Comparative Analysis of Building Frames - (12cp)
Sukhvir Singh - SU17-036

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The purpose of this project is to evaluate the use of steel, timber and concrete to build structures and ensure low costs of operation, better utilisation of the available resources, using materials that are energy efficient and to evaluate the bending strengths and reliability of these different building materials.

The research has been undertaken with a detailed theoretical evaluation as well a computer model to ascertain the various aspects of these building materials i.e. steel, timber and concrete to construct structures. The computer model was created using Microstran software for steel, reinforced concrete and timber frames for a medium size building (5-8 stories). The model allowed for comparison of design actions obtained for each structure and also check their reliability and strengths. The research shall help the readers to understand in more detail the different properties and behavior of the modeled structures.

A presentation of previous studies is included to allow the reader to understand the context of the modeling work carried out. The study will help the readers to compare the different costs, reliability, energy efficiency, etc. of steel, timber and concrete to make structures one by one and shall conclude the best resource using these parameters. The model uses a time frame of one month to assess time-based parameters such as energy efficiency.

Results from the computer modeling were validated by reference to literature and perceptions of current practitioners.

Based on the parameters investigated, the modeling shows that a reinforced concrete frame is generally the best alternative frame than steel or timber based frames.
Investigating the Effect of Rock Joint on the Behaviour of the Structure under Earthquake - (12cp)
Tuan Trung Le - S17-201

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Assessor: Associate Professor Hadi Khabbaz
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One of the most important topics discussed by engineering researchers all over the world has been how to create an optimal design for buildings in geotechnical regions which are vulnerable of seismic loading, facing land scarcity problems. Catastrophic earthquakes like Kobe Earthquake in Japan 1995 and Izmit Earthquake in Turkey 1999 are considered a huge challenge for engineers to design structures that are sustainable through such kind of natural disaster, resulting in lower fatality and less significant damages to the surroundings area.

The need for seismic design of new constructed building is emphasized so that these structure are able to perform reasonably well in case of heavy earthquakes. In nature, the rock foundation is stratified with different layers and orientation. This project gives the attempt in investigating the effect of the rock joint on the behavior of the tall building under seismic load. In this project, the orientation of the discontinuities is considered when two different groups of sliding angle (dip angle) are taken into account. Specialized software to analysis the earthquake wave called Plaxis 3D is used to stimulate the structural behavior.

The resulting displacement in x and y-direction, the shear force and the acceleration are recorded to interpolate the relationship between rock joints and the stability of the superstructure. Therefore, the connection between the level of damage and the orientation of the rock joint is established. The purpose and output of this project is to improve the seismic safety of mid-rise building in order to prevent potential damage from earthquake.
Culturally Conducive Sustainable Building Model - (12cp)
John Kirby - S17-027

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This essay will focus on the local Indigenous people of Brewarrina, the Ngemba People and the current Aboriginal Housing designs and resources developed for this community. This work uses both a qualitative and quantitative approach to explore historical, cultural, social and architectural issues that impact on local Indigenous community members. This research will collect information from current Indigenous residents of Brewarrina who are both Aboriginal Housing tenants and those who own their own homes.

This research uses both a qualitative and quantitative approach to collect and analyse information. The qualitative approach will use focus groups and semi-structured interviews to collect data on personal narratives of local Indigenous Elders and community members. A thematic analysis of these personal experiences will be conducted to draw out key themes and concepts to inform a more culturally appropriate understanding of peoples lived experiences in these dwellings.

The quantitative approach will examine the current Australian Government design codes of Aboriginal Housing. The In-depth quantitative analysis will examine what culturally appropriate methods does the Aboriginal Housing department use to design and determine the needs for a Culturally Conducive Building Model?

This project aims to a) challenge the Government’s current Aboriginal Housing designs by involving local Indigenous communities in the decision-making processes to develop a more Culturally Conducive Building Model approach and b) to compare the current Government costs of Aboriginal Housing to that of the proposed Building Model proposed in this research. The objective is to design and develop housing that empowers Indigenous communities to feel a sense of ownership and a sense of belonging in the architectural design and fundamental purposes of housing.

Based on the findings of this research I will design and develop a three-dimensional structure of a Culturally Conducive Building Model for the Brewarrina Indigenous community.

Keywords
Indigenous, Technology, Innovation, Engineering, Culturally Conducive Building Model
The Geotechnical Challenges Associated with Implementing High Speed Rail on the East Coast of Australia - (12cp)
James Scognamiglio - S17-102

Supervisor: Associate Professor Hadi Khabbaz
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High Speed Rail is currently utilised by 16 countries worldwide, with a total of 42,000 km of high speed track in operation. Across 14 countries, both with and without existing high speed rail infrastructure, 15,000 km of track is under construction, with a further 41,000 km of track in the planning stages across 40 countries.

In 2011, the federal government allocated A$-20 million for the most comprehensive high speed rail feasibility study undertaken in Australian history. This report, completed in 2013 by AECOM, along with 6 consultants, proposed a high speed rail alignment from Brisbane to Sydney to Melbourne. An interactive map of the proposed alignment has been created as part of this project, along with a geological analysis of the entire alignment as a basis for researching, demonstrating and understanding the geotechnical challenges of high speed rail in Australia, with strategies to overcome them. Case studies from both the local and wider international community were identified and utilised in this project along with a wide variety of technical papers.

