL).

This project also hopes to build upon the growing research field of DMD with the findings presented within this paper. With the ultimate goal of developing an affordable product which would allow the user to have a greater sense of independence and control. Future iterations of the project aim to improve the performance, usability, comfort and aesthetic design of the exoskeleton for use in practical settings.

Developing a Platform to Facilitate the Use of Drones in Urban Activities - (12cp)

Adam Love - A18-076

Supervisor: Dr Michael Behrens
Major: Innovation Engineering Major BE and BEDipEngPrac

Unmanned Aerial Vehicles, more commonly known as Drones, are a rapidly developing area of technology. Currently, the majority of commercial drone usage is in highly specialized applications of aerial surveying and monitoring. However, technological advancements and recent a reduction in drone manufacturing costs have now made it feasible to investigate the usage of drones in a variety of situations in urban activities.

This project aims to design and prototype a potential solution that facilitates the use of drones as an everyday, urban service. Through partnering with UTS Rapido, a full stack software framework has been designed and prototyped to enable consumers to book drones for a variety of scenarios including parcel delivery, aerial photography and crisis situations. The software is designed to be modular, expandable and able to interface with a variety of drone manufacturers as not to limit future expansion.

The first component is the database layer, consisting of an SQL database that stores users, bookings, locations, associated information and actions that can be performed by available drones. The second layer of the software suite is the server-side application that manages logic, data validations and provides an API to create and update records in the database. This layer is also responsible for interfacing with external API's provided by drone manufactures in order to communicate flight path information and receive real-time status updates from individual drones. Finally, the client-side application provides an interface for customers and administrators to interact with the system. This project also aims to investigate the current industry trends in software technologies, managing security risks, performance optimizations and authentication solutions.

Predicting Pitcher Performance in Major League Baseball - (12cp)

Dineth Dayananda - A18-055

Supervisor: Associate Professor Paul Kennedy
Major: Electrical Engineering major BE BEDipEngPrac

With the rising payrolls of Major League Baseball (MLB) teams it is becoming increasingly important for scouts and analysts to sign players that will get the best results for the team. One way of achieving these results is using advanced statistics to track and predict a player's performance throughout their career, this is known as Sabermetrics. The most famous example of Sabermetric use in the MLB was during the 2002 season when Oakland Athletics General Manager Billy Beane signed players overlooked by other teams that he thought would be a good fit for Oakland based off their career stats. Since then, almost all MLB teams have added data analysts to their baseball operations department to gain an advantage over their opponents.

This project looks at baseball pitchers and how they perform before and after receiving common injuries specifically, Ulnar Collateral Ligament (UCL) tears, rotator cuff tears, shoulder inflammation and oblique injuries. In order to obtain the data necessary to perform this study I designed web crawlers which went through the list of players to be studied and downloaded the desired information about them.

One issue that arose from the dataset was that due to the large number of attributes that were present in the dataset, it was difficult to visualize how different datapoints were clustered as well as the differences between each cluster. To assist in solving this problem, a data dimension reduction algorithm called T-Distributed Stochastic Neighbor Embedding (t-SNE) was used.

Once the data had been obtained and processed, unsupervised machine learning techniques such as clustering were performed on the dataset to create a useable model.

Analysis of Interim Microgrids as a Sustanable Catalyst for Early Stage Suburban Development in Western Sydney - (12cp)

Md Intisarul Hoque - A18-299

Supervisor: Dr Ricardo Aguilera Echeverria
Major: Electrical Engineering major BE BEDipEngPrac

Western Sydney (Australia) is currently undergoing a major suburban expansion with land readily being developed to meet the needs of a growing population. However, despite the current demands for growth, projects expanding into previously rural land can often be delayed by several years, as developers must wait for a suitable connection to the electrical grid before residential dwellings can be built. This work explores the opportunity to use a portable interim microgrid power plant to catalyse these suburban developments through the application of distributed and sustainable technologies.

The feasibility of the system is assessed within the design constraints and Australian context. A preliminary study to determine the most suitable generation and storage technologies is followed by a detailed mathematical modelling of the proposed system. The system's performance is analysed in 30-min intervals over a single year; this helps capture both seasonal and daily variations in energy demand and supply.

The suburb of Camden is selected as a representative of Western Sydney characteristics. Load profiles are derived from publicly available Net System Load Profile (NSLP) data for the distribution region as well as average household consumptions. Similar profiles are derived for solar and wind, where average climate data from the Bureau of Meteorology (BoM) is mathematically extrapolated into 30-min diurnal cycles. Simpler calculations for battery storage and backup power complete the microgrid model from which is used to measure system performance across various configurations.

A financial study is linked to the technical model to analyse the least-cost configuration of the system across a 20-year lifetime. These costs are further evaluated against the financial benefit of accelerating land development. The final study runs both the technical modelling of the system alongside this economic analysis to provide a complete assessment of the proposed portable microgrid solution.

Continuous Torque Estimation of Two Speed Induction Motors for Gantry Cranes - (12cp)

Adam Walsh - A18-002

Supervisor: Associate Professor Peter Watterson
Major: Electrical Engineering major BE BEDipEngPrac

Gantry cranes are often fitted with overweight cut-out devices which rely on the measurement of line variables to a two-speed induction motor. The devices that are currently in the market are unable to measure an overweight condition during starting or speed changes due to the associated inrush currents and acceleration torque. This poses a severe safety risk for cranes which rely on this method.

The purpose of this study is to investigate a method of estimating the motor shaft torque during these events, which could be later incorporated into an overload controller. This is done by analysing the various torques in a typical hoist, modelling a line start induction motor in Simulink with a fixed torque load. A dq transform is applied to the line variables using a synchronous frame of reference. Using the dq components, the air-gap torque is then calculated. The rotor speed is estimated by using the air-gap torque and power.

The modelled torque estimator provided a torque estimate which was within +/- 4.5% accuracy during starting under ideal conditions and also with voltage drop on the incoming supply cables. The stator resistance was found to be an essential variable for the accuracy of the motor torque prediction and would need to be corrected for temperature changes by using a thermocouple embedded in the stator windings. The speed estimation was found to be within 2% accurate. The model results are then compared with results from an actual hoisting motor which is starting and lifting known loads.

These results show that it is possible to measure motor shaft torque during starting and speed changes. In the future crane load limiters could provide more accurate overload detection during starting and speed changes thus making the plant safer to operate.

Analysis of Renewable Generation on the Sydney Trains Electrical Distribution Network - (12cp)
Tristan Chambers - A18-066

Supervisor: Associate Professor Peter Watterson
Major: Electrical Engineering major BEBBus BEBSc

The purpose of this project was to investigate and evaluate the impacts and opportunities of renewable energy generation on the Sydney Trains electrical network, with an in depth focus on Photo-voltaic (PV) technologies, both already installed and future installations. This provides the opportunity for available renewable energy resources to be more efficiently utilised, allowing for potential bulk energy consumption savings, and in-turn real monetary savings, taking into consideration the ever-increasing retail electricity price.

The primary goal of this project was to prove that the impact of allowing energy exports from PV into the Sydney Trains electrical network would be negligible. A detailed literature review undertaken on other electrical networks identified three main problem areas with PV; (1) Voltage Rise – Most problematic, (2) Voltage Stability – No Impact and (3) Total Harmonic Distortion (THD) – Negligible. The model utilised to analyse the impacts of these three problem areas was completed in Electrical Transient and Analysis Program (ETAP). Multiple modelling scenarios of a case study location within the Sydney Trains electrical network were first built and then analysed, utilising different network configurations. The worst-case scenario i.e. greatest voltage-rise was modelled again, adding as much PV as theoretically possible to the case study location. By proving that the results from the model are within voltage tolerances (+10%/-6%), there should be no further opposition to exporting PV generated energy into the Sydney Trains electrical network.

The secondary and tertiary goals of this project were to investigate potential for further PV installations on existing rail estate roofing i.e. train stations and the feasibility of energy storage. The investigations were carried out looking at safety, reliability, maintainability and cost. The financial viability of each option was ascertained utilising Net Present Value (NPV). The findings show that there is an abundance of unused roof space in the rail corridor for PV installations, but for now energy storage options are not yet financially viable.

How Do First Year Students Perceive and Prioritise the Importance of Future Work Skills? - (12cp)

Rebecca McCreath - A18-319

Supervisor: Professor Roger Hadgraft
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

The future of work is coming, whether we're ready or not – and many engineering students face a disconnect between the skills they've focused on developing across 5 years, and those that industry are looking for. In particular, right from first year there is a lack of appreciation for the importance of the so called 'soft' skills – ranging from verbal and written communication, to adaptability and problem solving.

This capstone seeks to explore the value that first year students see in these hard and soft skills and investigate how that mindset might be shifted to best prepare students for the future workplace. Students & staff were broadly surveyed through a quirky interactive stall involving paper planes and post it notes to provide an overview of the perceived role and skills of an engineer. This data was then used to shape a series of interventions in the first year subject 'Engineering Communication', which are collated to provide a final set of recommendations on how to facilitate student learning from the first year of engineering to prepare students for the future workforce.

Key insights from this research are that students in first year may say they value soft skills, but are still developing their understanding of themselves as engineers and need strong support from tutors to make connections between the value of these skills and their professional identities. Key enablers for this professional identity development come in the form of teaching approaches which use clear goals, consistency and reinforcement to help bridge the students' experience and knowledge gaps. Students also require focused time and a hand-on, engaged teaching approach to familiarise themselves with these new concepts, and for tutor led sense-making to continuously reinforce the value of these soft skills and make connections to future applications.

Electronic Nose - (12cp)
Minghao Wang - A18-274

Supervisor: Associate Professor Steven Su
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

With the development and innovation of science, people become more sensitive to the problem— “food safety”. It is not accurate for people to judge whether the food is fresh via their sensory function (i.e. taste and smell), as there may be significant differences between people’s sensory function. Moreover, people’s sensory function could be influenced by emotion, physical condition, and fatigue. Therefore, even the same person may have different judgment about the freshness of food under different circumstances, which will lead the result to be more subjectivity. In addition, without the help of technology, people cannot be sure whether there will be toxic elements or gas existing in the food.

In that case, the purpose of my project is to identify the freshness of meat via professional testing equipment. The main project for my capstone is to get a detailed enough training set for testing the next step. My plan is to get a 21-day training set (3 times a day and three types of meat each time). To leave enough time for the chemical reaction in meat, the interval of getting training set will be eight hours. This method will ensure the accuracy of the effectiveness of testing results. When the training set is completed, the data collected from the equipment will be analyzed with MATLAB. The research outputs (meat freshness model) could be used for detecting the freshness of meat timely.

Spectrum Sensing Using UAV - (12cp)
Andrew Pope - A18-089

Supervisor: Dr Ying He
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

The radio spectrum is the underlying medium through which wireless communication occurs. As a finite resource, the spectrum must be subdivided and shared appropriately between private (e.g. mobile communications, broadcasting) and public-sector organisations (e.g. national defence, emergency services). Currently, regulatory bodies favour fixed licensing schemes to minimise the interference between operators using the spectrum. However, reports of idleness suggest that the spectrum is being underutilised by up to 85%. Alternative regulation options use access systems for opportunistic sharing of underutilised spectrum bands. In a shared model, a ground network of cognitive radios are used to monitor spectrum usage and operator presence in a geographical area. However, investigations have shown that accuracy and coverage of information is heavily dependent upon initial sensor deployment, highlighting that the flexibility of data acquisition is limited.

This project aims to develop an experimental spectrum sensing prototype, combining software defined radio (SDR) and unmanned aerial vehicle (UAV) technology to perform airborne signal detection. Gaining popularity in both commercial and research applications, UAV devices are fast becoming an essential tool for general purpose remote sensing. In this project, a universal software radio peripheral (USRP) is mounted underneath an Intel Aero UAV to report real-time spectrum and geolocation data to a base station wirelessly. This is facilitated by a software application, written in Python, that leverages the GNU Radio and DroneKit software libraries to perform frequency domain, energy-based spectrum sensing. Results demonstrate that the platform can correctly detect the presence of signals and maintain stable flight, despite the extra weight and power consumption of the sensing hardware. As such, this prototype has the potential to augment data produced by current shared spectrum solutions, offering another source of real-time, location orientated, spectrum information.

Recording Human Movement for Habitation Purposes - (12cp)

Jason Scott - A18-009

Supervisor: Dr Zenon Chaczko
Major: Electrical Engineering major BEBBus BEBSc

Recent advancements in embedded technology such as component integration, component size and cost reduction are the key factors that have initiated the development of wearable devices. As human biomechanics can be overwhelmingly complex with varying degrees of motion, it has previously been challenging to accurately model human movement with a wearable device. Specialized sensors often only concentrate in recording a single degree of motion. Component integration and component size reductions now allow many different and smaller sensors to be fitted to wearable devices contributing to more accurate movement capture.

This project aims to demonstrate a wearable hand-sensor prototype which will record and model hand kinematics. With the addition of an IoT (internet of things) connectivity framework, it is possible to transmit movement data in real-time or record data locally. The project at its core utilizes a Raspberry Pi. It serves dual purpose to both collect and transmit data over a python server to a 3D model on a WebGL webpage. A Bosch BNO055 inertial measurement unit and flex sensors are used to collect hand movement information and demonstrate the functionality of the networking framework.

The ability to record movement permits the option for both the data to be modeled in real-time or collected and analyzed later. This flexibility creates a broad range of usage applications from real-time remote operations of robotic control to early detection of involuntary movements of Parkinson's disease diagnosis. The ultimate goal of this project is to provide a viable framework to serve as a template when interchanging with other biomechanical sensors for various applications.

DNS Tunneling for Personal Communication - (12cp)
Robin Wohlers-Reichel - A18-325

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

While Wi-Fi hotspots are widespread and ubiquitous, many hotspots charge customers for their use. In scenarios with fewer alternative means for connectivity, hotspots are more likely to require payment to connect the internet. Domain Name System (DNS) tunnelling is a technique whereby Internet Protocol (IP) packets may be transferred from a secured network to the greater internet. By encoding packets in DNS queries, data may be transferred be- tween internet hosts and around hotspot pay-walls. Proven open source tools exist which implement this technology, however these tunnelling tools require complicated set-up processes which are unsuitable for end-users.

The purpose of this project is to explore the practical application of DNS tunnelling for personal communication. Using robust system design processes, the requirements, architecture and implementation details of a system are identified. Furthermore, steps are taken to ensure system quality and verify the implementation against requirements. Design drivers include reliable connectivity, message security, and packaging core functionality as a framework for integration with other mobile apps.

An Over The Top (OTT) communication app utilising DNS tunnelling would enable users to connect to any hotspot and communicate with others free of charge, provided they have the app installed. The outcome of this project has been to implement a DNS tunnelling framework and integrate with the Open Whisper Systems iOS ‘Signal’ app. The three components of this framework include a Linux server application, an iOS library and a DNS tunnelling protocol. By integrating with ‘Signal’, users of the tunnelling-enabled app may communicate with all other users of the official ‘Signal’ app, which is available in both major app stores.

This project presents little technical risk and an opportunity to create something new with existing, proven technologies.

Smart Application of Internet of Things - (12cp)

Sonali Ashok Kumar - A18-140

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BEBE(Hons) BBus, BEBE(Hons) BSc

The purpose of this project is to design an aesthetic system for robot navigation through a specified floor plan. The goal is to demonstrate the process as a 3D simulation, performed using Autodesk Maya and rendered with Adobe After Effects. This project draws upon UTS as a case study and will showcase robotic interactions at an Open Day event. It will incorporate the use of beacons, Optical Character Recognition (OCR) and other systems, allowing users to embrace the applications of Internet of Things (IoT).

Additionally, the robot's capability will be enhanced as it assists visitors through it's chatbot feature. The chatbot is created on Amazon Web Services (AWS) Lex and handled in AWS Lambda using JavaScript. The robot will avail information such as campus and course details, including facts about UTS that will intrigue potential students.

Software robotics will be demonstrated using the Robotic Process Automation (RPA) tool Automation Anywhere (AA). With the click of a button, a scheduled time or any other trigger, the entire process will be run and self-demonstrated at the capstone showcase.

Companies are investing in moving components of the business to a smarter and more centralized approach due to its advantages and long-term stability. Automation plays a big role in this change as it ensures benefits such as time, energy and cost savings, increased customisation options, flexibility and most importantly the perfect work-life balance. Therefore, the overall objective of this project is to demonstrate the potential of robotics, both hardware and software, in making day-to-day life more comfortable and exciting. Apart from personal knowledge expansion and learning, the anticipated outcome is to ensure relevant audiences are well educated of the capabilities of the technologies present around us.

Micro Lab for Field Assessment/Detection of Environmental Pollutants - (12cp)

Robert McDonald - A18-062

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

The prevalence of environmental pollutants in Australia and throughout the world is significant. One such pollutant is plastic, with "global annual plastic production reaching over 335 million tonnes in 2016" (Lebreton et al., 2018). A total of 3.5 million tonnes of plastics were consumed in Australia in 2016-17 and the national plastics recycling rate was 11.8% for the same year (Australian Government 2018). Plastic not recycled and disposed of in landfill and can make its way into the wider environment through river systems into the ocean. Plastics within the marine environment that range in size from 5 millimetres (mm) to 1 micrometres (µm) are termed microplastics.

The prevalence of microplastics within the marine environment has the potential impact the food chain through bio-magnification, posing a threat to humans as the toxins accumulate as they progress through the food chain (Reisser et al., 2013). Current methods of collection, detection and classification of microplastics are extremely labour intensive, with post-processing analysis performed in laboratories.

The object of this project is to investigate and develop a micro lab for the field assessment/detection of microplastics. The techniques employed to detect micro plastics are photography and near-infrared spectroscopy. Samples are photographed and scanned at a wavelength range from 900 – 1700 nanometres. Image and spectroscopy data is post-processed to determine colour, size and identification. Image processing techniques are employed to determine colour and size. Sample identification is achieved by comparing spectroscopy data to the known absorbance plot signatures of plastic categories Polyethylene Terephthalate (PET), Polyethylene (PE), Polyvinly chloride (PVC), Polypropylene (PP), Polystyrene (PS). The results of the project provide the basis for potential development of autonomous microplastic field detection system.

Precision Agriculture: Water Management, for Low Interaction and Recreational Farming Contexts - (12cp)

Taylor Graham - A18-086

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Agriculture is a significant part of Australia's national identity, contributing substantially to its economy and shaping its culture. As technology continues to rapidly develop, it is critical to review how it can be applied to agricultural contexts to improve yields, reduce waste, and assist in the engagement of more Australians in agriculture.

Precision Agriculture (PA) is a developing field, which has emerged out of the improvement in technologies classified under the umbrella of Internet of Things (IoT). Development specifically in areas of sensors, wireless networks, battery and power sources, and cloud computing, have been the primary drivers for PA. The purpose of PA systems is to closely monitor and appropriately react conditions in the environment. Allocating the amount of water to deliver to a section of a field over another due conditions such as soil tension, weather patterns, or UV index, is one such example of a PA system.

One of the major issues the Australian agricultural industry has faced this year has been widespread drought in NSW and other neighbouring states. This issue has inspired this project into investigating how PA might be able to assist in the area of water management.

The purpose of this project is to investigate and design a PA system with the focus on water management for small scale and recreational farming contexts. This will include the supply, distribution, and reuse of water across a diverse range of environments. This is done with the aim encourage the introduction of PA systems to a much broader audience, with affordable, simple to install systems being more attainable. The project will implement a software development methodology to collect requirements, and develop architectures a range of architectures. A selection of prototypes will be developed from the designs as a proof of concept for future development.

Blockchain and Its Benefit for Distributed Medical Records - (12cp)

Andrew McAdam - A18-182

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Blockchain and distributed ledger technology provide a means of secure data storage amongst a number of parties who share a common ledger of information. Additionally, it provides immutability of records written to prevent fraudulent activities. The aim of this project is to analyse the use of blockchain and distributed ledger technology in the medical space and how they may improve the data security and business processes in the industry.

To address the problem, exploration of current systems and their behaviour against a new solution will be shown to determine how we can keep current processes, such as how medical records are stored but provide additional benefits such as security and data ownership for the user. Furthermore, to achieve these requirements, an application will be developed to interact with the blockchain ledger to store and retrieve user data. This system will be setup to match how medical records and patient data currently operate but also demonstrate the benefits of distributed ledger technology. Users will be given more control and ownership over their personal data and gain control over how that data is used. Building on the research from the medical record application, insights into other areas of the medical industry that distributed ledger technology could be used will also be explored. Areas, such as the use of tracking medical supply chains for users to ensure that their prescriptions are correct and not out of date further highlight the reusability of the application being developed and large list of potential use cases that distributed ledger technology can solve.