This project has established the geology and topology of the east coast of Australia is highly variable and complex along the proposed alignment. The geotechnical challenges found and investigated as a result of this geological analysis included dealing with soft soils, the presence of coal seams and acid sulfate soils and how they affect infrastructure and the complexities of tunneling in the major cities. Strategies to overcome these issues were suggested based on previous experiences.

This project also undertakes a comparative analysis of high speed rail with the Space X Hyperloop in terms of implementation and cost, with the intention of ensuring current technologies are considered in the report, concluding that high speed rail is still the most viable form of high speed transport in the world today.
Design of Shallow Foundations for Vibration Controls- (12cp)
Anjali Warsapperuma - A17-251

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The rapidly expanding industrial world has enforced the adoption of heavy machinery and equipment that are now capable of generating large amount of power, with a range of speeds under continuous dynamic operating conditions. These machineries produce high levels of dynamic forces that induce large stresses upon the resting sub-structure. Therefore, the structural integrity of the foundation plays an important role in determining the operating performance in addition to meeting the environmental demands.

The project aims to provide a design technique based on the limit state design approach as well as Global factor of safety method for shallow block foundations under steady-state dynamic action on cohesionless soils. The soil-foundation system is anticipated to exhibit four modes of vibration (two translational and two rotational), each modelled as a single degree of freedom lumped mass-spring-dashpot system. The design of foundation is primarily based on dynamic loads, soil properties and the performance criteria.

An interactive graphical user interface has been developed using MATLAB software, where the user can easily input design variables. The program is capable of determining the bearing capacity, settlement calculations similar to static design, as well as carry out a vibrational analysis for each of the four modes of vibration. Soil isolation efficiency which is responsible for the transmission of vibration to the environment is also calculated to facilitate optimizing the design. The program will enable geotechnical engineers to carry out preliminary design of shallow block foundations under dynamic loads.

Finally, practical examples of two cases are provided to validate the reliability of the program, besides its range of foundation design problems that it can solve.
For nearly four decades, geosynthetics have been used effectively as a way to reinforce the soil in retaining walls. It is understood in the engineering community, that in order to mobilise the interfacial shearing resistance between the geosynthetic sheets and the soil, a good quality, coarse-grained backfill is required. However, in some parts of the world, large quantities of good quality backfill is difficult to source and problematic to transport to the sites where retaining structures are needed the most.

This report uses finite element modelling of soil reinforced retaining walls to determine the validity of using thin layers of well-graded, coarse-grained soil around the geosynthetic reinforcement as a means of mobilising interfacial shear resistance and thus, allowing the remainder of the backfill to be poor quality soil with low frictional strength. Six parametric finite element models, using varied frictional soil thicknesses around the geosynthetic layers, have been simulated to analyse the deformations observed and to determine if this technique is viable in a full-scale retaining wall simulation.

Deformation results suggest that shear resistance between the geosynthetic sheets and the soil increased with the addition of thin frictional soil layers, however, the extent of poor quality backfill in the retaining walls render them instable and unable to stand under their own weight. Only with frictional soil layers of thickness greater than 250 mm, do the retaining wall simulations show any ability to resist failure. This study disproves the theory that a thin frictional soil layer technique can be used in retaining walls where poor quality soil is the bulk material. It highlights a need for further exploration into solving the problem of communities not having access to high quality backfill for the purpose of retaining wall construction.
The Challenges of Tunnel Construction in Unforeseen Ground Conditions - (12cp)
Simerpreet Sohi - S17-116

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As the built environment progressively grows higher and higher leaving little room for future development, trends show that in order to allocate limited space and valuable resources to prospective infrastructure development, tunneling is the future. Currently in Australia the two largest infrastructure projects are both underground tunnel transportation systems, with the NSW government spending $20.8 billion on the Sydney Metro – Stages 1 & 2 alone. Thus, it is inevitable that many civil engineers in Australia should contribute to tunneling projects during their career, therefore a sound understanding of the holistic approach to tunnel construction is fundamental for the professional development of civil engineers.

This project provides comprehensive methodologies based on academic research on how to efficiently overcome tunnel construction issues, when unforeseen ground conditions are encountered. The methodologies proposed also take into account the monetary and time implications imposed. Currently, the literature pertaining to tunnel constructability and soil conditions is limited, with minimal constructability connections between the two factors. However, this project aims to bridge the gap between both tunneling and soil conditions to provide a succinct and cohesive approach to tunneling and the related issues. As ground conditions, such as in-situ stresses, compressed air and groundwater govern the techniques and methods used in tunneling, it is paramount to address these effectively in order to generate the most efficient and economical approach to construction.

The Sydney Metro – Norwest Station Pedestrian Underpass is used as a case study for the methodologies founded in this report. The conditions encountered during the construction of the 45m mined tunnel have been analyzed, with the corrective techniques applied during the construction reflecting those founded in the methodologies. Lessons learned from construction of this project are discussed in the report.
Exploring Flexible Work Options for Women in the Civil Construction Industry - (12cp)
Taylah Bryce - SU17-009

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

This study explores the challenges that have emerged from the outdated and inflexible workplace culture of the civil construction industry, and how it is affecting female engineers and women in other functional site roles. The study primarily explores the following issues: the strong presence of a long-hours culture, the perception of staff who pursue a work-life balance, and the perception of part time and flexible working options within the industry.

The study has been presented as a qualitative research project where members of the industry, particularly female engineers, have answered questionnaires regarding the primary issues listed above. The study was conducted over three phases: The first phase aimed to document a female’s perspective on the construction workplace culture; the second phase focused on the perceptions of the same respondents regarding the industry’s acceptance of work-life balance and whether any of the aspects surrounding their workplace culture has discouraged them to stay in the industry; the final phase targeted men and women in management and employer roles to determine their views on part time and flexible working options within the industry, before requesting them to offer any suggestions regarding flexible or part time work options in a site office context.