An Exploration of the Piano as a Novel Medium to Augment MYO Data - (12cp)

Joshua De Los Santos - A18-215

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Off the shelf muscle activity sensors, in this case Thalmic Lab's Myo Armband, on its own do not provide the clarity and resolution to accurately produce data to provide a physiological evaluation of a body part, in this case the hand.

The purpose of this project is to explore the piano as a novel medium to augment the data being output by a Myo sensor to gain a greater understanding of the health of hands. At its core, it will be an exploration of the effectiveness of Myo sensors under the context of rehabilitation. This is achieved by cross referencing the MIDI output when a key is pressed on an electronic piano with the muscle activity data being streamed by the myo sensor. This will allow insight into pressure being exerted by fingers, hand-eye co-ordination, timing, which finger is being used the most and vice-versa which fingers aren't being utilised as frequently. This project will also explore the quality of MIDI fused with Myo sensor data and what observations can be made when analysing it.

This data can primarily be used as a new means of aiding in music rehabilitation or therapy. It can however be extended to practices beyond the medical field; it can be used to enhance music pedagogy, offering a discrete evaluation of a musicians playing or performance. This project also has practical implications for hobbyist musicians as a means to self evaluate overall hand strength and co-ordination as well as a method to map out which fingers press what keys in real-time.

Assistive Humanoid Robot for Elderly People (Personal Trainer for Senior Citizens) - (12cp)

Menka Mehta - A18-259

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Senior citizens consider the worst part of aging to be the changes that occur to their bodies. For this reason, they avoid doing body exercises and therefore often prone to heart diseases, muscle disorders and many other ailments. Although weakening of bones and muscles is inevitable as we grow old, we can still maintain our health by doing regular physical exercise. Encouraging elderly people to do physical exercise can be challenging, therefore the Robot-Trainer is introduced to make their exercising journey exciting accompanied by a friendly humanoid robot.

The main goal of the system is to program the robot to interact and conduct physical exercise training sessions with elderly people, in order to maintain their physical fitness and mental health. In this system, attendees at the training center will be able to register as new members and will be able to keep track of their weekly/monthly/yearly attendance through a client application. Collected data can be stored in the cloud real-time database for keeping track of attendees and future analytics purpose. Predictive Analytics conducted in the cloud database will be able to provide exercising statistics for each elderly person attending the training. It will also be tracking how many people attend the sessions on daily basis, so the system can be further improved.

The application will allow the robot to interact with the attendees, encourage them to exercise and look after their well-being. The exercise training module will include Simple Yoga and Aerobics sessions where group of elderly people can train whilst interacting with a robot-trainer. The client application includes a diet module which is able to provide information on different diets to the users and encourage them to follow a healthier eating practice. The system utilises the ultrasonic sensors and NFC tags to develop an intelligent IoT identification, localisation and tracking.

The developed application supports a number of functionalities that include data collection and presentation, notifications and communication functionalities. The Ipal Robot has an Android Operating System and the client application follows Android design principles and utilises external services such as Firebase Real Time Database, Authentication Services, Cloud Storage, Gmail Integration API and several other media processing API’s and libraries. The future implementation of this application can exploit other functionalities such as Facial Recognition, Mobility and Environment Monitoring Modules.

Framework for Collaborative Sharing of Trusted Sensitive Information - (12cp)
David Niwczyk - A18-224

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

Today, we use Public Key Infrastructure (PKI) to create trust on the internet by issuing verifiable certificates to domains through a hierarchical structure of centralised authorities. Using PKI and blockchain, the W3C Verifiable Claims Working Group has developed a standard for verifying individuals, organisations and their data with Decentralised Identifiers (DIDs). The advent of DIDs has brought with it the possibility of entities to verify and manage digital documents without relying on centralised authorities but rather shared roots of trust.

The aim of this project is to develop a framework that leverages DIDs and blockchain to create trust in the validity of shared documents and analyze its viability. The proposition is to watermark digital documents with the DID of the issuer, providing integrity and a non-reputable, verifiable document. The document could then be sent physically or digitally to a recipient who could verify the document's issuer and integrity using the watermark through the framework.

The expected uses include combating fraud with document verification, bridging trust between issuer and receiver and giving individuals power over their own documents. The framework could be applied to invoices, medical records, government documents, etc. More broadly, the framework can be extensible to referencing invoices with distributed ledger transactions for end to end auditing.

Online 3D Digital Object Management System - (12cp)

Jacky Ye - A18-054

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

With the increasingly availability and technological development of 3D printing, 3D object files have become progressively important to manage and view through different interfaces. The goal of this project is to create a system that would allow for any user to be able to manage or manipulate 3D files of their choice through the developed project. Over time, a need for such a system will rise similar to how the development of 2D printing lead to the development of document management software like Microsoft Word.

Research was undertaken to investigate the standards of 3D object files currently existing and how they can be possibly manipulated and managed. The decided file types that the system will support will include VRML, OBJ, STL and potentially LAS, a lidar file format. To ensure the system will be as accessible as possible, it will be developed using Web Technologies employing the use of Three.js, a JavaScript library and Application Programming Interface (API) that is able to create and render 3D digital objects in a Web browser through the use of WebGL technology.

The developed 3D Digital Object Management System followed a prototype driven approach applying but still applying the formal analysis of the Software Requirement Specification (SRS) and system design. The system was tested using real-life scenarios with scanned 3D files of real people and then loaded by the system for viewing, further rendering and manipulation. The system allows for flexible viewing, manipulation and management of both locally scanned and remotely located 3D files. The system allows rendering of 3D scenes, as well as, 3D printing.

Analysis and Extraction of Information from Scanned 3D Objects - (12cp)
Robert Novak - A18-063

Supervisor: Dr Zenon Chaczko
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

The aim of this project is to provide the functionality of analysis and the extraction of information from scanned 3D objects. Current 3D scanning solutions use a selection of technologies, such as depth sensors, structured light patterns, infrared, or a stereo camera setup. 3D scanning has shown potential within the engineering field to allow for scanned objects to be reverse engineered for the use of rapid prototyping. The rising popularity of 3D printing has also placed more demand on the ability to scan a physical object to reprint later.

Early research on this topic was conducted with the use of Microsoft Kinect and various 3D scanning software solutions. Issues were found with the resolution and quality of the Kinect's RGB camera. Notably, several artifacts occurred such as incorrect image stitching and gaps in the scanned model.

By utilising libraries, such as OpenCV and JSFeat, the project has access to a number of programming functions aimed at Real-Time Computer Vision. These functions can assist with photogrammetric range imaging techniques such as the detection of interest points and image matching. SIFT, SURF, and ORB are three examples of feature detection algorithms which determine the interest point and its defining properties. These features can include the detection of edges, corners, or other interest points in an image.

The project considers the implementation of Real-Time Computer Vision and 3D object reconstruction for the purpose of analysing possible improvements to the 3D scanning process. Additionally, the project also explores the different feature detection algorithms and techniques used in Computer Vision and image processing. These feature detection techniques assist with the extraction of information from a scanned 3D object. This allows the software to determination the accuracy of the original scanned object.

The Change in Engineering Characteristics of Reinforced Concrete with Fibre Reinforced Polymers - (12cp)

Emmanuel Caringal – A18-285

Supervisor: Associate Professor Anne Gardner
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While steel is currently the most common material used as reinforcement for reinforced concrete structures, it is highly susceptible to corrosion. This is particularly significant for structures located adjacent to coastal lines due to interactions with the marine environment. Ensuing maintenance and rehabilitation costs have been estimated at US $900 billion in global infrastructure alone.

Fibre reinforced polymers have been proposed as an alternative to steel reinforcement in reinforced concrete as it can withstand the effects of corrosion. Additionally, it is more lightweight and has mechanical properties that are ideal for use in beams, columns and slabs. Glass fibre reinforced polymers (GFRP) and carbon fibre reinforced polymers (CFRP) have been heavily researched and are the most commercially available products although they are not widely used. Consequently, many countries especially Australia have not incorporated the used of fibre reinforced polymers in their standards.

This thesis has addressed the adequacy of fibre reinforced polymers as an alternative reinforcement with reference to Australian Standard 3600 (Concrete Structures), Australian Standard 1170 (Structural design actions), Australian Standard 5100 (Bridge Design), Canadian Standards Association S6-06, Canadian Highway Bridge design and S806-02, Design and Construction of Building components with fibre reinforced polymers. The serviceability limit state of beams and columns have been assessed with the typical loading experienced by a bridge and results have concluded that it meets these minimum requirements. This includes analysing the ultimate capacity of moment and shear, the crack width and the deflection which are assessed against the Canadian and Australian Standards.

To emphasise the use of fibre reinforced polymers in structural components such as slabs and beams, models of fibre reinforced polymers compared to steel has been analysed with Microstran to highlight the minimal difference in the maximum moment, shear and deflection shown in this program.

Both GFRP and CFRP are both costly compared to steel, however taking into account their reduced maintenance and rehabilitation costs makes them cost competitive over a 20-30-year service life.

In assessing and providing a comparison to steel reinforcements, this paper ultimately aims to garner interest around fibre reinforced polymers and encourage implementation into standards of different countries for widespread use. Overall, CFRP and GFRP are both costly and brittle but are more durable and have the mechanical properties to replace steel reinforcement in reinforced concrete.

Modular Formwork Systems - Modern Engineering Methods to Increase the Efficiency of a Construction Firm - (12cp)

Adrian Sopina - A18-024

Supervisor: Associate Professor Anne Gardner
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Concrete formwork labour and material costs currently ranges within 20-30% of the total budget for concrete framed structures, it is the single largest cost of the construction process. Optimisation of formwork design and implementation is one challenge for modern engineers who are constantly trying to improve the efficiency and productivity of the construction process. The advent of modular formwork systems has enabled significant improvements in reducing projects duration, cost and environmental impact whilst also enhancing levels of safety. Modular formwork systems are a series of interconnected nodules and panels which are pre-engineered before their arrival onto a project and assembled on site for a variety of different purposes and in a variety of differing shapes and sizes. Numerous modular formwork systems currently exist within today's market from many suppliers, however quantifiable evidence of their effectiveness has largely been un-published within current scientific literature.

To evaluate the improvements in efficiency that one can gain by implementing modular formwork systems over antiquated conventional formwork techniques, a comparative analysis was performed. The study compiled data from modern case studies of numerous techniques and construction scenarios to quantify the level of efficiency one can achieve through the adoption of each system.

The study found that significant improvements in productivity, safety, budget and environmental impacts can be attained through the implementation of modular formwork systems. The study also identified the limitations of each system and made recommendations regarding the technical considerations of implementing each modular formwork system.

Investigation into the Impact That Rapid Urban Development Places Upon Existing Infrastructure Systems in the Greater Sydney Area - (12cp)

Paul Galea - A18-190

Supervisor: Distinguished Professor Biswajeet Pradhan
Major: Civil Engineering Major BBEBBus and BEBsc

Today, a city such as Sydney is seen as a powerful symbol of human civilisation and urbanisation, causing its population density to peak as it provides a hub for many economic, social, cultural and technological domains. However, as this population continues to grow, the constraints of Sydney's unplanned centralised city design are limiting its growth due to limited infrastructure and developable space. To address these issues, over the last decade, significant urban growth and investment has been placed into developing the Greater Sydney region, with a particular focus upon Western and South Western Sydney. By doing so, government, councils and developers are attempting to provide access to a range of new amenities and housing that will suit different needs, budgets and lifestyles, in addition to helping provide downward pressure on housing prices.

Despite this, there has been limited understanding of the challenges, uncertainties and risks that this rapid urban development causes and whether there has been sufficient planning and forecasting that considers the long term changing requirements of a city. Significant changes to infrastructure, regulations and land zoning have been undertaken which has seen major upgrades to arterial roads and utilities and the availability of more diverse housing options. Additionally, these developments are bringing access to an array of new parks and open spaces, shopping and commercial zones and even Sydney's second major airport and the 'Aerotropolis' such infrastructure introduces.

By utilising quantitative and qualitative research methodologies delving into urban city designs and standards, the research will provide details on how cities are designed to cater for the limitations of its existing utilities. Ultimately, a greater understanding will be generated into whether proper urban planning has occurred or rather, has development been rushed by councils and developers for the wrong reasons. Recommendations will be made into the processes of long term development and how to address the restrictions involved with existing infrastructure, although, challenges surrounding corruption and bribery within the industry sees some limitations in the findings. Hence, from this research, further understanding and improvements can be made in understanding how we plan and develop the cities of the future.

The Investigation of Built-In Structural Resilience in Buildings and Bridges - (12cp)

Leila Abou Jabein - A18-216

Supervisor: Professor Jianchun Li
Major: Civil Engineering Major BE and BEDipEngPrac

Built-in structural resilience in buildings and bridges have been a new trend for the future of civil engineering design in order to achieve the smart city concept. Such changes will greatly impact design, construction and asset management of future civil infrastructure, particularly for disaster prone area such as our neighbouring country New Zealand. Therefore, research and development in building resilience to civil infrastructure have tremendous value and importance.

The project explores the frontier of building structural resilience in order to provide a structure that has the ability to effectively mitigate the hazard from seismic loading. It can be achieved by integrating a smart device such as Negative Stiffness Devices (NDSs) into the structure, which provides adaptability to a structure to allow the over stressed structural components to reverse their stiffness to avoid further stressing of the components thus preventing the collapse of the structure.

This project provides an insight into two NSD concepts, one of which was designed by Apostolos A. Sarlis and Satish Nagarajaiah, and the second a revised model which was developed during this Capstone project to gain a detailed understanding of how the device behaves under seismic loads and how it affects the deformations and structural integrity of buildings and bridges during an earthquake event.

This project also explores utilising 3D printing to develop a prototype that has been designed in Solidworks to perform practical seismic testing on the device that mimic that of an earthquake event. The project also undergoes a comparative numerical analysis through the use of SAP 2000 to model the devices and apply a time-history analysis from data collected from past earthquake events and collating the results to compare the effectiveness of the two devices.

The project aims to learn from past NSDs and provide detailed insight into how these devices can be simplified to ease the implementation and cost of these devices in future structural developments. This study will contribute to the future research of these devices and learn from the implications of the simplified device and its limitations.

Dynamic Response of Structural Columns Subjected to Impact Loading - (12cp)

Xiang Yuan Hou - A18-317

Supervisor: Dr Jun Li
Major: Civil Engineering Major BE and BEDipEngPrac

In structural engineering communities, how to resist column collapse under impact loads have received increasing attention for numerous years, particularly after the 9.11 terrorist attack on the Twin Towers in New York and the 5.12 Wenchuan Earthquake which has caused nearly 70,000 casualties due to structural collapse of millions of buildings. However, in some parts of the world, the actual collapse analysis does not exist in a practical context. Hence, research work and design guides are needed the most.

This report uses LS-DYNA finite element modelling of structural columns to determine the effects of numerous factors on the impact load and structural deformation of the column. These factors are the concrete strength, velocity, transverse and longitudinal reinforcement of the member. The effects of these elements on different durations and types of loading are examined to stimulate structural behavior and deliver a valuable reference for the establishment of a parametric function of each factor and applied to the simplified analysis of impact-induced collapse of structural column.

The resulting impact damage and stress displacement generated under different conditions are recorded to interpolate the relationship between the structural column and the impact load. Therefore, the connection between the degree of damage and various factors is established. According to the comparison of simulation results and data from investigation, impact damage and various factors can be simply expressed as a function and applied to the simplified analysis of impact collapse of column structure. The purpose and output of this project is to improve the seismic safety of the structural columns in order to prevent potential damage from impact loads.

Consolidation of Unsaturated Soil - (12cp)
Johnson Ashak - A18-209

Supervisor: Associate Professor Hadi Khabbaz
Major: Civil Engineering Major BBEBBus and BEBsc

Civil Engineering is a multi-faceted industry that aims to solve a range of issues and dilemmas. Soil mechanics and consolidation of unsaturated soil is a natural phenomenon that was pioneered by none other than Terzaghi. Since then, technology has revolutionized the civil engineering industry through remarkable advances in computer simulations and calculations. In this day and age, we are able to model both simple or complex problems through the streams of technology – such as MATLAB, Plaxis or Microstran.

Soil consolidation occurs when a soil stratum is subject to various vertical loads that can alter the overall volume of the soil strata due to granular realignment. Although the volume of the soil remains constant, the reduction in air and water changes the volume of the soil strata itself. There are two types of seepage, these are known as one-way or two-way drainage. Each variation of seepage has an impact on the rate of drainage.

This thesis will aim to model soil consolidation through a user friendly, client oriented platform on MATLAB. The MATLAB program will aid both researches and designers in the geotechnical engineering field. This platform will enable laymen in industry to calculate critical values such as stress, strain and total settlement based on a number of variables. With a simple GUI interface, users will be able to enter variables of any soil strata. MATLAB will then take the inputs, run a series of complex calculations and display the key values that will demonstrate and identity the total settlement of the soil strata based on a number of factors.

Design and Performance of Composite Cold formed Steel and Engineered Timber Flooring Systems - (12cp)
Robert Neate - A18-087

Supervisor: Dr Harry Far
Major: Civil Engineering Major BE and BEDipEngPrac

A recent trend in structural engineering has been the implementation of steel and concrete composite slab systems, which reduce the time and costs associated with traditional concrete flooring systems during construction. Whilst innovative, this technique has been around for over twenty-years and is generally limited to profiled steel sheeting and reinforced concrete.

Previous research has found that the composite action between cold-formed steel members and engineered timber products can be utilised to create structurally sound and economical flooring systems. There are also numerous environmental benefits associated with the use of timber products in lieu of concrete; including, but not limited to an indirect reduction of greenhouse gas emissions, recyclability as well as increasing a buildings green rating.

This study investigates the composite action between cold-formed steel and engineered timber floorboards with the primary focus being the presentation of span tables for several types of these composite systems.

Fully Non-linear analysis has been performed on multiple models of these composite systems using SAP2000. The models were initially verified against a physical experiment undertaken by previous researchers, Kyvelou, Gardener & Nethercot, as well as ANSYS models created by Dr. Sardar Malekmohammadi (UTS). Further parametric studies were creating using Australian cold formed steel sections and timber flooring products. The results of the models have been recorded and sorted into span tables using the theory of Servicability Limit State (S.L.S) Design. These span tables can be used by designers to appropriately size cold formed steel and timber composite flooring systems for use in the Australian construction industry.

Investigation on the Properties of Coarse Reclaimed Aggregates and Their Effects on Concrete Strength and Workability - (12cp)

Boi Tran Ly - SU17-015

Supervisor: Dr Harry Far
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Fresh concrete waste is constantly generated in concrete batch plants during the production of ready-mix concrete and this waste is generally dumped in landfills. Natural aggregates are a finite extractive resource and so there is an increasing demand and interest in recycling concrete waste to produce recycled aggregates. In Australia, the most common type of recycled aggregate is recycled concrete aggregates, which is produced by crushing hardened concrete, typically from construction and demolition waste. Currently, a similar process is being used to recycle fresh concrete waste, where the concrete waste is taken to the landfill, allowed to harden and then is crushed. This temporary dumping will not only occupy landfill area but also increase waste processing cost due to the double handling of material.

An alternative solution is the utilisation of reclaimers which process fresh concrete waste at the concrete batch plant to produce reclaimed aggregates. The use of a reclaimer provides many benefits such as reducing waste in landfills, eliminating double handling and allowing for better utilisation of concrete agitators. However, despite these benefits, there is a lack of utilisation in Australia. The hesitation to adopt a reclaimer can be partly attributed to the minimal amount of published information and current utilisation in the concrete industry. Therefore, this paper aims to provide information on the characteristics of coarse reclaimed aggregate and their effects on concrete strength and workability to increase interest in utilising reclaimers.

The mechanical properties of coarse reclaimed aggregates were determined through aggregate testing and were then compared to literatures that investigated the characteristics of recycled concrete aggregate. Two sets of concrete trials mixes were conducted to determine the effects of coarse reclaimed aggregate on concrete strength and workability.