The results of the study were presented quantitatively in the appendix, where they were further discussed and explained in the findings, and carefully considered to offer relevant and feasible recommendations to contractor organisations and their employers and staff. The recommendations have been addressed in a way that a gradual workplace culture change must be accepted and acted on throughout the entire workplace. Additionally, both genders must be invited to benefit as the way forward to a better workplace culture will be more accepted when our male colleagues, who dominate much of this industry, also feel included and considered.
Steel I girders with corrugated webs are appropriate alternatives for normal flat-web girders in steel structures since they provide lighter and smaller beam features in steel design. Based on existing literature, the corrugated webs beams (CWBs) have provided many advantages for structural applications (e.g. increasing shear and flexural strengths). CWBs have been used in some parts of Australia without detailed information about mechanical properties of them. Therefore, a reasonably adequate table of mechanical properties for corrugated-web beams is required to introduce mechanical properties of this type of beams to Australian engineering community.

This paper investigates steel I girders with corrugated-web profile and makes a comparison of mechanical performance between normal welded beams and optimum CWBs. The theory of Ultimate Limit State (U. S. L.) design will govern the entire simulations using Australian Standards. Fully non-linear analysis in SAP2000 is employed to evaluate the beams in this project. Firstly, the initial corrugation size including corrugation length (e.g. 320mm, 400mm, and 500mm) and corrugation angle (e.g. 15 degrees, 20 degrees, 25 degrees and 30 degrees) is determined for optimum development of CWBs. Stresses and deformations of WBs and CWBs are then analysed. The results are recorded and compared to highlight the benefits of CWBs in order to proceed the desired optimisations. Moreover, investigations regarding to force-displacement relationship (stiffness) and bulking analysis of the webs are carried out and presented to further validate the advantages of corrugated webs beams. Comparing the results, most reasonable cases of CWBs optimisation are selected and a detailed table of mechanical properties of CWBs is proposed for practical purposes.
Comparative Study of a Civil Structure from Traditional Methods vs. Building Information Modelling (BIM) - (12cp)
Alexander Marambio - SU17-029

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The construction industry has continuously analysed and considered different methods/processes that can improve and streamline the construction process throughout all stages of a project. One method that has been introduced in some countries including Australia is Building Information Modeling (BIM). This method utilises computer based programming that integrates detailed/specific information within a three-dimensional model of a project. Having critical documentation and information centralised in one model is extremely beneficial as it assist in the coordination between different disciplines within a project. Hence, improve productivity and cohesiveness.

The aim of this project is to conduct a comparative study between traditional methods and the use of BIM for the construction process of a project. This would highlight what method is superior in improving productivity, cost and time. A systemic literature review provided a thorough insight of traditional methods used in the past few years, as well as an overview understanding of BIM’s functionality and benefits. The comparative aspect of the project will involve reviewing a recently completed project with the absence of BIM and contrasting the same project with the implementation of a BIM model.

The main area of focus for BIM will be the scheduling (time) of a project, which is the fourth dimension BIM uses as part of producing a comprehensive and interrelated model. Ultimately, the findings will help outline the key advantages of BIM while capturing elements that it may lack or need improvement. This information can be used to further improve BIM’s capacity in the industry and give users an insight of the forthcoming technology that may become the governing approach in Australia.
Building Information Modelling (BIM) is a technology that has recently been popularised in the construction industry, this technology is recognised for its ability to address the inefficiencies of traditional management. There is a rising implementation with the use of BIM within the architectural, engineering and construction (AEC) industry to adopt BIM practices on projects. Although some major companies have accepted the use of BIM as a way of innovating and gaining predominant success. Although this is the case there has been many questions that have been raised, such as: ‘What are the risks of using BIM? How does this technology improve cost, time and quality? Is BIM distinguished as a process or a tool?’ These types of question will form the foundation of this research task.

Hence, having to discover the applicable form of literature, this research task is to analysis which is the most efficient method between traditional management and concurrent management by exploring two dimensions of BIM, 5th Dimension which relates to cost, quality and time; 1st Dimension which links to concept design and tender, by using these dimensions we will then discover the beneficial relations between the two concepts.

To test this, we will have to administer a handful of example projects that have been subjected to the use of BIM, this project will have to satisfy the specification of a high-rise building. The findings of these results will conclude if BIM can really benefit the cost, time and quality factors of a project compared to traditional methods. Furthermore, the successes recorded by these projects will consequently increase the adoption of BIM. Nevertheless, the findings to this research will emphasise the efficiency and benefits that BIM has to offer to the AEC industry.
Optimizing Project Management for Multistorey Buildings – Comparative study on Traditional & New methods of Building Sustainability and Facility Management (12cp)

Sidhanth Hari Kumar - SU17-028

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Major: Civil and Environmental Engineering Major BE and BEDipEngPrac

Within the engineering industry, there are multiple factors, which all need to cohesively work in-sync to produce a project. Project management is a very demanding task that involves high risks of failure without detailed planning. Therefore, this study will research the impacts of new technology and methods on building sustainability and facility management. During the Climate Change Agreement in Paris, they recently passed a new agreement to move towards a zero net emissions. With the development of technology now BIM has started implementing many aspects into the program to help assist with energy consumption and facility management. BIM provides the ability to construct a whole project virtually before any of the physical construction can occur. This allows the overall accuracy of the project to increase leading to less time, money and resources wasted (Zhang et al., 2016).