Maintenance of Corrosion on Steel Bridges - Environmental Interaction (Effects & Control) - (12cp)
Brian Pham - A18-280

Supervisor: Professor Huu Hao Ngo
Major: Civil Engineering Major BE and BEDipEngPrac

In the past years, there has been a consistent growth in asset maintenance and preservation of structures in Australia due to the large increase in demand for repairs and asset preservation of steel structures. In Australia, the annual asset maintenance costs are estimated to be approximately $32 billion in 2016. However, avoidable corrosion damage to these assets makes up at least one quarter of these annual costs. This economic impact affects the wider community and emphasises the importance of correct rehabilitation methods and processes, by which large cost savings may be applicable for many structures.

Corrosion induced the deterioration of the steel bridge integrity has been a major problem in the rehabilitation industry for steel bridges. Corrosion is an electrochemical reaction that can be commonly seen in two forms, namely 'Atmospheric Corrosion' and 'Chemical Corrosion'. Corrosion occurs when acidic substances and water react with or come in contact with different types of metals, such as steel and iron. Corrosion can also be significantly influenced by the exposed conditions and surrounding environment, such as bridge location and water quality. If the steel bridges are not maintained and managed properly, the corrosion process can accelerate and have shattering impacts on the structural steel members of the bridge.

This project investigates the effectiveness of current prevention methods currently utilised in the industry and the environmental impacts of these current methods, because the current methods used may have negative effects on the environment. Comparing the advantages and the disadvantages in relation to corrosion prevention can greatly benefit the community. The effectiveness, cost, risks, and feasibility of each prevention method will be analysed and evaluated as well in this project.

Management of Corrosion on Steel Bridges – Evaluation of Technology Methods - (12cp)

Lwin Maung - A18-281

Supervisor: Professor Huu Hao Ngo
Major: Civil Engineering Major BE and BEDipEngPrac

The phenomenon of corrosion is defined as an electrochemical reaction between a solid, generally a metal (steel) and its environment. This reaction results in deterioration of the material and its overall properties. It is an on-going engineering problem regarding infrastructure assets (e.g. bridges) and is a common issue unless managed effectively.

Corrosion of steel bridges can cause section loss, further leading to the compromised ultimate strength, structural integrity and serviceability of the structure, which can affect the intended function of bridge and make it unsafe for users.

In Australia, the yearly cost of asset maintenance is estimated to be approximately $32 billion. Avoidable corrosion damage accounts for $8 billion and continues to have a major economic impact on industry and the wider community (Build Australia, 2018). Therefore, the asset maintenance of bridge steelworks not only greatly impacts the lifespan of the bridge but also the economic costs.

It is worth investigating how corrosion is managed on steel bridges. Corrosion management and inspection usually follows a process of prevention, detection and application of control methods in the early stages. Following this process would significantly save time, cost of maintenance and would help prolong the structures service life.

This project studies and assesses the effects of corrosion on steel bridges, current and emerging non-destructive techniques (NDT) and technologies for detecting the corrosion. The project also provides readers valuable insight on the aspects of how government bodies such as Roads and Maritime Services (RMS) plan bridge inspections, as well as the scope of each current and emerging method utilised. The effectiveness of the various methods for corrosion control and their advantages and disadvantages will also be evaluated, including recommendations.

A Critical Literature Review Based Study on Evaluation of Municipal Waste Pyrolysis in Converting Waste into Energy - (12cp)

Noah Kashabech - A18-173

Supervisor: Professor Huu Hao Ngo
Major: Civil Engineering Major BBEBBus and BEBsc

There is currently a rapid rise in waste due to the increases in global population and the economic development of nations around the world. Pyrolysis is a current technology being researched for use to solve this problem and convert waste into energy. This research article aims to critically review 80 research publications spanning the problem, the pyrolysis system and how it may be used for sustainability. Aspects such as pyrolysis system design, thermolytic kinetics, reactor design, feedstock types, product yield and their utilization are presented. It was found from this review that pyrolysis feedstock includes biomass, plastics, rubbers, electronic waste and a range of organic wastes. There are multiple challenges surrounding this technology, including the removal of impurities from the waste, pre-treatment requirements such as feedstock particle size and the selection of suitable pyrolysis parameters to acquire a certain product yield in a heterogeneous waste sample. Despite these challenges, pyrolysis is more environmentally viable than landfill dumping and current combustion techniques. Products derived from this technology have multiple uses in agriculture, energy production and chemical manufacturing. Conclusively, further research is required to develop systems that may overcome or simplify the problems to increase the viability of such technology. It is also suggested that engineers study the possibility of scaling down such a system for use in developing countries to reduce waste directed to landfills for a nations' development.

Analysing the Unique Characteristics of Submerged Floating Tunnels and Designing for Accessible Structure Maintenance - (12cp)

Jerome Guinto - A18-213

Supervisor: Dr Jack Wang
Major: Civil Engineering Major BE and BEDipEngPrac

Submerged Floating Tunnels (SFTs) have been discussed theoretically by engineers for decades but have yet to be designed and physically constructed. SFTs have a unique design because they are suspended in water using the law of buoyancy and hydrostatic thrust rather than being embedded into the seafloor (Hoa et al. 2016). As a result of the surrounding environment, the design and construction of SFTs pose complex engineering challenges.

Thorough research and investigation of the concept's viability is essential to ensure that it is a suitable option to replace conventional transport infrastructure. Sound background and analysis of SFTs must be conducted before its implementation into the real world. Current academic research focuses heavily on feasibility and initial design. However, for SFTs to be an appropriate replacement of conventional transport infrastructure, it is critical to evaluate structural maintenance and longevity. This thesis will aim to address the gap in academic research by understanding the unique characteristics of SFTs in respect to accessible structure maintenance.

The objective of this research project is to determine and recommend specific design considerations to combat common structural and maintenance defects that arise due to SFTs' complex design. Specifically, the report explains the unique components that make up SFTs including Ballast Systems, Pontoon Tethers, Concrete Connections, Ventilation, Waterproofing, Safety bays and Emergency exists. Comprehensive research and investigation into these design components have been explored in great detail.

Through a thorough academic literature review, the study will present the most effective practices that will aid accessible maintenance procedures to ensure the structure's longevity and durability, ultimately remaining safe and sustainable throughout its service life. In addition, there is great potential to expand on these concepts further through controlled laboratory testing, adding to the understanding of accessible structure maintenance in SFTs.

Verifying As-Built Deliverables Using Augmented Reality: Towards a Hololens Handover Helmetsample Capstone Project- (12cp)

Sally Archer - A18-313

Supervisor: Associate Professor Julie Jupp
Major: No Major

Project delivery within the construction industry is defined by an ingrained contractual nature, with defined contractual provisions outlining deliverables in alignment with the owner's project requirements. As the utilization of Building Information Modeling [BIM] tools and workflows expand throughout the industry, the use of BIM data beyond design and construction are becoming apparent. The potential of BIM to increase the efficiency and accuracy of existing close-out and handover processes has many benefiting to assist building and facilities managers traditionally saddled with incomplete, incorrect or obsolete documentation. Through implementing BIM, centralized information repositories can be utilized to manage structured data and asset information.

Despite established benefits of BIM in operations and maintenance [O&M] and/or facilities management [FM], its application on live projects remains limited due to a number of constraints spanning the client, consultant and contractor interfaces. A key barrier to model-based data reuse in the O&M phase relates to a lack of quality assurance [QA] protocols to effectively and efficiently validate that virtual geometry and linked metadata correlate to as-built conditions and installed plant/equipment specification. Augmented reality has been identified as a potential infield platform to support the validation of 3D deliverables and associated metadata, however this remains an undeveloped area of research and industry implementation.

As owner's increase their digital sophistication and move to asset/FM platforms that leverage model-based data, it is increasingly important for head contractors to implement standardized processes to ensure a consistently high handover deliverables is achieved.

The purpose of this research is to understand and map the current infield processes associated with a head contractor's collation and commissioning of handover deliverables – the activities, documentation, resources and QA methodologies. This traditional document-based workflow can then be translated to a digital 'BIM-enabled' process with associated QA protocols, and how this methodology can be implemented on a live industry project.

The Effect of Path Dependence on BIM Adoption and Implementation in Tier 1 Construction Firms in Australia and The United Kingdom - (12cp)

Steven Washburn - A18-083

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Major: Civil Engineering Major BBEBBus and BEBsc

With increasing levels of complexity in building and infrastructure projects, the AEC industry has been moving further towards BIM to support design, construction and operations. Research literature on the role and value of model-based approaches to the construction phase indicates that BIM has the potential to increase efficiency on complex projects when planned appropriately and executed precisely. However, compared to more advanced industries around the world such as the UK, Australia lacks maturity relative to the adoption of a consistent approach to the implementation of BIM.

This study focuses on Multiplex Constructions, a prominent Tier 1 contractor in Australia and the UK, and investigates their approach and attitude toward BIM across these two regions. In the UK, Multiplex has been forced to standardise its approach to BIM due to the governmental mandate introduced in 2016. In Australia, where no similar mandate exists, Multiplex continues to operate using traditional methods of construction and has not yet developed a standardised approach to BIM implementation on projects.

The hypothesis of this research is that Multiplex Australia operates subject to a well-known phenomenon called path dependence and must be presented with an incentive to move onto differing paths. A three-round Delphi study was utilised to gather data from a panel of 12 BIM experts currently working for Multiplex in Australia and the UK by investigating approaches and attitudes towards BIM in both regions. The findings indicated that Multiplex is indeed prone to path dependency in Australia, preferring traditional approaches to project delivery at the present moment. Compared to the UK, it was concluded that there are too few drivers motivating Multiplex Australia to pursue a strategic enterprise approach to BIM implementation or to actively pursue BIM based projects due to the current levels of maturity in the Australian market. Within senior management, the attitude of ‘if it ain’t broke, don’t fix it’ dominates and is seen as being both practical and prudent in the current market. However, recent literature indicates that the BIM market is maturing. Therefore, it is evident that path dependency and unfamiliarity with digital innovation is impacting a Multiplex’s ability to adapt to new ways of conducting business in the digital age and may damage their reputation as a standout Tier 1 contractor.

Keywords: Building information modelling, path dependence, construction, adoption, implementation

Solar Steam Generation for Desalination: A Review of Recent Advancements and Technologies - (12cp)

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In an era of diminishing natural resources, an explosion of population growth over the last century and the rapid development of resource intensive industries, the utilisation and need for water has increased exponentially. As potable water only accounts for a fraction of the available water on earth, an impending water scarcity epidemic is soon becoming a global phenomenon. Desalination technologies such as reverse osmosis (RO) and multi-effect distillation (MED) propose ways of dealing with the crisis through the purification of concentrated salt water to produce fresh water. However, they possess technical inefficiencies, are expensive, complex and are not always viable in a rural, small scale setting.

This paper presents a technical review of recent advancements and technologies in water desalination with a primary focus on solar steam generation through a membrane material facilitated localised heating process. The literature review provides an analysis of advancements in membrane structures, their composition and characteristics which aid in solar absorption, photothermal conversion and heat transference to a bulk liquid. This analysis is followed by an evaluation of the purification efficiency and energy considerations of each membrane specific localised heating process, a contextual analysis of the social and economic implications of solar steam generation and barriers that restrict it from widespread adoption, with a focus on rural and small-scale viability.

As an emerging technology, Solar Steam Generation through localised heating has been proven to increase heat transference to a bulk liquid, optimise steam generation and presents a more economic, efficient and renewable way of desalination that's viable for small scale and rural use.

Transport Modes and Their Influence on Urban Character and Built Form - (12cp)

Jack Gelabert - S17-195

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The role of transport has never been more central nor critical, as nations and cities globally are challenged to sustainably accommodate growth today and into the future in already highly, urbanised, built-up, populous and strained cities.

History has witnessed how each successive transport revolution influenced and shaped the surrounding build form, settlement patterns, densities and land-use to resultingly transform society's mobility, employment and quality of life.

This paper looks to accumulate and further build upon preliminary high-level transport & land-use relationships, by articulating the casual mechanisms of transport which are responsible for shaping the urban fabric.

A lengthy and diverse literature review across transport studies, transport history, land-use, urban design and morphology, combine to form a synthesis explaining the cross-discipline interactions of elements in the urban system that eventuates the built-form.

This paper categorises three distinct functioning domains in which the transport/urban-form mechanism transpires and continually reinforces one another throughout numerous aspects.

1) The transit system itself generates different levels of patronage, boundaries of influence because of its different transport characteristics such as; relative speed; stopping patterns, frequencies which affects Level of Service.
2) The public street is the transitionary plane which allows travellers to interface with the local built form. Morphology aspects like block configurations, permeability of the street network allow for greater distribution of movement, permeating activity further to influence intensification of land-use and allow greater areas to be connected to high capacity transport.
3) The built-form: active building frontages utilise urban design qualities and diversity of land uses to multiply with activity levels to create and sustain greater public life. This fulfils public transport's capacity to encourage intensity of density and building uses.

This paper includes a qualitative assessment of the Eastern Suburbs bus network, to assess level of service influence to patronage levels. As well as the evaluation and comparison of different typologies that were formed around different transport modes to interrogate how operational characteristics distinguished these typology differences.

Analysis of Operational Procedure Within IWLR to Reduce End-to-End Run Time - (12cp)

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The Inner West Light Rail (IWLR) has experienced rapid patronage growth annually causing the level of service of the rail system to decline. During peak times the system is suffering from overcrowding, restricting the patron's ability to alight on the first available service. The current restraint of the system from supplying a larger capacity per hour is the end-to-end run time of the Light Rail Vehicles. The reduction of this end-to-end runtime can be achieved through either infrastructural changes, including track realignment or by operational procedure changes. Infrastructural changes require design and construction works to be completed which require large capital investment, due to this only operational procedure changes where investigated in this report.

A literature review was undertaken to investigate the current research and performance of the IWLR. From this, platform entry speeds was determined to be a viable option to investigate as there is international precedence of platform entry speeds being above the currently instated 20km/h speed limit on the IWLR. This report determines the viability of increasing the platform entry speed by theoretically analyzing the reduction of end-to-end runtime associated with the speed increase and weighing it against the reduction of safety performance and passenger comfort.

The theoretical models of the system showed that significant reductions to end-to-end runtime could be achieved by increasing the platform entry speed, whilst only marginally increasing the likelihood and consequence of a harmful event. The report further evaluates the risks associated with the speed increases at each station to make a recommendation of a suitable trial speed increase across the system.

Using Railsys Software to Evaluate Changes to Operations for Off-Street Light Rail on IWLR (Inner West Light Rail) - (12cp)

Matthew Elyard - A18-199

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This capstone project aims to model and evaluate operational changes and processes that would optimise and reduce the end-to-end run-time of the off-street sections of the Inner West Light Rail (IWLR) network, using RailSys by RMCon- a rail transport modelling system used widely in industry. This has been carried out as it has the potential to significantly improve light rail services for the community of the inner west.

The public transport network is a major cog in the commuter transit system of the Greater Sydney and specifically Inner City Sydney. The 2016 ABS Census reported that over 36.2% of all Inner City Sydney-siders utilise public transport for their daily commute. One of the key sources of public transport available within Inner City Sydney is the Inner West Light Rail (IWLR), the sole provider of rail transport in the area, which connects Central to Dulwich Hill, via Pyrmont Bay and Lilyfield. A 2014 IWLR forecast by EIS-STM estimated that 7.17-million patrons would use the network in 2016, increasing to 9.62-million by 2026. Since then, patronage has exceeded anticipated expectations, reaching 9.92-million in 2016, already exceeding the 2026 forecast, as shown by UTS Transport Research Centre Study in 2018. With patronage levels increasing by approximately 56% year on year from 2013-2016 (UTS 2018), the IWLR system is approaching its ceiling capacity. Without optimising operations of the current system, patronage growth will have adverse effects on the wider public and private transport networks.
The UTS Transport Research Centre (2018) have determined that by decreasing the end-to-end run-time of the IWLR by 4-minutes, one less light-rail vehicle is needed to provide the same Level of Service (LoS).

This study evaluates various operation optimisation concepts. By comparing these operational changes to the existing network conditions the savings in end-to-end run-time have been calculated as well as other system optimisations, with key findings and impacts discussed including:

- An assessment of the existing operations;
- Shortening of TSR sections equals a saving of 260 seconds;
- Higher speed-limit within station boundary equals a saving of 220 seconds;
- Decrease of long-dwell time at Dulwich Hill turnaround;
- Change of long-dwell time location;
- The testing of other UTS Capstone findings;
- The time-saving effect of combining the above.

Development of Autoclave Based Accelerated Test for Alkali Silica Reaction (ASR) - (12cp)

Muna Lama - A18-358

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Alkali- silica reaction (ASR) in concrete is a deleterious reaction which occurs due to the reaction between alkalis in the pore solution and reactive forms of silica found in some aggregates. A gel product formed by this reaction absorbs water and exerts expansive pressure on the concrete, resulting in cracking which reduces the mechanical properties and further causing damage by the ingress of water via cracks. Hence, it would be beneficial to identify this harmful effect at a very early age through an accelerated autoclave test method.

Since 1980s, researchers have developed and investigated the use of autoclave test methods to rapidly and precisely identify potentially reactive aggregates. These methods simulate the long term effect in concrete within a short period of time. Autoclave test method comprises boosting the alkali content of the concrete or mortar specimens and conditioning them at high temperature and pressure in a sealed environment. Some autoclave results have shown promise in classifying aggregates accurately with regard to their reactivity.

The objective of this research is to examine and determine autoclave test methods for monitoring potential expansion and deterioration caused by ASR in concrete within 7 days. Additionally, the effect of applied test parameters such as temperature, pressure, duration and alkali loading will also be investigated and validated.

This project is aiming to develop a rational, suitable ultra-accelerated autoclave test method that can simulate 20year long term effects in relation to ASR within 7 days. This will be a significant achievement which will enable civil engineers to construct sustainable concrete structures in the future.

Developing a Computer Program to Design & Analyse Cross-Sectional Shapes and Sizes for Steel, Timber, and Reinforced Concrete Beams - (12cp)

Ismet Ozen - A18-278

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Fundamental elements of structural systems that are able to carry loads mainly through withstanding the bending phenomenon induced into it are recognized as structural beams. Beams are adopted in engineering to strengthen the composition of the design. They are an integral member of design that can be composed of materials such as Steel, Timber and/or Reinforced Concrete.

This capstone project has developed a computer program called Salvatore. Salvatore enhances the structural engineering beam design experience through simplifying the calculation processes involved in designing and analyzing the cross-sectional shapes and sizes of different types of beams.

Along with comprehensive investigation into diverse methods of beam design, this interactive Graphical User Interface (GUI) enabled program has been generated using Microsoft Excel's Visual Basic for Applications (VBA) software language. Salvatore has been compiled to operate in accordance with relevant Australian Standards such as Steel Structures (AS4100), Timber Structures (AS1720.1), Concrete Structures (AS3600-2009) and Structural Design Actions (AS-NS1170.0-1).

The profound advancements unfolding in the construction and engineering industry may hinder the optimal design processes utilized by engineers today. This is due to the great magnitude of design variables and complicated connections conjured through the need for architectural designs. Therefore, through simplifying complex designs and isolating iterative calculation processes into manageable segments, the formulated software, Salvatore, will heighten the engineering experience for the designer through enhancing their understanding of the singular element within the entire structural matrix.

Salvatore has not been developed to compete or replace any commercial engineering software package that encompasses advanced finite element analysis applications. It is best suitable to be used in conjunction with the evaluation of certainty of analysis and detailing of designs in an all-in-one manner. Salvatore will bring simplicity and clarity to complex engineering designs, ultimately reducing the ambiguity in structural engineering.

A Comparison of Timber-Composite Flooring Systems in Medium/High Rise Buildings with Conventional Flooring Materials - (12cp)

Kevin Phan - A18-306

Supervisor: Dr Rijun Shrestha
Major: Civil Engineering Major BE and BEDipEngPrac

Currently within the construction industry, medium to high rise building structural components are typically made from a combination of steel and concrete. However, due to an increasing demand for construction works fuelled by a global increase of population densities, there has been a depletion of resources as concrete and steel are processed from non-renewable material sources. This has led to a shift in the market drivers pushing for a high demand in sustainable buildings using renewable materials and production methods that reduce carbon dioxide emissions

An alternative solution is the use of timber-composite systems which have the potential to provide similar structural performances to conventional flooring systems while reducing the embodied energy of the structure. Along with environmental benefits, timber-composite systems provide several economical and technical benefits such as the total reduction of weight within the system and ease of installation of prefabricated panels. Despite these benefits, outside of Europe, there has been a lack of implementation of timber-composite systems within Australian medium/high rise construction which may be attributed to the lack of design information and design regulations. A better understanding of how timber-composite systems will compare to the typical industrial materials in medium-high rise buildings may increase their usage and broaden their applications in the construction industry.