The distinguishing phase in this report will consist of qualitative collected data that will be gathered through literature reviews and published papers from respectable sources that compare current methods and past methods. In the contrasting phase, the quantitative data will be gathered through green star reports, manuals, waste produced and other aspects of the project. By comparing the actual data from the project, which has not used BIM, and inputting the original figures from the project into BIM, which will produce an output. The two sets of data can be contrasted and compared with the distinguishing section to determine if BIM can help increase productivity on construction sites. This study will hopefully pave the way to a better future for the industry and not only help companies but the environment and society as well.
Fiji is a country that is severely impacted by flooding. Due to Fiji’s topography and climate, flooding often causes substantial infrastructure damage and loss of life. Significant populations in Fiji are at risk of flooding, mainly those living in susceptible areas such as floodplains and deltas. Unlike Australia, Fiji has a limited official national or comprehensive system to assess and model flooding. There is an inherent need for an improved flood warning system to aid local and national flood preparedness and responses.

The objective of this project is to create a database of Intensity-Frequency-Duration (IFD) design rainfall estimates for Fiji, of which there is limited existing information. IFDs are used in flood risk management planning, as well as infrastructure design including gutters, storm water pipes, channels, levees, detention basins and dams. IFDs are estimated from the analysis of historical rainfall records to determine the magnitude and probability of large rainfall events in a region.

Current methodologies of deriving IFD estimates, such as Australian Rainfall and Runoff (ARR), have been reviewed and applied to rainfall data collected at Viti Levu, Fiji’s largest island. This broadly involved collecting available historical rainfall data, checking the data for errors, extracting the largest annual rainfall records and determining the probability of them occurring. The information derived was then used to estimate IFD data for the island.

The project has demonstrated that it is possible to create reasonable quality IFD estimates from a limited rainfall monitoring network. Once the methodology described in this project has been applied to a region, the reliability of these estimates can be further improved as more rainfall data becomes available. The project has demonstrated that the application of IFD estimation methods are capable of being implemented in other Pacific Island countries with similar rainfall monitoring networks.
Effective Control of Structural Torsion Induced by Earthquakes - (12cp)
Nicholas Nishijima - SU17-004

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Engineering structures exposed to earthquake excitations respond in a dynamic manner that is influenced by the design and structural characteristics of the building. Dynamic response exhibits in various forms, and although structures are commonly designed to withstand such events, specific forms of response may prove to be catastrophic, leading to potential failure and collapse of the structure itself. Structural torsion is a commonly observed phenomenon amongst structures located in regions of high seismicity. This form of response results in the building twisting laterally, whereby portions of a single floor level move horizontally relative to the rest of the floor. The torsional response of the structure creates localised high stress within the structural elements affected, which can potentially push the structure beyond its capacity.

This project aims to address the engineering problem at hand by identifying the key factors that play a significant influence on the amount of structural torsion observed in buildings. With the use of computer-aided engineering software and with the current research that is available today in the field of structural dynamics and earthquake engineering, the project establishes methods of mitigating structural torsion and analyses the effectiveness of such methods by comparison with alternative structural designs. The report also provides recommendations on design approaches that can significantly reduce torsional movements, such as new design techniques or the implementation of modern, smart structural components. By validating the relationships investigated in the project, the results can shed light on potential improvements to structural design methods, make recommendations on current code provisions and encourage further research into this area.
Effect of Boundary Conditions on a Long-Span Timber Cassette Floor - (12cp)
Min Kyaw Thu - S17-127

Supervisor: Professor Jianchun Li
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With the advancement of engineered wood products (EWPs) and environmental benefits, timber use is becoming more popular for multi-storey building applications. EWPs have high strength-to-weight ratio meaning it has the ability to span long lengths under its own self-weight and is thus suitable for floor systems. However, with its lightweight nature, timber floor systems become more susceptible to human induced walking excitation which is often the governing design parameter.

Ribbed-deck structures are an efficient design solution consisting of joists compositely connected to a flange member, typically made from laminated veneer lumber (LVL). Such systems are prefabricated off-site and span between primary beams. When designing other floor systems from traditional materials such as steel and concrete, it is often assumed that the connection system to the main structure is rigid under dynamic loads. However, as long-span timber floor systems are still emerging, the support conditions under dynamic loads are uncertain. Further, once walls are placed over the supports, additional clamping action may prove to be beneficial to the modal properties of the floor.

This paper investigates the effect of added mass at the supports on the modal properties of a long-span timber cassette floor. Impact hammer tests were conducted, and the dynamic characteristic of the floor is analysed according to its modal properties including; natural frequency, modal mass, mode shape, and modal damping. Four different scenarios were adopted: no load, and loaded conditions with 1 kN, 1.5 kN, and 2 kN on the supports. The loaded scenarios are to simulate the practical scenario (clamping condition) of a long span floor and wall of a typical building. Results show that the natural frequency has an increasing trend for the first bending and torsion modes.
Investigation into the Feasibility of Columnless Structures Utilising Magnetic Levitation-(12cp)
Benjamin Watt - A17-110

Supervisor: Professor Jianchun Li
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Major: Civil Engineering Major BBEBBus and BEBsc

The Columnless Structure is an innovative and futuristic design concept whereby magnetic levitation is utilised within multi-level structures as a form of slab support. Highly technical levitating magnet arrangements would be used in place of traditional steel reinforced concrete columns, essentially creating ‘floating’ slabs. The primary benefit of implementing this technology is that it would facilitate automated seismic dampening responses throughout multi-level structures during earthquakes, preventing structural damage. Additional benefits of implementing this technology would include streamlined high-rise construction processes, reductions in various construction related costs as well as enabling alternative and more effective structural design solutions.