This research project will analyse the feasibility of timber-composite flooring systems within commercial buildings against conventional construction materials such as steel and concrete. There will be a review of different types of flooring systems currently within the Australian construction industry. The objective of this model is numerically determined the minimum requirements for steel, concrete and timber flooring to pass the strength and serviceability requirements under vertical and lateral loads in accordance to the relevant Australian Standards and design codes.

The Demanding Houses In Future - A Revolutionary Housing Unit - (12cp)

Kirigaran Yogarajah - A18-244

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Major: Civil Engineering Major BE and BEDipEngPrac

An earthquake is a natural disaster which occurs due to violent shaking of ground surfaces resulting in the sudden release of energy in the form of seismic waves. Tsunami is one of the other natural disasters which also occurs due to underwater earthquakes resulting in large destructive waves. Most earthquakes and Tsunamis create threats to humans and properties. Both of the above natural disasters have accounted for millions of deaths so far and it is still counting. Defending earthquakes and Tsunamis are an ongoing battle for many civil engineers.

Considering the above problems and considering the urge for innovative solutions, this project has proposed a conceptual model for a revolutionary housing unit. The basic concept of this housing unit is to propose an alternative load transfer path to transfer the loads from the structure without relying on the foundations at least during an event of earthquake or tsunami. The design of this proposed house is based on the principles of fluid mechanics to effectively function as a floating structure and as a movable structure when required. The application of the fluid mechanisms on the structure is to allow the structure free from the earth surface to completely keep away the earthquake loadings and tsunami loadings on the buildings. The proposed concept has been proved based on theoretical approaches complying with the appropriate requirements of the standards and based on market researches on the existing models. Construction materials with low density have been adapted to impose less structural weights while ensuring the structural requirements for the housing unit are met. Technologies from different engineering streams have been adapted into this proposed house in order activate the housing unit in self-pilot mode or auto-pilot mode to address the mobility features of the proposed structure. For the start of the proposed structures like this, the research has been based on small residential houses. Upon the success of the proposed structure, this principles can be applied to high raised buildings as well in future. Since this structure address the mobility features, these types of structures would create an opportunity to combine civil construction industries and transport industries together.

Modelling Piles in Surrounding Soils using Plaxis - (12cp)
David Rizkalla - A18-218

Supervisor: Dr Sanjay Nimbalkar
Major: Civil and Environmental Engineering Major BE and BEDipEngPrac

Pile raft is a commonly adopted foundation for supporting structures located in soft soils. While pile raft foundation has the ability to create incredible structures like the Burj Khalifa, there are risks that are involved in such foundations, if not properly accounted in the design phase.

Possible geological failure is a critical research component when designing pile rafts, due to the enormous impact that can occur to structures and potentially have fatal impacts on society. One of the most common issues that need to be dealt with when designing pile rafts, is the impact of settlement due to water. Ground conditions are complex and poses sever challenges due to groundwater, and has the potential to produce failure in subsoils.

The purpose of this capstone project is to understand how water drawdown will affect the stability of piled raft structures, how the surrounding soil will respond to piled raft construction. The displacement of various soil types (like soil and clay) and pile structures (for buildings or embankments) will need to be considered. Geological factors also need to be determined via literature review of previous geological research papers. By using all of these sources and analysing pile raft designs previously conducted, the parameters have been selected which best represent the soil profile of the Sydney region.

In this project, the finite element analysis program Plaxis 2D will be used to compare the impact of drawdown on different soil types and structural design of piled raft foundation. By quantifying the behavioural properties of material, numerical analysis is performed to evaluate the stresses and deformations occurring in and around the raft structure. Further pile strengthening methods will be assessed such as use of geotextiles and thickening the piles and their impact on reducing the settlement of the raft structure will be studied.

This dissertation deduces the load carrying capacity of pile rafts to withstand drawdown and structural loading. By conducting finite element analysis on pile raft structures, this can reduce dramatically the potential for failure of pile raft foundations in the industry. This project is a step towards accurate pile raft design and significantly reduce the possibility of failure of these structures.

Environmental Impact Assessment of Transport Infrastructure Projects - (12cp)
Shana Cai - A18-124

Supervisor: Dr Sanjay Nimbalkar
Major: Civil Engineering Major BBEBBus and BEBsc

Major transport infrastructure projects (i.e road and rail) are classified as 'State Significant Infrastructure' (SSI) projects in New South Wales (NSW) under the NSW Department of Planning & Environment. These projects are of a large-scale that typically carries a high importance and impact over an area usually beyond the locality of a suburban community, hence classified as 'State Significant'. SSI projects have become essential to accommodate and support the increased demand for such infrastructure accompanying the continual growth in the Australian population.

Due to the extensive nature of SSI projects, environmental impacts associated with the project proposal are required to be assessed with accompanying risk mitigation measures. This assessment is to be written in the form of an official planning document known as an Environmental Impact Assessment (EIA) under the State Environmental Planning Policy (SEPP) 2011. The purpose of an EIA is to satisfy statutory legislative requirements as stated in the Environmental Planning and Assessment (EP&A) Act 1979 and the Environmental Planning and Assessment (EP&A) Regulation 2000. This documentation is crucial when obtaining a project approval as detrimental impacts to the environment may be resulted by the negligence of potential affects to the environment and the wider community.

The purpose of this capstone project is to review all relevant standards and guidelines by government bodies and authority agencies to investigate the major parameters in an EIA of transport infrastructure projects, focusing on air quality, noise and vibration impacts of road and rail SSI projects. Two case studies on Sydney Metro and WestConnex will be undertaken with reference to their associated environmental impacts. An investigative study on vehicular greenhouse gas emissions will also be conducted to correlate the environmental effects of vehicular traffic flow volumes on air quality, demonstrating the relationship between population growth and environmental impacts.

Removal of Metals from Acid Mine Drainage (AMD) by adsorption - (12cp)
Bibi M E A Esmaeel - A18-266

Supervisor: Professor Saravanamuth Vigneswaran
Major: Civil Engineering Major BE and BEDipEngPrac

Acid mine drainage is one of the major environmental problems nowadays resulting from the microbial oxidation of pyrite in presence of water and air, affording an acidic solution that contains heavy metal ions. The production of AMD and release of dissolved heavy metals is a critical concern confronting the mining business. This study focus on the removal of Fe, Cu, Al, Ni and Zn using zeolite. The adsorption behaviour of natural zeolite has been studied in order to determine its applicability in treating acid mine drainage (AMD) containing 20 mg/l of each of the metal (Fe, Cu, Ni, Al and Zn). To investigate the efficiency of natural zeolite as a potential low-cost material for the removal of these heavy metals from AMD laboratory experiment was performed.

The laboratory experiments were using a different concentration of zeolite, different pH of AMD with non-treated zeolite, different pH of AMD with treated zeolite. Different concentration of zeolite experiments showed that natural zeolite was capable of removing of heavy metals from AMD. During the experiment of different pH solution with non-treated zeolite, it was found that removal rate was increased with increasing of pH after adding the non-treated zeolite. In the experiment where the heat-treated zeolite was used, we also found that the removal percentage was increased with the increase of pH, but this time the removal efficacy improve in lower pH than it was with untreated zeolite. From the experiment, it was found that at high pH for treated zeolite the removal rate of 99.71 % of Zn, 100% of Cu, 99.57% of Ni, 99.49% of Fe and 99.47% of Zn. For normal zeolite, the removal rate of the metals was 0.06, 0, 0.09, 0.11 and 0.12 of Zn, Cu, Ni, Fe and Al respectively. From the experiment to remove the metal the result of heat-treated zeolite was used and the adsorption percentage was 99.35% of Zn, 99.47% of Cu, 100% of Ni, 98.71% of Fe and 99.95% of Al. Preliminary experiments using AMD samples showed that natural zeolite has great potential as an alternative low-cost material in the removal of metal from acid mine drainage.

Optimising the Block Placing of a Pre-Cast Concrete Quay Wall - (12cp)

Dennis De Groot - A18-093

Supervisor: Associate Professor Xinqun Zhu
Major: Civil Engineering Major BE and BEDipEngPrac

A quay wall is a maritime structure primarily used for the mooring or tying-up of vessels, and for loading and unloading of goods and passengers. Infrastructure like this is vital for modern economies.

A pre-cast concrete blockwork quay wall is constructed by placing large concrete blocks (around 2m x 2m x 7m), about 70 tons, into the water to form a wall that is then backfilled. These pre-cast concrete blockwork quay walls are used all over the world for its relatively simple and speedy construction process. Optimisng the construction of these structures has significant benefits in terms of cost, safety and time.

This capstone project investigates the optimisation of the block placing phase in constructing a pre-cast concrete quay wall. Generally, wave protection for the structure is built before construction begins on a quay wall, but that is not always the case. This project will focus on optimisng the block placing and backfilling of the quay wall in unprotected conditions.

To optimise the block placing of a pre-cast concrete quay wall many factors need to be analysed, including:

- The design wave events and the estimated forces that they exert on the structure.
- The various failure modes of a free standing, submerged, concrete quay wall.
- Various cross section designs of quay walls and their respective construction efficiency.

The results of this project provide a guideline for construction of pre-cast concrete blockwork quay walls. The research has a practical impact on the design and construction of the quay wall.

Critical Buckling Analysis of Wind Turbine Blades - (12cp)

Adam Jut - A18-189

Supervisor: Dr Sardar Malekmohammadi
Major: Civil Engineering Major BE and BEDipEngPrac

As it is, widely known, non-renewable energy sources are fast depleting with large amounts of funding being invested in determining alternative energy production methods. Wind energy is one of the fastest growing renewable energy sources in Australia. In ensuring wind energy is a feasible option, existing limitations in the technology must be overcome.

One such limitation in the existing technology is developing Wind Turbine Blades with larger spans while maintaining the low weight and cost in order to improve the turbines efficiency. In increasing blade spans, one of the most common failure modes is buckling. Due to the thin shell composite structure, panel buckling is the primary limitation in increasing the blade length. Due to the increased surface area of the blade, and additional materials, the load imposed on the blade is substantially increased and the existing materials utilised in the manufacturing process cannot withstand this added load.

This study investigates how the existing materials utilised in wind turbine blades behave under applied load and how substituting these materials with alternatives can improve their behaviour, with a primary focus on the buckling behaviour of the blade. The composite panel forming the shell of the turbine blade is commonly made up of a Glass Fibre Reinforced Polymer (GFRP) skin and Balsa wood core. Balsa has been used as the core material due to its high strength weight ratio and low density. The study will be completed in two key stages. Simplified hand calculations will be used to identify potential alternative materials through analysing a simple section under pure axial load. The second stage will involve creating a Finite Element model substituting the materials identified in stage 1 into the model and analysing the behaviour in buckling.

3D Printing of Bio-inspired Cellular Structures with Complex Architecture (12cp)

Jing Yin Ooi – A18-157

Supervisor: Dr Sardar Malekmohammadi
Major: Civil Engineering Major BE and BEDipEngPrac

Cellular materials are widespread in nature (e.g. wood and bone) and in advanced engineered structures such as aircraft, wind turbines blades and recently airless tires. The prevalence of cellular materials and structures in our everyday life easily goes unnoticed, however in many instances where strength, stiffness, energy-efficiency and lightweight are required (often concurrently), cellular structures are often considered as the preferable design by experienced design engineers. The emergence of additive manufacturing technologies, also known as 3D printing, opens up a new route to fabricate cellular structures. Combined with computational tools, it profoundly extends engineers' ability to selectively place materials where they are needed in their designs. In pursuit of this liberty, assessing critical factors such as the lead time, brittleness, cost and defects is therefore of chief importance; as these factors can adversely compromise the economy of adapting 3D printing for manufacturing structural grade cellular structures. The purpose of this project is thus to review recent Fused Deposition Modelling (FDM) technologies with a vision towards guiding future researchers and engineers in making informed decisions in selecting the most suitable 3D printer for each application.

Three state-of-the-art FDM printers which are available in UTS ProtoSpace are chosen for assessment: MarkForged X7, Stratasys F270 and Stratasys Fortus 450mc. Quantitative and qualitative data on material properties, visible defects, dimensional accuracy, printing cost and lead time are collected and compared. We first review various constraints on 3D printing technologies identified in the literature at the respective times of investigation. Small cellular structural elements are designed and printed in ProtoSpace to discern the limitations that are still hampering the 3D printing technologies today from manufacturing large structural parts for civil engineering applications. The project is mainly focused on fabricating honeycomb structures and cellular sandwich structures inspired by the microstructure of wood due to its high specific stiffness and strength under bending. Results suggest that cost, printing time and presence of small defects are among the main challenges that prevent us from fabricating large structural elements using the available FDM technology. Furthermore, the long-term and fatigue behaviour of such elements need more in-depth research.

A Review of the Classification of Reinforced Concrete Coastal Structures with Respect to the Attack of Airborne Chlorides - (12cp)

Alexander Shanahan - A18-308

Supervisor: Professor Vute Sirivivatnanon
Major: Civil Engineering Major BE and BEDipEngPrac

Section 4.0 of AS3600 Concrete Structures and AS5100.5 Bridge Design stipulates the design for durability requirements of reinforced concrete coastal structures in Australia. Coastal structures are given a B2 classification, which is shared with permanently submerged structures.

The biggest detriment to coastal concrete structures is the corrosion of steel reinforcement, attributable to carbonation and the intake of chloride ions. The corrosion of steel reinforcement is an electrochemical reaction and is instigated by a reduction of pH (~8.6) in the presence of chlorides, oxygen and water. The deposition of chlorides on the surface of coastal structures is a function of wind speed, wind direction, humidity, orientation and surface roughness. The concentration of airborne chlorides decreases significantly 200m beyond the coastline, and are almost negligible at 500m. Chlorides subsequently penetrate into the concrete through a combination of diffusion and capillary action, which is limited by the permeability of concrete and its moisture content (relative humidity and rainfall). In contrast, submerged structures are surrounded by water and chlorides, yet lack in a sufficient concentration of oxygen, impeding the corrosion process. Exposed coastal structures are also susceptible to carbonation induced corrosion, a process that is absent to those submerged. In this process, the pH of concrete is reduced due to the reaction of carbon dioxide with cement paste, releasing chlorides through the carbonation of Friedel's salts. Although the chloride concentration in submerged concrete may be higher (faster corrosion initiation), the occurrence of carbonation and significant higher quantities of oxygen (203,000mg/L vs 7mg/L) may result in an exacerbated corrosion process (propagation). Accordingly, this project discuses the need for a revision of the classification of coastal structures, taking into account the diverse exposure conditions and mechanisms that lead to the corrosion of steel reinforcement, including methods to model the transportation and ingress of airborne chlorides into the concrete.

Compliance Acceptance of Concrete in Australia - (12cp)
Pabita Basnet - A18-294

Supervisor: Professor Vute Sirivivatnanon
Major: Civil Engineering Major BE and BEDipEngPrac

Using Australian Standards such as AS3600 and AS1379, the overall quality of concrete is tested in terms of compressive strength, to determine structural performance and durability, for the built structure. With modern industry desires placing a higher emphasis on the financial feasibility and efficiency of projects, there is a growing need to ensure the quality of concrete.

Test methods to determine the quality of concrete are provided through AS1379, which presents two statistical methods ensuring the compliance of concrete with the projects' specified requirements. The strength grade assessment method is split into two, one for the supplier (production) and one for the consumer (project).

Construction practices require decisions on concrete quality to be made in a timely manner. Decision making can't wait until a large number of samples have been tested. Thus, for production purposes a small number of samples are frequently used to create a standard deviation, despite a higher number of samples equating to a lower risk for both the supplier and consumer. This standard deviation allows for 5% of the samples to fall below the characteristic strength of concrete but in reality, construction projects may span for a long duration and decisions made for a previous interval of construction cannot influence decisions after a certain point of time. To determine the feasibility of an average group of n samples during the production process, as specified in AS 1379, quality control tests invoked during the construction are examined.

The Modelling of Drug Delivery inside the Human Body for the Target of Cancer Cells - (12cp)

James El-Chami - A18-284

Supervisor: Associate Professor Ananda Sanagavarapu
Major: Biomedical Engineering major BE, BE DipEngPrac

As a leading cause of death in the population, 1 in 2 Australians are forecast to be diagnosed with cancer by the age of 85 with more than 48,000 deaths from cancer estimated for 2018 (Australian Institute of Health and Welfare 2017). Targeted drug delivery is a method of transportation of a pharmaceutical whereby its effect is maximised due to an increased concentration travelling to the affected location within the human body. This in turn minimises the potential of side-effects on neighbouring healthy locations.

Bacterial chemotaxis is the chemical gradient of bacteria which defines its movement, whereby the flagella directs the bacteria towards a positive chemical gradient and consequently away from repellents. Utilising the bacterial chemotactic movement, there is potential of creating a system where the drug is able to bind to the bacteria. This acts as a vehicle in directing the system towards the tumour site. Quroum sensing then enables the pharmaceutical to be released at the target location once a bacterial threshold is obtained.

This project models the bacterial directed pharmaceutical system towards tumour sites in a 3D projection via ANSYS fluent. The advantage of designing the novel targeted drug delivery system is threefold. It enables the development of an autonomous system that effectively and precisely delivers an appropriate amount of drug to the target site. The system will be able to adjust the amount of drug released based on tumour size and activity. It is also able to identify the region of desired operation and characterise its biological parameters. These factors assist in the delivery of a pharmaceutical that directly targets the tumour cells. As a result, the technique has minimal effect on healthy cells which, if damaged, can potentially severely compromise patient immunity.

Developing Computer-Based Technology to Improve the Pathology and Understanding of Neuroblastoma - (12cp)

Louise Samios - A18-178

Supervisor: Associate Professor Gyorgy Hutvagner
Co-Supervisor: Dr Sarah Bajan
Industry Supervisor: Associate Professor Daniel Catchpoole
Major: Biomedical Engineering major BE, BE DipEngPrac

Imaging technologies, image processing and artificial intelligence can assist and improve experts' analysis and diagnosis of disease. Currently, we rely on human analysis of tissue samples under a microscope to diagnose disease. This approach is arguably limited by factors such as human error, availability of time/resources and reliance on the expert's knowledge. Incorporating trained image analysis technologies into the diagnosis pipeline can alleviate experts of these limitations.

This project investigates the application of image analysis software, to improve the understanding and diagnosis of a disease. We're focusing on classification and diagnosis of neuroblastoma. Neuroblastoma's the most common, paediatric, solid tumour; found in tissue of the adrenal medulla, sympathetic nervous system and paraspinal ganglia. Clinical response and treatment vary amongst patients; and there's little understanding of the cellular mechanisms influencing tumour development. Understanding these mechanisms may improve how we classify and diagnose neuroblastoma.

Interleukin 7 (IL-7) is a cytokine and growth factor, known for its role in the immune system. Preliminary results, suggest that IL-7, and it's signalling pathway, influence tumour development of neuroblastoma. This project uses technology to visualise and quantify the role of IL-7 and its signal pathway in neuroblastoma; to increase our understanding of the disease's cellular mechanisms.

We performed immunohistochemistry analysis on six pre-prepared tissue microarrays, each containing 120 samples of both control and neuroblastoma patient tissue. Testing for proteins that are predicted to characterise neuroblastoma. To quantify the data, virtual microscopy and specialist image analysis software is used. For data analysis, we use correlation studies between markers, pairwise relationships and multifactorial studies.

This study explores the importance of understanding the capabilities and limitations of microscopy, image analysis and pattern recognition, including data visualisation. Studying this pathway with this technology may improve our understanding of neuroblastoma, which may provide targets for future drug development and improve diagnosis.