This project aims to specifically demonstrate the feasibility of utilising repelling magnetic forces as a form of slab support. Scaled physical tests and simulations utilising ANSYS Maxwell were carried out in order to demonstrate the ability for repelling magnets to support specific masses at varying distances. Strong correlations were found between test and simulation data, validating a relationship between levitating distance and applied vertical force for permanent magnets of a specific strength. Demonstrating this concept in a scaled experimental set-up indicates the feasibility of its application within large scale structures.

Previous studies on the applications of magnetic levitation have been primarily focused on maglev transportation systems. In demonstrating the concept’s feasibility this project provides a well rounded conceptual understanding of the Columnless Structure enabling further studies into this particular area to be continued in the future.

The implementation of the Columnless Structure concept would minimise the devastating impact of earthquakes on multi-level structures and provide various other benefits. Although significant technological advances are required before this concept becomes a reality, this project aims to demonstrate the concept’s feasibility in order to provide a firm starting point for future research and development into this area.
As the limit of technology continues to expand at an exponential rate and more ‘Smart Buildings’ are becoming the norm, the Architecture, Engineering and Construction Industry (AEC) must develop new and innovative processes in order to encapsulate the available data in a coherent and manageable structure. Due to the increasing amount of data alongside the fragmented nature of construction and the risks, there is a viable need for a management system to gather and collate the information needed to meet the requirements of the life-cycle of the building.

Building Information Modelling (BIM) aims to provide the bridge between the interested parties of a building through the use of an integrated Multi-Dimensional Model. However, for this model to be successful, it is heavily reliant on the participation of all stakeholders involved in the life cycle of the project, from design and development, construction, operations and to the end of life phase. During the design phase, the client, contractors, consultants all must work together to provide the necessary requirements of the building. Without these, there is no framework to specify what data is to be provided and when throughout construction, which in turn reduces the capabilities of the model for when the building is in operations. When a project is devoid of the collaboration of all parties, the benefits that BIM provide are effectively pacified.

This thesis aims to explore how a contractor is able to effectively deliver a BIM enabled project through the use of Requirements and Systems Engineering. A literature review will be used as the basis of a discussion of the systems that are being utilized to develop, gather, organize and validate the requirements of a project. This will provide a platform for lessons learned to aid in the implementation of future BIM enabled projects as well as assessing how Systems Engineering methods and tools can be used to benefit the production of the Building Requirements.
Investigation of the Level of Service for the Sydney City & South East Light Rail Implementation against the Existing Bus Network Capacity- (12cp)
Jack Lord - SU17-045

Supervisor: Dr Michelle Zeibots
Assessor: Greg Sutherland
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It was announced in 2012 that the Sydney CBD & South East Light Rail (CSELR) was to be constructed, extending 11.6km from Circular Quay to Kingsford and Randwick via Surry Hills and Moore Park. The CSELR’s primary objective was to add capacity to the existing bus network that caters for passenger movements between the CBD and South Eastern suburbs. There are currently over 180,000 people entering the Sydney CBD in the morning peak via around 1,600 buses. Prior to the proposed network changes, the volumes of buses entering the CBD was fast approaching peak capacity along the 4 key access corridors through the CBD – Elizabeth Street, York Street, George Street & Anzac Parade.

In 2015, significant changes to the existing bus networks were made — this involved the permanent removal of bus routes using George Street onto other streets including Elizabeth, Castlereagh, Park, Druitt, Clarence and York Streets. Following the completion of the CSELR, a number of bus routes along the Anzac Parade corridor will be terminated or altered to accommodate the new light rail. A significant amount of scrutiny has been placed on the CSELR due to these proposed changes to the bus network. A significant concern is the reduction in bus capacity into the CBD that will be created via the removal of a large proportion of existing bus routes.

This report examines the proposed capacity along the new light rail and compares it to the existing bus network between the Sydney CBD and South Eastern suburbs. Following from this analysis, the investigation into the application of operational changes, identified in previous studies, can be applied to the proposed light rail to create an increase in operating capacity. The application of Opal data allowed for the analysis of the existing bus network to identify current patronage levels in the study area.
The Role of Small-Scale Crop Residue Gasifiers in Southeast Asia’s Clean and Improved Cooking Sector - (12cp)
Alexandra Devlin - S17-104

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Globally, 3.1 billion people still rely on solid fuel combustion for cooking. Loss of life associated with air pollution exposure to unclean cook stoves is a significant problem, claiming the lives of 4.3 million people annually. Inefficient and polluting cook stoves are detrimental to human development objectives and sustainability. Low socio-economic areas in Southeast Asia rely heavily on firewood, charcoal and coal as cheap and readily accessible fuels. Crop residues, such as rice husk, are also abundant in these agriculture-dominated areas.

This capstone project assesses the emissions performance and thermal efficiency of gasifiers which are the most advanced biomass clean cook stove option. It demonstrates that small-scale gasification at household-level is able to transform crop residues into high-grade heat for cooking in a more efficient and less-polluting manner. Under current agricultural practices, nearly all crop residues are uselessly burnt or discarded in many countries in South-East Asia.