Development of a Cell Stretching Device for Analysis of Lung Fibroblasts in a Dynamic Environment - (12cp)

Luca Piali - A18-204

Supervisor: Dr Joshua Chou
Major: Biomedical Engineering major BE, BE DipEngPrac

Cells in vivo exist in a dynamic environment of chemical and mechanical stimuli. Any alterations in a cell's form and function such as proliferation, differentiation, morphology and motility is often attributed to changes in chemical stimuli. However, studies in Mechanobiology have shown that cells will continue to display these changes when the chemical environment is unchanged but the stiffness of the substrate the cells are adhered to is varied (Janmey PA 2011).
The cellular conversion of mechanical stimuli to a biochemical response is known as mechanotransduction and is proving to play an essential role in a cell's development and behaviour. In particular, mechanical stretch in vivo can trigger a cascade of complex cellular events involved in the regulation and protraction of lung function (Wirtz HR 1990). Lung cells in vitro that have been exposed to variable stretch patterns have shown an increase in calcium concentration and surfactant secretion. Since many lung diseases stem from changes in tissue stiffness, the potential to prevent or reverse cell dysfunction and disease, such as ventilator-induced lung injury, could be achieved through the restoration of tissue mechanics.

Currently there are only a few viable methods to stretch cells in vitro with majority of the devices unable to alter the amplitude and frequency of stretch cycles and/or cannot be simultaneously imaged. The purpose of this design project is to build a cell stretching device that provides controlled, equi-biaxal strain patterns to live cells on a silicon membrane, mimicking the mechanical forces experienced by lung cells whilst offering the ability for both upright and inverted microscopic analysis of cells undergoing stretch. The intent is to replicate the cells natural environment in vitro for clinical diagnosis and treatment. This project presents a novel design to the field of Biomedical Engineering that will assist in the study of ephemeral and long-term mechanotransduction of cells when exposed to different chemical stimuli. Through this researches can better authenticate the reactions of lung fibroblasts in their studies.

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[2] Wirtz, H. and Dobbs, L. 1990, Calcium mobilization and exocytosis after one mechanical stretch of lung epithelial cells, Science, vol 250, no 4985, pp.1266-1269.

Deep Learning Brain Computer Interfaces - (12cp)
Anthony Mikhail - S17-107

Supervisor: Dr Steve Ling
Major: Biomedical Engineering major BE, BE DipEngPrac

Brain-Computer Interfaces (BCIs) are systems that allow control of physical or virtual objects through 'mind control'. This can be achieved by acquiring and processing certain signals from a user's brain (EEG) and determining the user's intended action based on those signals. For individuals suffering from paralysis (or other restrictive impairments), current conventional methods of interacting with technology (e.g. wheelchair joysticks, smartphone touchscreens) don't interface well with their needs. BCIs have a lot of potential within the field of Rehabilitation Engineering (the development of technologies to assist people living with disabilities), as effective BCIs may help these individuals to control assistive devices such as wheelchairs, exoskeletons and robotic limbs; helping to improve their sense of independence and overall quality of life. While BCIs have already been extensively researched, not much has been studied in using Deep Learning as an approach to implement BCIs.

The aim of this project was to explore the application of Deep Learning algorithms in developing 2 class and 4 class BCIs that can classify instances of motor imagery (left hand, right hand, feet, tongue). To do this, EEG data was taken from BNCI Competition IV. After processing the data (FFT, EEG frequency selection, Min-Max Normalisation & Data-to-Image Conversion), 2 class and 4 class Convolutional Neural Networks (CNNs) were trained to classify instances of motor imagery. This was all implemented using Python, and libraries such as Keras and TensorFlow.

For the first subject in the dataset, the 2 class CNN (right hand, feet) had a test accuracy of 82.6%, while the 4 class CNN (left hand, right hand, feet, tongue) had a test accuracy of 56.3%.

Develop a Real-Time Simulation System of 3D Transesophageal Echocardiography for the Computer Assisted Cardiovascular Intervention Test-Rig - (12cp)
Thomas Mantakoun - A18-303

Supervisor: Dr Liang Zhao
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

With rapid development and improvements in technology in the past years, computer assisted medical interventions (CAMI) have become more prevalent in medical practices. To perform CAMI, an accurate model of the patient is necessary. These are obtained through various medical imaging modalities such as CT, MRI or Ultrasound (US). 3D Transesophageal Echocardiography (TEE) is a medical procedure where a probe with an US transducer is attached at the tip, and is inserted into a patient's oesophagus. Multi-planar US images of the heart are then taken, providing great anatomic details of the internal structure of the heart.

To further advance the areas in which CAMI can be used, more research and testing of novel methods is required. These may include various new control and localisation algorithms. Currently, 3D TEE in combination with a 6DOF Electromagnetic tracker (EMT) for use in computer-assisted cardiovascular intervention is being investigated at UTS CAS.

3D TEE is semi invasive making it unsuitable to perform for solely research purposes. This has spawned the need for development of a robust testing and simulating platform. Currently the availability of 3D TEE simulators is limited. They are catered towards personnel training, and are not suitable for research purposes. The goal of this project is to bridge this gap, and to develop a real-time simulation system for the researchers at CAS.

The simulation will generate US images using 3D models of the heart generated by CT datasets. Appropriate noise will be applied to images to correctly mimic the characteristics of an US. The system will utilise the ROS (Robotics Operating System) framework to create the individual components of the 3D TEE simulation. These components include; data acquisition of EMT data, 3D ultrasound image generation/simulation using the transducers pose, and 3D segmentation display of the ultrasound data. To test the validity of simulator the system will be evaluated against real 3D TEE datasets.

The Exploration and Optimisation of Intra-Operative Image Segmentation of Heart Models from 3D TTE/TEE for Computer-Assisted Echocardiography- (12cp)

Jamal Moussa - A18-304

Supervisor: Dr Liang Zhao
Major: Biomedical Engineering major BE, BE DipEngPrac

Robust methods for the autonomous segmentation of biomedical images are able to assist clinicians in performing reliable clinical assessments. The advances in autonomous segmentation for the ultrasound modality is especially important as its low resolution makes reliable manual segmentation difficult. Ultrasound is also emerging as a tool to be used during intraoperative procedures in conjunction with surgical robotics, therefore development of reliable and robust segmentation models will not only assist reliable clinical assessment, but also aid in the advancement of surgical robotics research.

Most of the current advancements in autonomous segmentation exist for CT and MRI modalities due to higher image resolution while less advancements have been made for ultrasound due to lower quality images and artefacts such as speckle noise and shadowing. Current research into autonomous segmentation specific to cardiac ultrasound, Transesophageal echocardiograms (TEE) and Transthoracic echocardiogram (TTE) are especially limited. Good autonomous segmentation models however have been developed for ultrasound (such as breast and verve tissue) and therefore present promise for TEE and TTE.

This project focuses on training an autonomous segmentation algorithm using the U-Net convolutional neural network architecture to segment the cardiac chambers from the ultrasound images. The model is trained and tested with individual 2D slices from 3D TEE and TTE frames and is designed for robustness against parameters such as viewing angle, chamber size and shape. The algorithm also implements simple edge detection to further visualise cardiac chamber boundaries.

The results of this study will be valuable in driving efforts towards autonomous cardiac ultrasound segmentation for reliability in current clinical diagnosis contexts, as well as in the future of improving surgical robotics and ultrasound guided robotics systems. This project aims to contribute to the research regarding cardiac ultrasound, however may also inspire further work regarding ultrasound segmentation for different anatomical regions of interest.

Design of Cost-Effective Microgravity Simulator for Mammilian Cell Cultures - (12cp)
Isabella Pham - A18-180

Supervisor: Dr Nham Tran
Major: Biomedical Engineering major BE, BE DipEngPrac

As technology continues to progress there is a growing interest in the development of human space exploration and long-term space exploration to deep-space planets. One of the limitations of human deep-space exploration is the significant health impacts of extended space travel. The health impacts of microgravity are not fully understood. Ground-based simulators of microgravity are valuable tools for space flight research. These instruments allow the study of gravity levels on specific mammalian cell cultures. This will provide indispensable information on the impact of gravity on biological processes such cell metabolism and proliferation.

The aim of this project is to design a microgravity simulator that can be utilised in a tertiary research lab. The common microgravity simulator in industry is a random positioning machine (RPM). RPM have been shown to be a valuable laboratory device for micro-gravitational studies. However, the relatively high costs of commercial RPMs can limit the accessibility to micro-gravitational research to tertiary institutes.

This project will evaluate the cost of constructing an RPM to satisfy minimum functional requirements of micro-gravitational simulation. The design of the RPM has been focused on low cost and local resourcing. The aim of this project is to propose an RPM design that is significantly inexpensive when compared to commercial alternatives. The target market of the product is for tertiary institutions interested in space research and studying the effects of gravity on mammalian cells.

Design Optimisation of Polymerase Chain Reaction Machine to Promote Learning in an Educational Setting - (12cp)

Colin Guevarra - A18-077

Supervisor: Dr Nham Tran
Major: Biomedical Engineering major BE BBus

Innovations and advancements in modern technology are essential for economic growth and competitiveness on a global scale. Science, Technology, Engineering and Mathematics (STEM) education has seen an increase in demand as STEM contributes to economic prosperity through the introduction of new products, processes and technologies which combat global, social and economic challenges.

In Australia, student interest and subsequent enrolment in STEM education have declined over the past decades. An approach to address the trend of declining STEM enrolment in secondary and tertiary education is the implementation of project-based learning (PBL) where students develop critical analysis, creative thinking, problem-solving skills, all of which are essential in 21st-century occupations.

This project encompasses the design and development of a Polymerase Chain Reactions (PCR) device for use as a PBL educational tool. The implementation of this device will see students construct, operate and maintain a PCR device, where students will develop a technical, theoretical and scientific understanding of the intricacies and processes involved in STEM-related protocols. An emphasis on the assembly and processes of the PCR machine will allow students to experience how theoretical knowledge is translated into working physical systems.

The proposed device improves accessibility to students and educators through cost-effective components where readily available, off-the-shelf materials with relatively simple mechanisms are implemented. Compared to expensive, industrialised machines, where the working mechanisms are hidden, complex or are propriety, the proposed device will allow students to easily understand the underlying concepts and mechanisms. By allowing students to comprehend and understand the mechanisms of physical systems, students will develop a deeper insight into the applications and impacts STEM-related products, processes and technologies have on society and the economy.

Development of a Smartphone Application for the Polymerase Chain Reaction Machine in Educational Settings to Improve User Experience - (12cp)

Tina Vo - A18-092

Supervisor: Dr Nham Tran
Major: Biomedical Engineering major BE BBus

Education in Science, Technology, Engineering and Mathematics (STEM) have been widely understood to be crucial to the development of our current and future productivity. However, the number of students undertaking STEM subjects have been declining over the last decade despite the government's commitment to improve STEM skills in Australian students. STEM needs to be encouraged in secondary education for their interest to translate to a tertiary level education. Modern STEM courses have attempted to create positive experiences by combining real-life contexts with activities within the classroom allowing an increased motivation and consequent positive attitude towards STEM.

Given this premise, our project was to design an innovative smartphone app to engage students in biomedical engineering with a focus on diagnostic devices. Specifically, we draw on innovative methods of teaching STEM using a Polymerase Chain Reaction (PCR) application that will allow students to interact and understand the real-life contexts of molecular biology and the engineering concepts incorporated in the design. By improving the user experience of the PCR machine, the device can be utilized as an project-based educational tool to encourage and invoke interest in STEM learning and career development.

Classification of EMG Muscle Movements - (12cp)

Cong Minh Truong - A18-383

Supervisor: Associate Professor Steven Su
Major: Biomedical Engineering major BE, BE DipEngPrac

Electromyography (EMG) signals can benefit in biomedical/clinical applications, for example, to control other devices, like electronic prosthetic arms by collecting electrical signals from muscles. EMG signal is known as a biomedical signal that evaluates electrical currents during muscle contraction. EMG can be used for advanced learning methods for classification, detection, decomposition, and processing. This paper aims to show a method for the classification of muscle contraction in finger movements based on EMG signal analysis and also to propose an effective and efficient of understanding its nature. The implementation of this project is to control the fan speed and temperature sensor by using EMG signals after classification.

By using MyoWare Muscle Sensor to collect EMG signal from forearm muscles (brachioradialis and extensor digitorum) while moving different fingers in simple (individual), complex (combined) movements and hand movements (turn left and right). A certain number of data sets were collected on five healthy subjects for performing gradient method of supervised learning techniques, such as neural network, K-NN, and support vector machine. MATLAB and ANNHUB were used to build classification including data pre-processing, testing. Standard feature extractions (in time and frequency domain) used in the classification are RMS, Max, Peak, Power, Frequency, etc. The average accuracy from hand movements was up to roughly 90%, while simple and complex finger movements are lower approximately 75% and 78% due to unseen factors.

The results have shown that EMG has a huge potential in Biomedical Instrumentation. Further practical implementation of controlling other devices, such as wheelchair and prosthesis to improve the living standard of disabled people or patients suffered from the disease-causing inability to the mobility of limbs.

Calibration and Precision of Bone Mineral Density Measurements by Dual-Energy X-Ray Absorptiometry (DXA) - (12cp)

Daniela Tesoriero - A18-183

Supervisor: Professor Tuan Van Nguyen
Major: Biomedical Engineering major BE BBus

Osteoporosis is a common progressive skeletal disease that affects more than 1.2 million Australians (Watts et al. 2012). Dual-energy X-ray absorptiometry (DXA) is widely used for the measurement of bone mineral density (BMD) and is the gold standard in diagnosing osteoporosis. Within Australia, there are currently a number of DXA scanner models produced by different manufacturers. However, the between-clinic variation in DXA measurements has not been well documented. This study sought to evaluate the precision and accuracy of BMD measurements obtained by DXA machines across clinics in Sydney and to develop a calibration equation for standardising BMD measurements.

BMD was measured at the lumbar spine (L1-L4) and right hip on phantoms (whose true BMD value is known) using 13 GE-Lunar and 6 Hologic DXA scanners in 16 clinics across Sydney. At each clinic, triplicate scans were performed on both phantoms using a standardised procedure. The average of the 3 scans was then used as an unbiased estimate of the "true mean" BMD at the lumbar spine, femoral neck and total proximal femur.

Results showed that the within-clinic variation was less than 0.01 g/cm2 (or less than 1% relative to the mean) for BMD at all three sites. Additionally, the between-clinic variation for BMD at all sites was larger than the within-clinic variation, with the largest between-clinic variabilities being observed at the femoral neck measured using Hologic scanners.

The magnitude of the observed difference in measured phantom femoral neck BMD, if replicated in-vivo, could affect the diagnosis of osteoporosis. Furthermore, the difference between scanners could affect interpretation of serial changes in BMD when patients are measured at different clinics. This study has highlighted that there is substantial variation in measured BMD between-clinics compared to within-clinic variation, which underscores the need for standardisation of BMD measurements across hospitals and clinics within Australia.

Modernising the Self-Management of Exercise Induced Bronchoconstriction Using Mobile Apps and Internet of Things - (12cp)

Nwe Tha - A18-191

Supervisor: Associate Professor Valerie Gay
Major: Biomedical Engineering major BE, BE DipEngPrac

Exercise induced bronchoconstriction (EIB) is a chronic respiratory disease that presents in 90% of asthmatics, as well as individuals without baseline asthma. Provoked by vigorous exercise, EIB results in asthma-like symptoms, such as cough, wheeze or dyspnoea. Such symptoms can make exercising uncomfortable, or even impossible, which can prevent many sufferers from participating in exercise and significantly impact their quality of life. Inactivity among EIB patients can result in detrimental health consequences, such as poor respiratory functioning and decreased mental health. However, with proper self-management and regular exercise, barriers caused by EIB can be overcome. Upon conducting a literature review, it was found that individuals with EIB had misconceptions about the intensity, frequency and type of exercise appropriate for their condition. Furthermore, the literature review revealed that there are no tools or platforms available to support and assist the self-management of EIB specifically. To address this gap in EIB self-management, this research aims to design a smartphone “all in one” fitness and asthma management application that empowers patients with the ability to monitor and manage their EIB, as well as keep physically active. To present the concept of the mobile application, the app design will be embodied as a high-fidelity prototype. Key features of the app will include integration of Internet of Things (IoT) devices, such as an Apple Watch or Fitbit, to allow users to track and compare their activities with symptom and medication logs. In addition, the application will also incorporate real-time IoT data collection on environmental factors such as temperature and humidity which can trigger or worsen EIB. By providing asthmatics with a single platform where they can monitor their asthma and be motivated to exercise, the mobile application aims to give them more control on their asthma and improve their quality of life.

Personalising Asthma Management Plans for Young Adults with Asthma- (12cp)

Katherine Takchi - A18-210

Supervisor: Associate Professor Valerie Gay
Major: Biomedical Engineering major BE, BE DipEngPrac

Asthma is a chronic illness which, when triggered, causes the airways of the lungs to swell and fill with mucus, narrowing and tightening the passageways necessary for airflow. The lungs, consequently, fail to meet the high demand of humidification necessary to control human breathing. In the year of 2016, Asthma was the cause of death of 455 Australians, and 39,500 hospitalisations.

The literature review conducted has highlighted that the introduction of better self-management and personalized asthma action plans, this mortality rate has the potential to be diminished. Within the group of young adults between the ages of 17-25 years who are living with asthma, minimal action has been taken to account for their changing lifestyle choices in their asthma plan. This research addresses this gap and designs a smartphone application to assist those within this age group, who are undergoing a wide range of lifestyle and social changes, peer pressure and introducing their body to differing environments, such as consumption of alcohol and smoking. It is not uncommon that young adults with chronic illnesses indulge in these health risk behaviours, however they are immediately put at higher risks while doing so.

The method used to design this application included researching what teenagers find motivating and what kind of asthmatic feedback they would like, research was then conducted into the response applications used for quitting smoking/drinking. The program Proto.io was used to develop a high-end prototype of the app. It features functionality to interact with peers, to log drinks and provides clear instruction on how to respond to their needs during times they may feel less in control. By connecting to a smart watch, the app obtains real-time health data for each individual patient to get a more precise correlation.

Such an application has the potential to help young adults recognize worsening asthma symptoms related to their risky habits, and giving them incentive to be consciously aware of their personal triggers.

An Effective Daily Fitness Wearable Smartwatch App to Assist in Asthma Management - (12cp)

Vicky Seng - A18-111

Supervisor: Associate Professor Valerie Gay
Major: Biomedical Engineering major BE BBus

Asthma is a prevalent, long-term lung condition caused by the inflammation and tightening of the airways, thus identified as a major public health issue. More specifically, exercise-induced asthma is triggered by strenuous exercise instigating immediate bodily complications. The unfortunate underlying issue is the failure of proper adherence of asthma management whilst exercising, training or participating in sports, namely due to the lack of space for asthmatics to possess confidence in managing their own chronic disease.

This project addresses this issue by developing an essential management solution. Our literature review revealed that a plethora of medication treatment and self-management plans for asthmatics currently exist. After highlighting both their benefits and shortcomings, the research identified that wearables would be a substantial support for adherence of active people affected by asthma during exercise in different seasonal environments. Smart technology and machine learning have rapidly expanded to healthcare and medicine and nowadays, smart watches are accessible to the general public and are able to monitor the vital signs related to asthma and some even provide the user's location for the current environmental changes.

An enhanced smart watch app has been designed for this active target group employing real-time health sensor monitoring. Through appreciably thorough literature research, the relevant medical information gathered provides the acceptable ranges of the vital signs additionally integrated in the design for its feasibility and medical reliability. The distinguished feature of the app is personalised interactive voice commands acting as a warning system when an unusual or unsafe heart or respiratory rate is detected during physical exercising activities. The voice can be personalised, and the innovative prototype ensures fundamental user-centric principles are incorporated with an aesthetic design to appeal to users to optimise their performance in everyday use. The use of the smart app, in combination with a companion phone app that includes a complete exercise-induced asthma plan is a prospective management solution for active asthmatics as it could improve the confidence of individuals to remain active whilst exercising.

Investigating Faults that Lead to Medical Device Recalls in the Australian Market (12cp)

Anke-Thy Nguyen – A18-179

Supervisor: Professor David Eager
Major: Biomedical Engineering

As of April 2016 were approximately 86,896 products registered with the Australian Register of Therapeutic Goods developed and managed by the Therapeutic Goods Administration (TGA). The TGA is a regulatory body for therapeutic goods on the Australian market. The main category for these products includes medical devices, medicines, biological and chemicals.

With the large amount of medical products that are continually being registered for use on the Australian market these databases of recalls and adverse events consequently grow. New problems can often surface while old problems can also repeat over the different products through time. Therefore, it is critical to constantly monitor and assess these problems providing engineers with an opportunity to make use of such a vast amount of information to understand the common areas of fault leading to medical product recalls. This understanding can potentially be implemented into the design and management of medical products thus preventing repeated faults and improve the overall safety, quality and function of the product for the patient and staff using them. This capstone project focused specifically on medical devices in the Australian market.

The scope of the project was to develop a Failure Mode and Effects Analysis (FMEA) to address the risks associated with faults that lead to recalls occurring on a range of medical devices used in the Australian market. The medical device industry is highly regulated due to the severe and fatal consequences on patients and/or staff if a fault occurs. Hence, the purpose of this FMEA is to allow engineers in the early stages of designing a medical device to identify potential risk of faults; allowing them to focus resources into mitigating and monitoring them and ultimately ensuring patient safety.

Life Assessment of High Temperature Power Station Components - (12cp)
Hawaida Sarwar - A18-212

Supervisor: Associate Professor Dongbin Wei
Major: Mechanical Engineering Major BEBBus and BEBSc

The topic being undertaken as Capstone Research is a power generation industry based project. The primary purpose of this study is to conduct a remaining life study of the boiler high temperature components to provide insight into effects of transient operating conditions, damage mechanisms such as creep, fatigue, thermal shocks and temperature fluctuations on the components' remaining life.

This project objectives encompasses a study and research of;

- Dimensional Modelling of the geometry of high temperature boiler components to input into Remlife software
- Retrieving and graphing the history of plant start up and shutdown temperatures, pressures and other functions for the components and explaining the theory behind Remlife calculations
- Conducting Remlife modelling on high risk components for remaining life fraction determination
- Ranking of long term risks on plant components based on Remlife results including steady state creep rupture, creep fatigue cyclic life, ramp rate/operation sensitivity and stress profiles.
- Case Studies involving a comparative investigation between Remlife theoretical results to that of physical plant metallographic microstructural degradation assessment
- Recommendations for future life assessment and management of high temperature components by summarizing results and implications for the extended life of the power station under current operating conditions

The project involves a broad range of data collection, analysis, case studies and action research to achieve accurate results. The timeframe for the project allows for fourteen hours per week and a total of thirty-six weeks to complete onsite works and additional hours needed for research, university assessments, analysis and report compilation. As such a research methodology and detailed project management plan for the capstone project including a summary of project objectives, activities breakdown list, project timeframe, important milestones, allocated resources, associated risks and communication plan has been closely followed to focus effort as required to obtain the necessary results.

Critical Pipes Robot - (12cp)
Joshua Olson - A18-102

Supervisor: Professor Gamini Dissanayake
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Critical pipe network in Sydney has have been in service for over a century. Inspection and maintenance of these pipes to evaluate the possibility of failure and replacing these when required is essential for maintaining a reliable water supply. As these assets continue to age the cost to maintain and fix these pipes will continue to rise, therefore it is important the vulnerable pipes are identified early.

Sydney Water has engaged UTS to develop a tool that can be used for internal condition assessment of critical pipes that are expected to be in somewhat poor condition. It is expected that with adequate planning, a critical pipe can be shut down for a few hours, dewatered and a 2-3 m section of the pipe removed. The tool is to be inserted into the pipe through this aperture. Multiple sensors on the tool will be used to measure the thickness of the pipe wall using a pulsed eddy current technique. These measurements will make it possible to identify vulnerable sections of the pipe so that these can be replaced rather than the whole pipe, leading to significant savings. The focus of this capstone thesis is the design and development of the mechanical arrangement that can be used to transport a suitable sensor module inside a pipe. The specifications require a device that can inspect 500 meters of pipe. It is to be able to deal with pipe diameters ranging from 350-750mm. Several concepts have been explored and a detailed design of a robust field deployable model has been completed and partially manufactured. This is currently being evaluated in the lab with the expectation testing this device in the field before the end of this capstone thesis project.

Hybrid Power Generation in Remote Mining - (12cp)
Mathys Bouma - A18-056

Supervisor: Dr Geoffrey James
Major: Mechanical Engineering Major BEBBus and BEBSc

Mining is a major industry in Australia, representing over 45% of exports, and is a substantial consumer of energy, totaling 10% of national consumption. Many of Australia's mines are located remotely and require on-site electricity generation, which typically is provided by gas and diesel fueled generators. These have several disadvantages in terms of high fixed and variable costs, which can contribute in some cases to over 50% of a mine's operational costs and present logistical challenges for bulk fuel transport.

Renewable energy generation such as photovoltaic (PV) solar and wind power have reduced in price to the point where they are now able to compete with gas and diesel generation. The integration of low-cost renewables into the energy mix by miners may allow them to decrease their operational costs, exposure to volatile fuel markets, and improve their energy security. In Australia there are already several mining companies who are pursing this strategy, with Sandfire Resources operating a hybrid diesel/PV plant that generates roughly 20% of its on-site electricity from PV solar.

This study will examine the potential cost savings of hybrid electricity generation compared to conventional gas or diesel generation, and conduct a sensitivity analysis on key variables, including the cost of fuel and capital cost of PV solar. Microgrid simulations will be carried out using HOMER Pro to investigate these outcomes. This study will allow its readers to make general predictions on the payback period and rate of return for a mine's investment in PV solar.

The findings of this report present an interesting business case for mines within Australia to utilise renewables. The integration of potentially cheaper renewable generation into this sector may offer major opportunities for both mines and renewable energy developers alike.

Hyperloop Technology and Capsule Design Optimisation Research - (6cp)
Josh Murray-Howard - S18-207

Supervisor: Associate Professor Jin Ji
Major: Mechanical Engineering major BEBADipEngPrac

As the value of climate conservation in modern day society increases, the world moves towards cleaner energy, taking advantage of ever evolving new technologies. One such technology that was conceptualised two decades ago is the Hyperloop rail. This railway is formed around the idea of a vacuum-sealed tube through which a capsule can be propelled using a compressor. The advantage of such design eliminates air resistance and therefore theoretically will require less energy and will be capable of running at greater speeds than conventional rail. In 2013, Elon Musk proposed the creation of the Hyperloop rail across the United States and has since held several competitions open to universities around the world to develop the fastest design of the Hyperloop capsule.

The objective of this paper is to determine mechanical methods of capsule redesign in order to improve performance. There already exists several projects around the world that aim to construct a fully functional Hyperloop, the most advanced of which is Virgin Hyperloop One, who aim to have a functional product by 2021. This paper aims to determine areas of possible improvement in regards to mechanical design of the Hyperloop, primarily the capsule.

In order to outline the possible improvement areas, extensive research will be conducted into existing designs and interaction with enterprises that specialise in Hyperloop technology will be critical. The use of existing research will facilitate the possibility of developing a design that has the potential to show improved characteristics such as speed or efficiency than current designs. The goals to be achieved in this paper include proving such improvements through the use of software and modeling and also to create a scale model of the final design.

3D Printed Micromixer for Antibody Conjugation Utilized In Prostate Cancer Detection - (12cp)

Kenny Ng - A18-237

Supervisor: Dr Majid Ebrahimi Warkiani
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Prostate cancer is the second most common cancer among men. Screening for prostate cancer biomarkers has led to earlier detection of prostate cancer. The MiCheck test is a blood test that diagnoses aggressive and non-aggressive states of prostate cancer, which requires several laboratory functions to complete. An important function is bioconjugation, which couples antibodies to microbeads where they will be used to capture prostate cancer biomarkers. The challenges of conventional bioconjugation methods are that it requires a significant amount of time and a skilled technician to complete successfully.

The convergence of analytical chemistry and microfluidics has led to a rise of lab-on-a-chip systems that replicates laboratory functions onto a single chip. This project aims to solve the challenges of bioconjugation with a lab-on-a-chip system. A crucial component to the system is a micromixer that efficiently mixes different microscale fluids which can be used to mix antibodies to microbeads inducing bioconjugation. There are several advantages with this system such as a decrease in processing time, higher yield of bioconjugated beads, automation of the whole process, and process simplification, so skilled technicians are not required.

Development of a micromixer required a comprehensive literature review, incorporating analytical, numerical, and experimental techniques to develop the optimal micromixer. The design was made possible due to the advancements in 3D printing. A stereolithography printer is utilised to print complex shapes and channels in micron scale resolutions, allowing for ready to use components after it has been printed.

In the future, the results of this study lay the foundation for the development of a completely autonomous prostate cancer diagnosis device.

Vehicle Occupant Detection and Temperature Regulation System to Prevent Infant and Animal Deaths in Parked Vehicles - (12cp)

David Richards - A18-095

Supervisor: Mr. Peter Tawadros
Major: Mechanical Engineering Major BE and BEDipEngPrac

Globally, infants and animals are being left unattended in hot vehicles either from negligence or by accident, or because the driver is kept from returning. It is an issue that causes a high number of emergency situations whereby, especially in the Australian sun, the temperature inside the vehicle has exceeded safe levels for a living occupant. Without means of cooling the inside temperature or the ability to exit the vehicle, an occupant can be subject to extreme heatstroke and dehydration, leading to the possibility of permanent injury and in some cases, cause fatality.

In the US alone, it is recorded that between 1990 and 2017 there was an average of 37 infant deaths per year (1 death every 9 days), due to heatstroke within a stationary vehicle.

The natural progression of vehicle design has provided technology that protects occupants from dangers outside of the car, however there is now a growing awareness and need to protect occupants from internal threats as well.

This paper outlines and documents the prototyping and development of an autonomous system that can recognise when a person or animal is being subject to harmful temperatures within a stationary vehicle and can take active measures to protect the occupant inside. The solution proposed utilises a sensor array built into the headliner of a vehicle that can reliably detect temperature and the presence of a living occupant inside the vehicle. Through GSM it can send alert(s) to the driver and emergency services, and through intelligent and autonomous control, take charge of the vehicle subsystems, including the engine and air conditioning to regulate the vehicles internal temperature for the preservation of life.

With a focus on a low production cost and reliability, the technology is designed with the intent of being marketed towards vehicle manufacturers for integration into their upcoming models. Comments are also provided on how this technology could be developed into an aftermarket ‘bolt on’ system for integration into vehicles that are already on the road

Effect of Windcatcher's Inlet Shape on Ventilation Flow through a Room - (12cp)

Rahil Taghipour - A18-015

Supervisor: Dr Phuoc Huynh
Major: Mechanical Engineering Major BE and BEDipEngPrac

Natural ventilation is the process of supplying and removing air through an indoor space by natural means. Windcatcher has been used over centuries for providing natural ventilation using wind power, it is an effective passive method to provide healthy and comfortable indoor environment by decreasing moisture content in the air and reducing pollutants concentration. The windcatcher's function is based on the wind and on the stack effect resulting from temperature differences. Generally, it is difficult for wind to change its direction, and enter a room through usual openings, the windcatcher is designed to overcome such problems since they have vertical columns aimed at helping wind to channel down to the inside of a building. The efficiency of a windcatcher is maximized by applying special forms of opening and exit. The openings depend on the windcatcher's location and on its cross-sectional area and shape such as square, rectangular, hexagonal or circular. In this study the effect of the inlet design is investigated to achieve better air flow and increase the efficiency of windcatchers.
To achieve this, CFD (computational fluid dynamics) tool is used to simulate the air flow in a two dimensional (2D) room fitted with a windcatcher applying wind at different speeds ranging from 1m/s up to 14 m/s and based on different inlet designs such as a uniform inlet, a divergent inlet and a bulging-convergent inlet. Three dimensional simulations, which reflects the actual real life situation, have also been conducted for the same inlet designs with wind speed of 3 m/s. This study helps providing sustainable solutions to overcome energy consumption.

Design of an Anthropometry-Invariant Method of Analysing Deadlift Form Using On-Body Electronics - (12cp)

Dennis Duong - A18-193

Supervisor: Dr Marc Carmichael
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The conventional deadlift is a weight training that starts by gripping a barbell as it sits in front of the shins with toes pointing forward and parallel to each other. The barbell is then lifted by pushing with the legs and 'pulling' the bar off the ground. This is an exercise that targets the gluteus maximus muscle, with the hamstrings assisting the top half of the motion and the erector spinae stabilizing the back to maintain a safe posture.

Keeping a straight back throughout a deadlift and raising/lowering the hips starting position to match someone with a strong deadlift are common assumptions adopted by fitness enthusiasts. These are not safe assumptions as it is the lumbar (lower back) that needs to remain neutral, and an athlete's anthropometry (body segment lengths) will affect their hip position. Currently, optical motion capture with professional analysis is the only way to assess deadlift form.

This project will focus on the creation of an independent platform for fitness enthusiasts to use in diagnosing their deadlift competency. This will be done by providing feedback on lumbar flexion and deadlift form breakdown. Lumbar flexion is calculated using angles measured from two accelerometers placed on the T12 and L4 landmarks of the athletes back. A Graphical User Interface (GUI) has been developed to accept athlete-specific foot, tibia, femur, torso and arm lengths to produce a simulated stick model of the athlete performing a deadlift with acceptable form. Deadlift form is broken down by comparing the back angle at the L4 landmark with the back angle of the simulated model with acceptable form. These results have potential to prevent deadlift injury through biomechanical analysis conveyed through a GUI, ensuring individuals continue deadlifting safely.

Towards Predicting Abnormalities Associated with Heart Rate for Smart Sports Wearables - (12cp)

Trinesh Ramachandra - A18-206

Supervisor: Dr Marc Carmichael
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

In the fitness field, many athletes and individuals experience a variety of strenuous exercises to help them get in shape or gain muscle. Exercises involve muscle contraction which requires a chemical called ATP (Adenosine triphosphate), and as the exercise intensity increases, more oxygen is needed to facilitate ATP production. To raise blood oxygen levels, the heart rate will increase to pump more blood as the athletes respires more often. This increase in heart rate is linearly related to the exercise intensity and as there is a maximum exercise intensity, there is also a maximum heart rate. As athletes push themselves over their maximum exercise intensity to improve their capabilities, they may be unaware that they have exceeded their maximum heart rate to dangerous levels.

Predicting the heart rate before their limit or identifying abnormalities associated with the heart rate will provide vital information to the individual or athlete. This information can determine the limits of the athlete or stop them from experiencing short-term effects such as syncope, feeling anxious, paleness and blurred vision.

The aim of this project is to create a predictive filter to estimate the characteristic motion of the heart for the purpose of detecting syncope. The predictive filter uses Fourier Series to model the periodic motion, Linear Least Squares to estimate initial parameters and an Extended Kalman Filter as the estimator to obtain unknown variables. These concepts will be simulated through MATLAB and integrated towards creating a prototype of a smart sports wearable that has the ability to predict the beating heart in real-time.

Design, Build and Concept Validation of a Perpindicular Axis DLP 3D Printer - (12cp)

David Henderson - A18-036

Supervisor: Dr Michael Behrens
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Within Australia's manufacturing industry, companies are looking to leverage new 3D printing technologies to improve their outputs, increase productivity and find efficiencies in their manufacturing processes. Many labour intensive, specific and costly manufacturing process are becoming uneconomical to undertake in Australia and production and jobs are moving offshore. 3D printing on an industrial scale has the potential to turn this trend around.
The purpose of this project is to leverage additive manufacturing to replace traditional manufacturing processes with more economical and flexible production methods. This capstone explores the viability of a novel design of 3D printer as part of a parent project between the University of Technology Sydney (UTS) and Mineral Technologies (MT) (a Downer company).

This capstone project started out as a concept design in a feasibility study which detailed potential configurations for a printer designed to print helical shaped gravity separator spirals. Of the multiple configurations, a perpendicular axis DLP 3D printer was chosen for design validation. Using a recognized engineering design methodology, the process of design understanding, translation, ideation, prototype and testing was followed to produce an artefact capable of meeting the design requirements. The printer was then constructed from both off the shelf and bespoke parts to test the ability of this configuration to print scale spiral models.

The main aim of this design validation was to explore how to successfully achieve a print on a rotating bed and overcome the challenge of converging layer heights on the printed spirals. If achieved, this will be the first time this has been done using this printer format and technology. This method could be used to create an infinite build printer that would allow even the longest spirals (12m) to be printed using a small footprint, mobile printer to provide a more cost-effective manufacturing process, in a safer and more flexible work environment.

Kinematic Exoskeletal Glove to Aid Passive Rehabilitation for Stroke Patients - (12cp)
Sherwin Ho - A18-044

Supervisor: Dr Michael Behrens
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

In Australia, someone is affected by stroke every 9 minutes and regional Australians are 19% more susceptible. Advancement in technology and treatment has given stroke patients another chance at life and is no longer a death sentence. Studies have found that intensive rehab in the first 6 months has been beneficial to patients who are affected by acute strokes with their Activities of Daily Living (ADL). Sadly, due to the lack of resources, these rural communities are unable to reach the necessary care needed for regular rehabilitation treatments.

This emphasizes the importance to bridge the gap between the accessibility to treatment centres for rural communities compared to those in metropolitan areas. The ideal solution would be allocating more physiotherapist within these areas, but the logistics and resources required to fulfil this void are currently infeasible.

One of the major symptomologies of stroke is the loss of mobility in high dexterity limbs, especially the hand. The challenge of creating a mechanical system for hand rehabilitation is the difficulty to cater for a diverse range of hand sizes and joint locations within one generic design. Another issue is ensuring that the equipment is affordable to all who are affected, not just the privileged.

The capstone project aims to explore and develop a low cost, exoskeletal hand attachment to assist with passive rehabilitation. The end goal is to have patients fitted and educated by a trained therapist or technician after being diagnosed, allowing them to acquire the necessary treatment in the comforts of their own homes.

Mechanical and Material Testing for Surface Optimisation of Medical Grade Children's Foot and Ankle Orthoses - (12cp)
Kate Leone - A18-221

Supervisor: Dr Michael Behrens
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Ankle and Foot Orthoses (AFOs) are a type of medical prosthesis that impose forces upon the lower limb and ankle of a patient for the purposes of improving gait and giving support. The corrective benefits of orthoses result from structural support, functional corrections, ankle protection, plantarflexion reduction, dorsiflexion assistance, or minimisation of the effects of drop foot. Current industry standards of producing AFOs are a combination of long and inefficient methods. Including hand casting the patient and creating a model with plaster and then vacuum forming. The orthotists are required to make corrections and small, labour and time intensive modifications by hand to reach the optimal surface and support. AFOs are commonly worn by children with Cerebral Palsy or other growth and mobility problems. Skin sensitivity is an important consideration of AFOs as these children who require orthoses often cannot wear socks or other layers between their skin and the orthoses. A smooth surface finish is key to the comfort and in turn the success of the orthoses.

AbilityMade is a Sydney based social enterprise shaking up the medical orthoses market by 3D scanning with an Instantaneous Scanner Rig and 3D printing the AFOs for children. This project is a collaboration with AbilityMade to optimise and characterise the surface finish of printed ankle and foot orthoses.

The surface of 3D printed ISO10993 compliant bio-compatible materials using varying printing technologies is compared. These results are considered in tandem to the results of mechanical and fatigue testing. Each sample is exposed to either ultraviolet light, sweat, heat or dye to represent the wear on the material from exposure to the sun, contact to human skin, alterations and addition of straps by the orthotist, and cosmetic adjustments.

Machine Learning Applied to the Classification and Recognition of Produce - (12cp)
Peter De Jersey - A18-207

Supervisor: Associate Professor Robert Fitch
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

In recent years machine learning has become "the most promising method for object recognition" [5]. This combined with the availability of open source frameworks makes machine learning an extremely attractive choice for an object recognition system for a self-serve supermarket checkout.

Grocery shopping is something Australian's do 1.95 billion times a year [14]. With only 47% of users stating self-service checkouts are simple to use [13] it's clear there is an issue with current systems?

Produce recognition technology already exists however most networks focus on recognition for autonomous robotic applications such as Voxnet [11]. In the proposed use case, the ability to differentiate between subcategories of fruit (such as a granny smith vs. fuji apple) is extremely important. In networks available today such as Voxnet this is not a concern and not completely implemented.