Apart from high thermal efficiency and low emissions, another benefit of gasification systems is that biochar is produced which has a range of applications that add value to agricultural supply chains. Biochar is a carbonaceous and highly porous material with advantageous biological, chemical and physical characteristics. It can be used as a soil amender, water filter, air purifier, construction material admixture, compost additive and fermented feed reformer. Systems engineering was adopted to explore the dynamic role of gasification and biochar in waste transformation systems.

Field testing carried out in Lao assessed the gasifier’s emission reduction capacity in contrast to traditional solid fuel combustion. Efficiency analysis determined the gasifier’s comparative specific fuel consumption and thermal efficiency capabilities. Further testing in Sydney quantified the gravimetric fine particulate matter, benzene, carbon monoxide and carbon dioxide emissions. Stakeholder consultations and cookstove market analysis were undertaken in Lao, the Philippines and Vietnam to gauge cultural acceptance of this technology. Social engineering was adopted to analyse the cooking technology’s complex relationship with the consumer. Moreover, small-scale crop residue gasification demonstrated significant potential to serve developing nations of Southeast Asia.
Analysis on the Durability of Residential Structures in South East Asia Comprising of Bamboo Structural Elements - (12cp)
Aishwarya Kesawamani - SU17-017

Supervisor: Dr Rijun Shrestha
Assessor: Dr Sardar Malekmohammadi
Major: Civil Engineering Major BE and BEDipEngPrac

Bamboo is widely acknowledged as a non-timber renewable building material in the world. Due to its rapid growth rate, bamboo can be planted and harvested within four years. According to Jiang (2007), Yu et al. (2011), Zheng et al. (2014) and Yu et al. (2015) bamboo is regarded as a material which has potential to replace traditional construction material due to its high strength, availability and biodegradability. Although there are concerns of durability aspect of bamboo which are reinforced by comments made by (Xiao, Inoue, Paudel and Adhikary, 2008) in “though people are aware of the beauty and the strength of bamboo, they are reluctant to make permanent structures with it because they are scared of its non-durability”.

This project included a field test which investigates the deterioration of bamboo when exposed to moisture and submergence in still water. This experiment simulates the in-situ conditions of structural elements such as columns.

Observations were made about the general physical condition of the specimen. It was clear that as the time progressed due to wetting and drying cycles, the samples exposed to weather had a considerable amount of organic growth on the surface. The cross-section of the specimen also showed the penetration of organic matter through about 4 millimetres into the sample. The results show that despite extreme weather conditions bamboo is a promising material to be used for residential construction in south-east Asia although further mechanical testing on these samples is required to validate these findings.

Various bamboo treatment techniques were studied to increase the service life. It was identified that Modified Boucherie Treatment was the most efficient and economical form of treatment as it was successful in treating 1200 bamboo poles (Xiao, Inoue, Paudel and Adhikary, 2008) within a month utilising limited resources.
Investigation into Engineering Solutions for Use of Bamboo as Reinforcement in Concrete - (12cp)

Joseph Andre Bengua - S17-018

Supervisor: Dr Rijun Shrestha
Assessor: Dr Sardar Malekmohammadi
Major: Civil Engineering

Steel has been used as reinforcement in concrete structures for decades. As concrete has a low tensile strength, steel and concrete when combined together can work compositely to handle flexural, shear, and axial effects due to design loads. However, with the limited availability and cost of steel, other solutions for concrete reinforcement should be considered. Bamboo is a possible alternative that can provide a similar linear-elastic behavior to steel at a fraction its cost.

This paper aims to discuss the design considerations for bamboo as a replacement for steel in reinforced concrete beams. It will investigate the strength limitations, durability, workability, and cost to create bamboo reinforced concrete beams, and compare them with equivalent steel reinforced concrete beam design. This will be achieved by examining the current research on bamboo reinforced concrete design, and adapting the Australian Standard concrete design methodology to formulate an updated concrete design methodology specifically for bamboo reinforced concrete beams. This study will only focus on the flexural and shear effects of bamboo reinforced concrete beams.

Although there is a common misconception that bamboo is as strong as steel, in its natural form it cannot replace steel as a reinforcement in large-scale concrete structures. Thus, the results of this study endeavours to potentially provide design considerations for use of bamboo as reinforcement in low to mid-scale concrete structures, particularly in places where steel is less accessible or is too costly.
Engineering Education: A Review of Structural Engineering Subjects in UTS’ Civil Engineering Degree- (12cp)
Scott McKeon - S17-083

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

Engineering is at the forefront of educational change, as the profession mixes both technical mastery with professional communication skills. Historically, engineering education has followed methodologies set out by the Grinter Report (1955), working towards mastery of engineering sciences. More recently, this has shifted towards a greater focus on leadership, team work, communication and versatility in understanding global challenges.

So how does The University of Technology Sydney (UTS): Engineering compare against current literature and worldwide standards of engineering education?

This capstone has reviewed educational pedagogies and various learning frameworks specific for engineering education and implemented semi-structured interviews with 6 subject coordinators for each structural subject in the UTS Civil Engineering stream. These individual interviews explore the content taught, the delivery of the subject and how learning outcomes are assessed. A final workshop was undertaken with management reviewing the 6 subjects at an overview level.

Key findings include:
• The subjects are somewhat isolated and poorly connected with each other
• The subjects focus more on analysis rather than design, which is a current gap for students entering the industry
• Identification of constraints on the subject coordinators, i.e. time, budget, class size etc.

This is preliminary research which includes the method this capstone has undertaken to assess how UTS: Engineering can better adapt to changes in educational technology, enhance the student experience and produce high performing graduates for industry.

Recommendations include:
• Further research in this area of study at UTS is required
• Review subjects for alignment to create a connecting narrative between subjects
• Align this research with current goals and direction of this Faculty
• Further develop feedback paths for students and industry.
• Focus groups in each subject to provide feedback to the subject coordinator
Stability of Railway Tunnel Subjected to Drawdown and Freight Loading 2-Dimensional Finite Element Modeling- (12cp)
Rubani Khanna - SU17-003

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

Railway tunnels have become a norm for metropolitan regions across the world to allow for growth on and above surface. While underground railway provides an immense opportunity for cities, it also poses substantial safety risks. Geological failure modes are crucial research factors for railway tunnels due to the heavy impact to substructures, superstructures, patronage and persons. The largest risk today for railway tunnels is the impact of water on ground settlement. Water can weaken the subsoil drastically causing unexpected failure instantaneously.

The purpose of this capstone is to assess the impact of rapid drawdown on railway tunnels and assess the behaviour of the tunnel and soils. The geological factors have been deduced utilising an exhaust of literature review and interviews with field engineers. Utilising these sources and analysing tunnel failures over the last fifty years, these geological parameters have been selected as the most appropriate to cater to the soil profile which can be found in Sydney.

By comparing drawdown impact at different stages of a tunnel, we were able to quantify the behaviour of the materials and model with finite element method using Optum G2. The finite element mesh outputted from Optum has allowed analysis of the stress and deformation on the tunnel.
This study deduces the extent to which railway tunnels are impacted by the rapid drawdown. Understanding these parameters for tunnels has the potential to reduce tunnel failure significantly. This analysis is a step towards reducing tunnel failure as usage of such infrastructure modes continues to increase around the world.
Application of Paulownia Wood in Cross-Laminated Timber (CLT) Structural Members.
- (12cp)
Al-Amin Islam - SU17-039

Supervisor: Dr Sardar Malekmohammadi
Assessor: Dr Rijun Shrestha
Major: Civil Engineering Major BE and BEDipEngPrac

Paulownia is a very adaptable and extremely fast growing hardwood that has recently gained popularity within the construction industry. Paulownia has a very high potential to be used for structural applications such as laminated timber. Cross Laminated Timber (CLT) is known to be the engineered wood of the future. CLT is an orthogonal laminated structure which can be used as a full size wall or floor element as well as linear timber member capable to bearing in-plane and out-of-plane loads. This main objective of this study is to develop an analytical model to predict the bending performance of Cross-Laminated-timber and successfully design a new CLT product using Paulownia lumber. The design of CLT structures are mainly driven by the serviceability criteria and thus accurate elastic properties are required. The experimental study by Akyildiz and Kol is taken under consideration which provides mechanical and physical properties of Paulownia tomentosa. Two different analytical model is developed based on the CLT Hand book to calculate the effective bending stiffness using the Mechanically Jointed Beams Theory (Gamma Method) and Composite Theory (K method). An experimental study by Davis et al (2017) analyses the bending and shear performance of hybrid cross laminated timber of four different configuration made from Spruce-Pine-Fir (South) (SPFs) and laminated strand lumber (LSL). This experimental study will be used to optimize an appropriate design configuration of the cross laminated wood panels. The analytical predictions based on higher-order theory are in excellent agreement with the experimental study. Furthermore, the analytical model is used to virtually test CLT panel consisting of paulownia in four different configuration. The results indicated that layup with paulownia lumber as the core material gives the best bending stress at failure. Finally, two analytical models are employed based on the theoretical and experimental studies to evaluate the bending performance of CLT panels. In future, these finding can be used to design and further study the performance of Paulownia-based CLT panels.
Modelling the Properties of Geopolymers - (12cp)
Abdullah Hashmi - SU17-012

Supervisor: Dr Sardar Malekmohammadi
Assessor: Dr Nadarajah Gowripalan
Major: Civil Engineering Major BE and BEDipEngPrac

The present work focuses on modelling the effective elastic properties (bulk, shear and Young’s moduli) of geopolymers made of fly ash. Several models for estimating the elastic properties are reviewed. Based on the microstructural data, Hashin’s composite spherical assemblage (CSA) initially proposed for advanced composites has been selected to investigate the elastic properties of geopolymers based on constituent properties.

Recent experiments by Das (2015) have been used for providing the necessary inputs and experimental results for comparison. The primary assumption states that Hashin’s Model should provide reasonable results as it was initially designed for heterogenous materials with a defined matrix, a property exhibited by geopolymer concrete. Should this assumption be valid, the output predictions must be in close variance to the experimental results obtained from Das’s experiment. The three solid phases in the geopolymer are NASH gel, partially reacted fly ash and unreacted fly ash. Pores are distributed between the NASH gel and partially reacted fly ash though the exact pore distribution is unknown. The program created enables adjustable void distribution due to its effects on stiffness.