By using preprocessing techniques utilising depth data, we can reduce the search space of the CNN while maximising the amount of useful information passed to it. Furthermore, to prove a viable solution can be created with today's technology the system is implemented on a low power embedded system and evaluated

UAV Object Identification Using Augmented Reality - (12cp)
Danna Nguyen - A18-112

Supervisor: Associate Professor Quang Ha
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

With the introduction of unmanned aerial vehicles (UAV) military organisations worldwide have made it essential to incorporate UAVs in numerous operations in all branches of military from army, navy and particularly the air force. These operations can include reconnaissance, intelligence gathering, surveillance and search missions. With the benefit of separating the operator from the vehicle, UAV's have allowed potentially dangerous missions to succeed in the field without risking personnel safety. Hence the push to improve the relationship between human and UAV have been the focus in UAV research.

One complication during missions is where pilots and operators experience a low level of situational awareness. Situational awareness is how well the operator is perceiving relevant elements in the environment around the UAV, comprehending their meaning in relation to the mission goals and the projection of the element's future states. This capstone aims to improve the situational awareness of UAV operators in a search and identify mission by using augmented reality to display information.

An experiment was conducted with numerous participants to identify a particular marker out of six in two different flight videos recorded from a UAV. The videos are viewed in a virtual reality headset to emulate the 'closed room' effect UAV operators experience when separated from the UAV. Selected at random from a bank of twelve videos, the first flight is viewed raw and the second has an augmented reality interface applied, displaying information about the time and distance concerning the marker and most importantly a visual indicator around the identified marker. Results collected from this experiment highlight the difference in performance and situational levels experienced by the participant with and without the augmented reality interface.

UAV Electrical Energy System Optimisation - (12cp)
Shaneel Dutt - A18-115

Supervisor: Associate Professor Quang Ha
Major: Electrical Engineering major BE BEDipEngPrac

Unmanned Aerial Vehicles (UAVs) is an innovative and emerging technological platform that can be applied to provide an abundant amount of benefits to society and commercial industries. The potential uses for UAVs range from a variety of different objectives including: surveillance, incident or risk identification, locating objects/areas of interest and the transport of commercial goods.

However commercial and privately-owned UAVs have electrical energy limitations in terms of flight endurance. Current brands of UAVs can only offer any time between 5 – 25 minutes of flight time depending on the size and capacity of their lithium polymer batteries.

The focus of this capstone is to enhance the flight endurance of a UAV by optimizing its electrical power system through the integration of a renewable energy resource. By considering Australia's climate and weather patterns it was decided that solar energy would be a promising and appropriate technology to utilize in achieving this goal.

Throughout the duration of this capstone, extensive research was conducted in order to facilitate the construction of a prototype UAV, called the Hybrid Solar Lipo UAV (HSL-UAV), that would compare the effects of solar energy on lithium polymer battery performance. It was decided that the HSL-UAV would be built in a quadcopter multi-rotor topology; due the amount of versatile applications and popularity associated to this type of configuration.

The project was separated into 4 distinct stages which were:

- Research on multirotor configured UAV's and solar energy systems
- Selection of appropriate components for the HSL-UAV including multi-rotor parts and solar energy system materials.
- Construction of the HSL-UAV with appropriate functional flight testing and validation
- Investigating and comparing the effect of the hybrid solar energy system to a non-hybrid lithium polymer battery system.

The process of all four stages has been documented and a working HSL-UAV prototype was successfully constructed.

Non-Destructive Testing of Concrete Using Capacitance - (12cp)
Don Sooriyaarachchi - A18-151

Supervisor: Associate Professor Sarath Kodagoda
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Concrete is the most used construction material in the world and as with all construction material, the strength of concrete deteriorates with time. This is mainly caused by moisture, rebar corrosion, and chloride ion permeability. Due to this, preventive maintenance is done on concrete to extend the life of the structure and reduce the chance of it failing. Assessing the quality of concrete is an essential part of preventive maintenance. Non-Destructive Testing of concrete is becoming increasingly popular due to the ease of testing without affecting the structural integrity of the structure being tested. This project will focus on using capacitance for non-destructive testing of concrete.

Capacitance is the ratio of the change in an electric charge in a system to the corresponding change in its electric potential. The device works by creating an electric field between 2 electrodes and it measures the change in capacitance caused by the specimen being tested. The change in capacitance will then be used to analyse the thickness of the concrete, the presence of rebars and the anomalies of the concrete specimen being tested.

The device has a rotary encoder attached to the axle connecting the rear wheels and is designed to take a reading every centimeter of its path. An Arduino is used to log data from the sensor onto a computer and a MATLAB code then analyses this data to generate a qualitative analysis of the specimen being tested.

Using capacitance for non-destructive testing of concrete has many advantages compared to other testing methods used in the industry. It is fast, contactless and can be calibrated to be used in wet conditions. This device can be further automated and used for testing in extreme conditions such as sewer pipes.

Investigation into the Efficiency of Propeller Tunnels - (12cp)
Brodie Crossman - A18-342

Supervisor: Dr Suvash Saha
Major: Mechanical Engineering Major BE and BEDipEngPrac

A key design element for many vessels is the operational draft of the vessel. Typical catamaran designs integrate the propeller and supporting appendages below the keel line of the vessel. Vessels requiring performance in shallow-water operations may have to utilise alternative propeller arrangements to minimise navigational draft.

In the naval architecture industry, a solution to this problem is to use recessed propeller tunnels. Designs incorporating the use of propeller tunnels gain many advantages, the static draft of the vessel is reduced, optimum diameter propellers can be used and the propeller shaft angle can be reduced. It also gives the designer greater flexibility in the arrangement of machinery and shafts.

In high speed vessels, the frictional resistance make up to 40% of the hulls total resistance. Propeller tunnels typically cause an increase of wetted surface area and as such we expect the tunnel to increase the frictional or viscous resistance of the hull. Residual resistance is the resistance caused by the energy losses associated with the waves generated by the vessel and the vicious pressure resistance. We expect the propeller tunnel to impact the wave generation of the hull and in turn impact the hulls residual resistance. This is an engineering problem as the integration of recessed propeller tunnels results in uncertainty of hull efficiency and performance.

The objective of the study is to determine quantitative data on the total bare hull resistance of a high-speed catamaran hull with an implemented propeller tunnel design and compare those values to the resistance of the same hull without a propeller tunnel. For the purpose of this study, the hull form used is Incat Crowther Pty Ltd's designed hull 'Cat Coco Isle De Ligue'.

This data is to be obtained using computational fluid dynamics software Numeca FineMarine, which is a 6 degree of freedom incompressible flow solver, to simulate the complex flow over the vessels hull. Resistance curves are produced for speeds between 5knots and 30 knots for both hull forms as are free surface elevation plots.
A mesh convergence study is conducted to analyse the validity of the modelling process and the results are compared against real world values for results based on the vessels sea trials to assess the validity of the study.

Self-Expanding Stent Design Using Topological Optimisation - (12cp)

Pavittar Singh Johal - A18-152

Supervisor: Associate Professor Zhen Luo
Major: Mechanical Engineering Major BE and BEDipEngPrac

Coronary artery disease is a major issue affecting approximately 643,000 Australians in 2014-15 (Australian Institute of Health and Welfare 2016). Stents are medical devices which are implanted inside patients in order to treat coronary artery diseases. Stents function by expanding inside the body and opening up the clogged artery so that blood can flow. Existing stent designs are quite effective, however improvements can be made, as issues exist with the structure of current designs, such as compliance, stent volume and wall apposition problems. Topological optimisation is a method that can be implemented to advance stent design and resolve these issues by generating a new stent structure.

Topological optimisation is a method which allows for material to be distributed within a design domain so that optimal structural performance can be obtained. This project proposes the use of topological optimisation in a micro-scale design to create a new self-expanding stent structure with negative Poisson's ratio (NPR).

The basic working principle of a stent with NPR is that when the stent is in compression it becomes smaller in both transverse and longitudinal directions, whilst it expands in both directions when in tension. This is advantageous as NPR can reduce the density of the design, meaning the volume of the stent can be reduced, with a smaller stent being optimal during the implantation process. Furthermore, the fact that NPR allows for the stent to expand proportionally in all directions means it can solve the wall apposition problems that exist in current stent designs.

Utilising MATLAB a new unique 2D stent structure with NPR was successfully generated through topological optimisation after numerous iterations. This structure was converted into a 3D model for the purpose of a static structural analysis using the finite element method on ANSYS. The simulations proved the successful generation of a stent with NPR characteristics in both tension and compression states, under the required loading conditions.

This project will be beneficial to society as a self-expanding stent with NPR will result in improved performance and easier to implant due to its reduced diameter. It will help the biomedical industry in their research to improve their methods in treating and improving the lives of patients who have cardio-vascular heart diseases.

Prototype Dual axis CNC Milling Machine– the Design and Development of an Alternative Personal CNC Milling Machine - (12cp)

Mark Hobday - S17-117

Supervisor: Mr. Ahmed Y Taha Al-Zubaydi
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Subtractive and Additive Advanced Manufacturing in Australia has accelerated in growth both within businesses and privately. There are a variety of options in the market, each having their own advantages and disadvantages based on design and cost. CNC milling machines have lacked the development in the private sector and therefore have become a second choice to an additive alternative such as a 3D printer. There have been previous developments for personal CNC milling machines but the transition from commercial machines to personal machines has lowered the quality or made the price unobtainable for the individual.

Current models in the market have utilised different drive and control mechanisms including robotic arms, lead screws and drive belts paired with a control circuit. This paper analyses these systems and determines the most effective method to be incorporated in the prototype design.

This study examines the CNC milling machine and its effectiveness on a variety of modelling foams including EVA foam, XPS Styrofoam, EPS Styrofoam, and Polyurethane foam. Tests were designed to investigate different cutting methods used in foam CNC milling machines including hot wires, laser cutters, water-jet cutters, and spindle milling. Each process was measured in its dimensional accuracy and surface finish, as well as manufacturing cost, waste production, cutting implement size and ease of use.

The project details the process of designing and optimising an innovative CNC milling machine to increase accuracy, decrease manufacturing time and reduce wastage. There were several key findings from the investigation, which have been incorporated in the design of a new personal CNC mill. The research showed that the most cost-effective system for movement included a lead screw system with a breakout board and stepper drivers. Furthermore, the most accurate machining methods included a hot-wire paired with a routing bit. The prototype design has been simulated using G-code to create different models resulting in accurate parts.

Overall, this paper proposes an effective prototype to develop further to enable access to subtractive manufacturing for the individual.

Construction Part of a Regenerative Indirect Evaporative Cooler (IEC) System with a Parallel Flow Heat Exchanger - (12cp)

Mohammed Al Sultan - A18-270

Supervisor: Mr. Ahmed Y Taha Al-Zubaydi
Major: Mechanical Engineering Major BE and BEDipEngPrac

As ambitious energy and environmental targets have been introduced, there has been a constant increase in the requirement for air conditioning all over the world in recent years. Accordingly, there has to be development of air conditioners which are highly efficient and can run on low polluting energy sources. How a regenerative indirect evaporative cooler (IEC) system performs alongside a parallel flow heat exchanger, which is present in a Desiccant Cooling system that may both dehumidify and cool humid air, is evaluated through this thesis. Quantifying the system thermal and electrical performance for differing component dimensions and operating conditions and identifying its range of applicability are part of its objective. The industrial development of the system benefits from this information. Finally, once if and how much the system is more efficient than electrically and thermally driven chiller-based systems is understood, the objective will be achieved. Channels, which are made up of sew in interfacing and Aluminium foil, fan and a counter-flow indirect evaporative cooler mainly constitute the system. The air inlet conditions and air flow rate are taken into consideration for conducting a sensitivity analysis of the DPC performance and the parabolic moisture concentration profile assumption, which makes it possible to consider the resistance to moisture diffusion in the sew in interfacing, is used as basis of the desiccant wheel model. Furthermore, the Dew Point Cooler (DPC) sew in interfacing capacity is optimized by recirculation fraction of approximately 0.3. The inlet humidity ratio mainly influences the supply temperature. To enhance cooling capacity and thermal performance, the two parts alongside a compact air-to-air heat exchanger are combined by the desiccant cooling system. Regeneration temperatures between 50◦C and 90◦C, which enable low temperature heat sources, are taken into consideration for investigating the system performance. Moreover, an area effectiveness coefficient, which remains at 0.55, characterizes the tuned DPC model. The internal heat and mass transfer processes to be analysed and repetitive design and optimization simulations and seasonal simulations to be conducted, the models have to be accurate and need to consume low computational effort. Thermal COP above 1 and electrical COP above 20 are acquired as most promising results are yielded by the utilization of exhaust air from the conditioned space for indirect evaporative cooling. Because of this, we can see that there is great probability of the system to save energy in terms of electrically and thermally driven chiller-based system. Ultimately, there is introduction of a new technical solution having the purpose of making desiccant cooling systems not to depend on external water sources. Evaporative coolers are run by condensing water desorbed from the desiccant dehumidifier in a closed regeneration circuit. Because of this solution, the system can run without water and water demineralization equipment, which uses additional water and elevates operational costs and maintenance, is not required to be used. However, higher electricity consumption, regeneration temperatures, space requirements and investment costs are some of the disadvantages. For the desiccant cooling system operating with dew point cooling, analysis of the solution is conducted.

Construction and Testing of an IEC System with a Parallel Flow Heat Exchanger - (12cp)

Amer Abdullah N Turkistani - A18-290

Supervisor: Mr. Ahmed Y Taha Al-Zubaydi
Major: Mechanical Engineering Major BE and BEDipEngPrac

As ambitious energy and environmental targets have been introduced, there has been a constant increase in the requirement for air conditioning all over the world in recent years. Accordingly, there has to be development of air conditioners which are highly efficient and can run on low polluting energy sources. How a regenerative indirect evaporative cooler (IEC) system performs alongside a parallel flow heat exchanger, which is present in a Desiccant Cooling system that may both dehumidify and cool humid air, is evaluated through this thesis. Quantifying the system thermal and electrical performance for differing component dimensions and operating conditions and identifying its range of applicability are part of its objective. The industrial development of the system benefits from this information. Finally, how much the system is more efficient than electrically and thermally driven chiller-based systems is understood, the objective will be achieved. Channels, which are made up of sew in interfacing and Aluminum foil, fan and a counter-flow indirect evaporative cooler mainly constitute the system. The air inlet conditions and air flow rate are taken into consideration for conducting a sensitivity analysis of the DPC performance and the parabolic moisture concentration profile assumption, which makes it possible to consider the resistance to moisture diffusion in the sew in interfacing, is used as basis of the desiccant wheel model. Furthermore, the Dew Point Cooler (DPC) sew in interfacing capacity is optimized by re-circulation fraction of approximately 0.3. The inlet humidity ratio mainly influences the supply temperature. To enhance cooling capacity and thermal performance, the two parts alongside a compact air-to-air heat exchanger are combined by the desiccant cooling system. Regeneration temperatures between 50◦C and 90◦C, which enable low temperature heat sources, are taken into consideration for investigating the system performance. Moreover, an area effectiveness coefficient, which remains at 0.55, characterizes the tuned DPC model. The internal heat and mass transfer processes to be analysed and repetitive design and optimization simulations and seasonal simulations to be conducted, the models have to be accurate and need to consume low computational effort. Thermal COP above 1 and electrical COP above 20 are acquired as most promising results are yielded by the utilization of exhaust air from the conditioned space for indirect evaporative cooling. Because of this, we can see that there is great probability of the system to save energy in terms of electrically and thermally driven chiller-based system. Finally, there is introduction of a new technical solution having the purpose of making desiccant cooling systems not to depend on external water sources. Evaporative coolers are run by condensing water desorbed from the desiccant dehumidifier in a closed regeneration circuit. Because of this solution, the system can run without water and water demineralization equipment, which uses additional water and elevates operational costs and maintenance, is not required to be used. However, higher electricity consumption, regeneration temperatures, space requirements and investment costs are some of the disadvantages. For the desiccant cooling system operating with dew point cooling, analysis of the solution is conducted

Optimisation of Sound Source Localisation and Mapping with a Microphone Array and RGD-D Camera - (12cp)

Patrick Korczak - A18-119

Supervisor: Dr Teresa Vidal Calleja
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Sound source localisation and mapping combines the field of Simultaneous Localisation and Mapping (SLAM) with robotic audition to significantly improve robotic perception. While computer vision has dominated research in robotics, audition provides unique sensory data that transforms the way humans interact with robots. Sound analysis involving acoustic localisation, tracking and separation are key in identifying and responding to certain cues in human behaviour that are normally unobservable by other means. Speech is integral to human communication and providing robots with 'hearing' strengthens human-robot interaction. Processing auditory data is critical in many applications that are blind to other sensors. Robotic audition emulates human auditory capabilities as we present a solution that localises and maps a sound source in 3D space with great accuracy using estimation methods.

This report explores acoustic localisation methods and the capabilities of different sensor models as we implement a calibration procedure on a planar microphone array. Subsequently, different techniques in the SLAM process are introduced. The research is underpinned by validating an online solution that integrates acoustic localisation with open-source vision based SLAM. This is implemented on an exteroceptive sensor suite comprised of a planar microphone array and RGB-D camera.

We demonstrate the effectiveness of online estimation strategies by implementing an EKF filter that feeds a pose-graph optimisation to accurately localise a sound source in the presence of uncertainty in 3D space. Moreover, an offline calibration process is undertaken using least squares to model the relationship between sensors in the sensor suite. We evaluate the performance of our real-time implementation using the sensor suite in an office-like environment to accomplish sound source SLAM.

Gaussian Process for Characterising Sensor Observation Model for Human Tracking in Crowded Environments - (12cp)

Liam Davey - A18-174

Supervisor: Dr Teresa Vidal Calleja
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

People detection and tracking is a critical part of many robotics applications where working in human occupied environments is required. A framework for detecting and tracking humans in a crowded environment using a depth camera was developed at UTS (Virgona, Alempijevic, & Vidal-Calleja, 2018) and is aimed towards developing an intelligent system capable of sensing the behaviour of commuters in an inner-city train station. This framework has intended to improve people tracking in environments with many people and frequent occlusions. The current usage of the framework is to understand and more effectively manage congestion.

This capstone project focuses on the orientation observation model of the framework and aims to improve the model. The framework currently obtains the shoulder orientation measurement likelihood assuming an ad-hoc Gaussian noise model. This capstone project aims to use Gaussian Process (GP) regression to learn the orientation observation model, instead of hand-crafting it.

The UTS Data Arena's OptiTrack motion capture system was used to acquire the dataset to train the GP model. Ground truth shoulder orientation was provided by the motion capture system, while the observations were processed by using data from a depth camera and pre-processing steps of the developed tracking framework. This step fits ellipsoids to the shoulders and head of observed people in the field of view.

The information contained in extracted ellipsoids is then used as input for the GP model. This model outputs the mean orientation (θ) and likelihood (L_\theta) of the observation, which aims to be incorporated into the observation model used by the tracking algorithm. Evaluation of the proposed model will be done by comparing with the existing ad-hoc Gaussian model.

Applying Deep Learning Algorithms for Hardware Implementation of CTU Partitions in HEVC - (12cp)

Adrian Caruana - A18-188

Supervisor: Dr Teresa Vidal Calleja
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Video encoding enables the efficient storage and transmission of high-quality digital video. The hardware and software required to deliver digital video must constantly progress to meet the increasing quality and quantity of consumer video demands. The High-Efficiency Video Coding (HEVC) standard achieves high coding efficiency at the expense of substantial encoding complexity.

Selecting quadtree-like partitions for the Coding Tree Unit (CTU) in HEVC predominantly contributes to its encoding complexity. The Rate Distortion Optimisation (RDO) algorithm takes a 'brute force' approach that exhaustively evaluates each permutation of possible CTUs, choosing the permutation with both the lowest bit cost and highest visual quality. However, RDO's significant complexity renders it incompatible with a real-time encoder. This can be solved by reducing complexity at the expense of the encoder's performance.

Predicting the quadtree structure of a CTU can greatly reduce encoding complexity by avoiding the need for RDO entirely. Given that Convolutional Neural Networks (CNN) are well suited for image-based binary classification tasks, this project proposes the use of a Low-Complexity CNN to perform real-time partition prediction for CTU generation in a hardware implemented HEVC encoder. The goals of this capstone project are to substantially reduce the encoding complexity of HEVC, maintain encoder performance, and deliver a register transfer level implementation of the algorithm for Blackmagic Design®.

LiDAR-based Object Detection with YOLO9000 - (12cp)

Benny Dai - A18-053

Supervisor: Dr Teresa Vidal Calleja
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

In order to develop a robust object detection system for autonomous systems, there is an emphasis to incorporate multiple modalities to overcome the challenges that are encountered with an individual sensor. One of the major motivations for this capstone project is that the use of RGB images as inputs in a detection system is known to suffer from the inability to detect objects in low-light conditions - whereas LiDAR does not.

In the past few years, there has been a considerable and significant amount of development in the object detections of RGB images since the demonstrated efficacy of deep convolutional neural networks (DCNN) - whilst the adoption of deep learning methods has only been recently explored in the LiDAR domain. One of the main benefits of harnessing deep learning is that the network is capable of learning abstract and powerful feature representations - superseding and alleviating the resources that were typical in feature engineering.

The largest downside of implementing DCNNs is that it requires a significant amount of data in order to solve their 'task'. This capstone project addresses this particular problem by utilising transfer learning, which reduces the amount of data and length of time required to develop the model. To be specific, we adopt the use of pre-trained convolutional weights from Imagenet in the RGB domain, and train for detections in the LiDAR domain. In essence, the convolutional neural network's capability to reason on shapes is transferred from visual images into a different modality such as LiDAR post-processed images. Results showed high performance in the validation dataset obtained with the Velodyne 16 and KITTI Dataset.

Development of EASPL8 – A Better Way to Fit L/P Plates to Vehicles - (12cp)
Adam Gillmore - A18-113

Supervisor: Dr Terry Brown
Major: Mechanical Engineering Major BE and BEDipEngPrac

The states and territories of Australia require novice drivers to display appropriate learner (L) or provisional (P) plates whilst driving. These plates are important to ensure other road users are aware if a less experienced driver is around them.

Current L and P plate holders on the market are difficult to use, cause damage to the vehicle and detract from the vehicle's aesthetics. These drawbacks increase the likelihood of the plates becoming dislodged or not being fitted correctly in the first place. Australian states and territories have steep penalties should a driver fail to adequately display the required plates. As an example, New South Wales drivers are fined two demerit points and $257, equating to half of a learner or P1 driver's license.

EASPL8's need was initially explored in 2012, where a proof of concept (POC) was developed and field tested. This early development and market confirmation led to a patent being filed to protect future development (2013101099 – search available on AusPat). The cost to upscale manufacturing for the POC was realised to be prohibitive due to a lack of understanding surrounding design for manufacture, assembly and cost.

This project completes a redesign of EASPL8 following the same procedures which would be completed by a design consultancy. The report steps through the process in more detail, starting with an existing design brief and market realisation which was studied to complete conceptual solutions. From explored concepts, one design is justified and proceeds to engineering development as well as design for manufacture. Throughout this process, consideration was paid to material selection, material capabilities, design rules for mass manufacture techniques as well as calculations for snap fit design.

Final deliverables of the project include:

- 3D files, designed and reviewed for manufacture;
- Working prototypes;
- 2D drawings including bill of materials;
- Comparative quotes for prototype and manufacturing.

Agricultural Automation- Control Systems for Smart Irrigation of Horticulture and Live Stock Grazing Control - (12cp)

James Asquith - A18-177

Supervisor: Dr Terry Brown
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Optimally managing water usage for horticulture and crops has been demonstrated to improve crop yield and minimise water resource consumption. Using time-based controllers to manage water consumption is a common form of irrigation management commercially available in Australia. This common method of irrigation, along with flood irrigation, leads to overwatering which may waste water and can damage crops. To adequately manage water efficiently, ensuring crops are not over or under watered, requires a holistic system approach. This system project shall monitor and automatically manage water and energy resources, including remote controlled pumping and irrigation equipment, to ensure the energy balance from solar power and optimal crop irrigation. Utilising historical and predicative weather data from the Australian Bureau of Meteorology, in conjunction with real time soil sensor feedback, can provide an understanding of the water requirements of the crops. Using this data in a closed loop Proportional, Integral, Derivative (PID) control program, will ensure crops never reach over saturation or wilt points. This methodology is applicable to all environments where water is a limited resource or are under drought conditions. The project has been designed for off grid power supply and isolated communication networks.

The developed program utilises the historical data from the Bureau to allow the farmer to budget water consumption for the upcoming crop season. This ensures that there is enough water allocated for the selected irrigation zones. The predictive closed loop nature of the project manages water usage by ensuring crops are not watered today, if it is forecasted to rain tomorrow. Controlling the irrigation using Evapotranspiration data from the Bureau ensures on average, the net soil moisture is obtained. The PID controller is activated when the minimum daily soil moisture is below the target control limit set by the user.

The project was implemented on a working farm in the Southern Tablelands in NSW to validate the control algorithm and assess the reliability of sensor data transmission in a harsh, isolated environment. The system demonstrated clear benefits both qualitatively and quantitatively to the end user of the project. This includes time savings due to leaky/ blocked pipe notification, automatic pump control and data indicates water savings due to the PID control program.

Reverse Engineering CAN Data for Automotive Vehicles - (12cp)
Brendan Potts - A18-370

Supervisor: Dr Paul Walker
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

The 2018/19 UTS autonomous vehicle project is focused on modifying a road vehicle to an autonomous vehicle and involves the collaboration of UTS engineering students and academics from various engineering disciplines. The aspect of the autonomous vehicle project that is covered in this capstone report relates to the formulation of the vehicle's controller area network (CAN) protocol. The CAN bus connects many components in modern cars, allowing systems to interact and share information such as steering angles, throttle position and engine temperature. The autonomous vehicle project requires the CAN protocol of the vehicle to fully integrate the autonomous system into the vehicle.

This capstone report details a reproducible method to analyse the CAN data related to an automotive vehicle and to define the protocol. The method developed relies on the following:

- Grouping potential signals into different classifications
- Using the OBD standard to find high speed versions of the same signals
- Using defined signals to find relationships with unknown signals
- Using equipment such as temperature sensors and dynamometers

This method optimises the reverse engineering process to obtain the signal definitions that make up the CAN vehicle protocol. The protocol definition obtained in this project is intended to be used with an autonomous control system running the robotic operating system (ROS) and integrated into the vehicle via CAN.

Results from testing and examples are provided in the report which demonstrate the viability of the method and how it can be used. It is harder to show that the grouping of signals optimises reverse engineering a CAN protocol as this requires the method to be used repetitively. Using external sensors and defined signals to find relationships to unknown signals has also proven to be a viable method to reverse engineer CAN signals.

World Solar Challenge Vehicle – Design and Optimization of the Rear Suspension for Ride Comfort - (12cp)

Phuc Khang Tran - A18-324

Supervisor: Dr Paul Walker
Major: Mechanical Engineering Major BE and BEDipEngPrac

UTS is in a collaboration agreement with QUT, RMIT, UniSA and Curtin University to design the mechanical systems for the 2019 World Solar Challenge. The competition requires teams to design, manufacture and then race a solar powered vehicle, from Darwin to Adelaide; a 3000km journey. The races are governed by rules, determined by race officials which protect the integrity of the competition and ensure the safety of participants. Some of these regulations include solar panel area limitations, weight limits, size metrics and energy storage requirements. Some of the rules ensure that these vehicles adhere to Australian vehicle regulations, as these cars are driven on public roads.

Our team was tasked with designing the mechanical systems of the vehicle and optimizing it's performance. One main segment of the mechanical systems is the suspension. The suspension system allows relative motion between the vehicle and the road, a major factor in the vehicle's ability to brake properly in emergencies and also provide passengers with a comfortable ride. It must also be able to withstand and react to major road irregularities such as potholes or speedbumps. The aim of this research project is to design and optimize a solar car suspension system aiming to minimize weight, energy consumption while being able to maintain road contact on bumps and turns. Strict weight goals are set to 5kg unsprung for each wheel including shocks, springs, control arms and brakes.

The resultant design from this project is a rear pure trailing arm, with 40degree angled 36mm piston shock absorbers mounted on the trailing arm itself. This design was chosen to accommodate the catamaran style aerodynamics body shape which implies very limited lateral clearance around the wheel hubs. A 1.2Hz natural frequency was decided to maintain ride comfort, supported by an Altair Motionview simulation. FEA studies were carried out to ensure that potholes and bumps would not cause damage to the structure of the trailing arm, this is yet to be physically tested due to time constraints.

World Solar Challenge: Optimise the Steering System for the Vehicle. - (12cp)
Mads Haugestad - A18-167

Supervisor: Dr Paul Walker
Major: Mechanical Engineering Major BE and BEDipEngPrac

University of Technology Sydney, in collaboration with RMIT, QUT, University of South Australia, and Curtin, are participating in the World Solar Challenge (WSC), sponsored by Bridgestone Corporation.

The aim of this competition is to design and build a vehicle that can be powered to run from Darwin to Adelaide exclusively on solar energy that will be accumulated using built-in solar cells/panels. To ensure that the vehicle uses the solar energy efficiently, it will be designed to be light weight

Due to the importance of a lightweight vehicle, this principle must be applied to all the individual parts of the vehicle, including the steering. The aim of this project is to design a steering system that meets all the requirements from the WSC rules, as well as the parameters set from the design requirements, minimising the space consumed by each part. The main focus of this research was to select a rack and pinion system that is light weight and it was decided that the steering rack will be located at the front of the wheel centre as this maximises the space for the driver and other components of the vehicle.

After the research for steering racks was completed, we had an option of two steering racks. The decision was made to go for the KAZ Technology Steering rack, due to its light weight of 1.36kg, and that the steering rack meets our requirements in term of rack travel and strength of materials. This steering rack required significantly less space than conventional steering racks, which made it easier to work with when deciding where to place the different components about each other.

Continued development would be to optimise the steering system for strength and for space required in cooperation with suspension and interior. Further work will also be required to consider the use of lightweight material such as aluminium to keep the weight down, as well as make sure that the system meets the strength requirements.

World Solar Car Project Team UTS - (12cp)
Kshitij Kharub - A18-318

Supervisor: Dr Paul Walker
Major: Mechanical Engineering Major BE and BEDipEngPrac

The contrast between contemporary mobility substitutes and the hunt for sustainability has been a big concern for the industry in the last few decades, enhanced by technologies that have been gradually narrowing this gap. Among them, solar cars represent a contemporary trend to supply this need.
The world solar car challenge has been a driving force for innovation in this sustainable transport sector since 1982, and the findings from this research will be used in the development of a prototype for the ATN Solar car team for this competition. The main aim of this project is to develop the mechanical components of the prototype such as steering, brakes, suspension, egress and safety systems. The objective of the research conducted in this report will be to design and build the front suspension of the solar car.

After careful analysis and research of previous generation solar cars, a double wishbone suspension was chosen for the solar car prototype as the geometry is easily adjustable, the suspension is easier to tune, and the suspension system weighs less as compared to any other system. The wishbones used in this system will have encapsulated bearings on the upright connection and rod ends on the brackets connecting to the body. The suspension geometry was fine-tuned using different methods and values of 0.25º, 4.28º and 0.71 were chosen for camber, caster and scrub radius respectively. A series of simulations were performed using Altair HyperWorks to minimise the change in the toe-in and toe-out angles to less than 1.2 degrees.

The design of the suspension has been completed in SolidWorks CAD package, and the stress analysis of the wishbones has also been conducted in ANSYS. The suspension system is ready to be manufactured and assembled pending approval from the aerodynamics team.

ATN World Solar Challenge Vehicle Team – Design and Structural Integration of the Interior Systems and Composite Chassis - (12cp)

Abhishek Malik - A18-282

Supervisor: Dr Paul Walker
Major: Mechanical Engineering Major BEBBus and BEBSc

The World Solar Challenge (WSC) is an engineering design competition focused on generating interest in the renewables engineering and alternative fuel sources amongst secondary and tertiary students around the world. For the sixteenth edition of the competition in 2019, the University of Technology, Sydney (UTS) is joining with the four remaining institutes of the Australian Technology Network (ATN) of universities to design and engineer an entry for the competition. The team will compete in the RACV Cruiser Class, which aims to focus students on design challenges like those faced during the design of regular production vehicles, such as accessibility, comfort, safety and aesthetics whilst also developing the most efficient solar vehicle possible.

For the ATN vehicle, UTS has committed to the design and build of the mechanical and interior systems. This report will detail the design and structural integration of the interior systems and composite monocoque chassis. The interior systems are classified as any major non-mechanical components within the physical interior of the vehicle consisting of the seating, doors and ventilation systems. The development of these systems followed a combination of established design methodologies, with initial ideation followed by rapid prototyping through computer aided design and engineering methods.

Design considerations explored during the structural integration of the interior components such as weight distribution, component geometry as well as torsional, shear and bending stresses aided in the determination of key load cases and geometric specifications for the composite monocoque based chassis. A simplified analysis of the chassis is completed using SolidWorks; complex analysis and simulations of the composite structure are out of scope. Static and dynamic load cases have been analysed to develop clear factor of safeties for all the components. These simplified mechanical models were then simulated through computational fluid dynamic (specific to ventilation systems) and finite element analyses (all structural components), allowing for the validation of each design iteration against pre-established and ongoing design objectives. Following the validation of the interior components and the chassis design, recommendations are made on manufacturing processes and timelines.

Interior Design for ATN Vehicle: World Solar Challenge 2019 - (12cp)
Aleksandar Babic - A18-126

Supervisor: Dr Paul Walker
Major: Mechanical and Mechatronic Engineering Major BEBBus and BEBSc

The burning of fossil fuels is the main source of energy generation, in our homes, and for transport. While it is effective in meeting the power requirements of the modern world, it is encompassed with serious negative effects on the environment. One way to reduce the environmental impacts of our transportation system is to design a zero emissions vehicle, powered purely by solar energy.

The World Solar Challenge (WSC) is an engineering competition established in 1987 by solar pioneers Hans Tholstrup and Larry Perkins. Since then, students from around the world gather every two years in Darwin, with their engineered and built vehicles, in an attempt to traverse 3000 kilometres across the outback to Adelaide. The Australian outback provides ample sun exposure which is highly favoured for this competition. However, it's harsh conditions can have serious impacts on the occupants of the vehicles. These conditions provide the basis for the interior design of the solar vehicle, which needs to be adapted to ensure the safety of its occupants.

For the 2019 competition, UTS is working collaboratively with other Australian universities as part of the 'Australian Technology Network' (ATN) to design and manufacture a vehicle that will participate in the Cruiser Class.

The scope of the interior design of the vehicle includes an analysis of the vehicle's component locations to achieve the optimal weight distribution and center of gravity, a sightline analysis to ensure that WSC regulations are fulfilled regarding occupant visibility, and the design and prototype of mechanical components. While the project will explore and examine the potential integration of current market solutions to suit the solar powered vehicle, the solar vehicle's uniqueness and niche requirements will require custom design and engineering solutions. The design process will encompass the mechanical components of the interior of the vehicle including mechanical safety devices, vehicle control systems, hydration and ventilation, and ingress and egress. In addition, the design will need to be ergonomic, aesthetic and in line with the team's competitive requirements.

Designing and Prototyping a CNC Guillotine which will be Used for Home/Hobby Manufacturing - (12cp)

Daniel Huynh - A18-354

Supervisor: Associate Professor Dongbin Wei
Major: Mechanical Engineering Major BE and BEDipEngPrac

The demand for innovating and developing small and compact technology without losing and whilst still enhancing its capabilities has increased rapidly. A great example of miniaturisation of technology is the generations of Computerised Numerical Controlled (CNC) programs. They are becoming smaller such as microchips but are also improving every generation by becoming faster, lighter and more accurate.

However, as technology and programs improve and become smaller the unit's themselves such as the CNC guillotine don't become smaller over generation. This causes major problems within the manufacturing industry, with the machines not being easily manoeuvrable which results in taking up a huge amount of space whilst still costing $10,000 or more for an old over-sized, second hand unit. This is particularly a problem with the rapid expansion in the home/hobby manufacturing industries that more and more people have become heavily involved in over the past years.

Therefore, I have partnered up with my fellow friend Ridvan Keskin (12057194) and have determined a solution of designing and prototyping a CNC guillotine which will be suitable and affordable for the average home/hobbyist manufacturer and also having the benefit of taking up very minimal room in any workspace area. The tasks have been fairly split with Ridvan focusing on the mechanical design aspect of the project. While, I challenged myself being in charge of the mechatronic side of the project i.e. programming, producing g-codes, wiring, fabricating a graphically friendly user interface board and ensuring calibration is correctly set up and operating.

The end result is a compact functioning prototype costing no more than $1200 whilst also being highly accurate due to being CNC programmed. Moreover, I believe by the product meeting the criteria of being an affordable compact CNC guillotine will be extremely competitive within today's manufacturing market.

Designing and Prototyping a High Precision CNC Guillotine for Home and Hobby Manufacturing - (12cp)

Ridvan Omer Keskin - A18-238

Supervisor: Associate Professor Dongbin Wei
Major: Mechanical Engineering Major BE and BEDipEngPrac

Since the beginning of the 21st Century, computerised numerically controlled (CNC) equipment has substantially improved due to the improvement of computer technology. Amongst the improvement of technology, there has been a great demand for accurate manufacturing equipment. The development of CNC equipment has marked a major improvement over the traditional method of non-computer type machining which involves manually controlling equipment.

With CNC technology, the end user is able to define their desired parameters for a piece that they need. The computer and equipment will then work hand in hand in order to produce the most accurate results. There is a highly saturated market of CNC equipment. However, none of them offer a compact, versatile and accurate yet cost effective form of Guillotine for sheet metal. Sheet metal is a highly utilized choice of material which could be used in applications ranging through automotive engineering, HVAC, panels/enclosures for Computerised equipment, and many other forms of products.

I have therefore partnered up with my fellow friend Daniel Huynh (12049894) to not only fulfill the requirements of this project but to also offer a viable and cost effective solution to the end user. The CNC Unit is a complicated piece of equipment. I have therefore split tasks from my friend Daniel. I have focused on designing the mechanical aspects of the guillotine myself i.e. framework, blade holding brackets, linear actuators and any fabrication involved as well as solidworks and FEA analysis and assigned the electric related tasks i.e. wiring, programming and calibration, and setting up user interface for my fellow friend Daniel to complete.

In summary, the advantage is that my product will offer the accuracy of a CNC Guillotine but with the affordability and compactness of an at-home manual guillotine unit.

Vacuum Desalination of Seawater using Solar Energy - (12cp)
Benny Tjandra - A18-262

Supervisor: Dr Phuoc Huynh
Major: Mechanical Engineering Major BE and BEDipEngPrac

The world has reached an alarming level of water consumption where 844 million people live without access to safe water in 2017. This contributes to 1 million people killed every year due to water scarcity. Although our planet is filled 70% with water, 97.5% of it is salt water, leaving us with 2.5% fresh water. While solutions have been implemented and one of the most common solutions is desalination (reverse osmosis, electrodialysis, multi-stage flash distillation, and multiple effect distillation), the energy consumption has resulted in undesired outcomes. Due to these reasons, developing a method of desalination is of significant interest.

The aim of this work is to develop an efficient autonomous desalination system powered by solar energy. During the desalination process, the salt and other minerals of salt water are removed to produce consumable water. One of the methods to separate consumable water from other particles is by extracting vapour.

In this experiment, the method of vapour extraction is performed by dropping the pressure of water to produce vapour in lower temperature. The solar panel will supply the energy for the whole system. The process starts from the pump to transport water from the ocean to a tank where water will be heated up to 70°C then it will be transported to a tank which is vacuumed using vacuum pump. It is connected to a copper pipe which acts as a condenser where it will produce consumable water for the final tank.

The goal is to produce a simple and effective method to produce consumable water, through extracting the vapour created in a low pressure and temperature environment where it requires low sustainable energy and works autonomously.

Vacuum Desalination of Seawater using Solar Energy - (12cp)

Nuo Chen - A18-162

Supervisor: Dr Phuoc Huynh
Major: Mechatronic Engineering Major 120cp

The world has reached an alarming level of water consumption where 844 million people live without access to safe water in 2017. This contributes to 1 million people killed every year due to water scarcity. Although our planet is filled 70% with water, 97.5% of it is salt water, leaving us with 2.5% fresh water. While solutions have been implemented and one of the most common solution is desalination (reverse osmosis, electrodialysis, multi-stage flash distillation and multiple effect distillation), the energy consumption have resulted in undesired outcomes. Due to these reasons, developing a method of desalination is of significant interest.

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