Using Hashin’s micromechanics model, the bulk and shear moduli of the material are determined at different steps. The material is homogenized assuming three different microstructure arrangements to determine its Young’s modulus. Predictions are compared with each other as well as experimental data reported in the literature. Very good agreement between the model prediction and experimental data for Young’s modulus of fly ash geopolymer is found. It is demonstrated that the volume fractions of phases have more significant effect on the elastic properties than the distribution of phases As Hashin’s model is a physically-based micromechanics model, its further extension to incorporate aggregates as a separate phase seems to be a promising approach for modelling the effective mechanical properties of geopolymer concretes in the future.
Smart Concrete Technologies in Civil Engineering Application- (12cp)
Sanny - S17-284

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

Smart concrete is the product of integrating traditional construction materials with modern technology for the purpose of creating a better solution in the construction industry. Incorporating certain polymers such as carbon fiber, nanophase materials, and shape memory alloys in the concrete mix has been proven to not only enhance the mechanical properties of the concrete but also make damage self-sensing possible in structure. Realising the potential of smart concrete, the study on developing traditional concrete into an intrinsic sensor has been gaining researcher’s interest. One of the possible applications of smart concrete is in the field of structural health monitoring. In the past, periodic site inspection and scheduled maintenance have been the common practice to monitor the condition of the structure. However, it is not cost-effective in terms of labor cost and downtime of the structure. Through the development of smart concrete technologies, it is hoped that they can replace the conventional method of structural health monitoring.

The focus of this thesis is to study different types of smart concrete technologies and their advantages and limitations over normal concrete. A Theoretical review will be conducted to obtain the data which then will be analysed to propose a structural health monitoring system in critical civil infrastructure, particularly in concrete bridges. A system which incorporates carbon fiber reinforced concrete as damage and weight sensor in concrete bridge will be proposed. Further explanation of the system will be specified in the paper.

This project therefore presents an insight on different smart concrete technologies in civil engineering applications. Additionally, it also provides the recommendation on how smart concrete can be used to replace conventional method in structural health monitoring.
Increasing Air-Conditioning Efficiency and Decreasing Energy Consumption: Alternative Use of PV Panels as a Heat Reduction Device - (12cp)
Sarthak Jain - SU17-019

Supervisor: Dr Ahmed Al-Zubaydi
Assessor: Associate Professor Guang Hong
Major: Mechanical Engineering Major BEBBus and BEBSc

One of the biggest issues in warm countries where more than 50% of the heat being gained in a single-story building/office is due to the roof, and the main source of heat sun, is air conditioning efficiency.

Air conditioning, which was once a measure of luxury in homes, has now become one of the fundamental requirements in houses and offices these days. In hot countries such as Australia, specifically in Sydney, almost every home has air conditioning. The Handbook of Energy Statistics 2016 indicate that consumption of energy in Australia from 2014 to 2016 increased by 10%. This increase in energy consumption is mostly due to rise in air conditioning demand in homes. Research shows this has now become a global trend and is one of the primary reasons that efforts have been made to continually improve the air conditioning efficiency, in order to subsequently achieve energy savings.

This study examines another such measure by effectively reducing the internal cooling load of single story office buildings in the city of Sydney (Australia) by focusing on placing solar panels to cover the roof area of the building. Software such as OpenStudio and Energy Plus are used as a tool to investigate this problem in conjunction with Sketchup.

There are several key findings from this investigation, mainly within the results section of this report. The simulation results portrayed a staggering 10% decrease in internal cooling loads and up to 4% decrease in total electricity consumption in the office. Furthermore, payback period was calculated to be approximately 42 months for a 8kW solar system, with a high return on investment of 26%. These calculations were also performed for 2kW, 4kW and 6kW systems to give a better overview of costs vs savings for the consumer as well as provide an array of options for investment.

Overall, this project proposes an effective measure to reduce the cooling load and energy consumption (in Sydney, Australia), thereby increasing air conditioning efficiency, reducing greenhouse gas emissions and validating the importance of PV panels in our day to day life.
The goal of this project is to design and build a wireless bioimpedance measurement device for use in the study of the relationship between systemic pH levels and bioimpedance. The intended device will operate as a “pHit-bit” with the potential to monitor a large range of pH altering conditions including athletes facing exhaustion (lactic acid build up), sleep apnea events (respiratory acidosis), extreme mood changes (respiratory alkalosis due to hyperventilation), asthma attacks (respiratory acidosis), and cardiac arrest (respiratory and/or metabolic acidosis). Bioimpedance analysis is a non-invasive and relatively quick method of body monitoring used for a variety of clinical condition assessments. Existing market options for the measurement of bioimpedance are heavy and costly technologies. This is due to equipment being designed to deliver a wide range of testing capabilities and thus being rather complex. To increase the ease of scientific studies relating to bioimpedance analysis, small, portable and wireless measuring devices need to be developed. Bioimpedance monitoring presents a gap in existing wearables technology waiting to be filled. To fill this gap, devices must be designed to meet a specific set of criteria to lessen their complexity. The developed prototype device is centered around an AD5933 high precision impedance converter and an Arduino Nano Development Board. At its current level of development, the prototype can produce a sine wave function between 1kHz - 100kHz, record the impedance responses and offer real time wireless data transfer up to approximately 10 meters. This translates to the capability of measuring impedances in the range of 100Ω to 10MΩ. The device is now ready for scientific validation.
Design and Prototype of a Water Pipe Inspection Robot- (12cp)
Corey Stewart - S17-085

Supervisor: Professor Gamini Dissanayake
Assessor: Associate Professor Jaime Valls Miro
Major: Mechanical and Mechatronic Engineering Major BE and BEdipEngPrac

It is generally recognized that about 70% of the worldwide asset base of urban water utilities consists of buried pipes. Critical pressure main systems, parts of which have been in service for over a century, constitute a large portion of these assets. With further ageing of these vital infrastructures, critical pipe failures will continue to occur resulting in very high-cost implications for the sustainability and effectiveness of water and services. In Australia, the total replacement costs of the pipe network are estimated to exceed AU$100 billion. Over the next five years, the costs of urgently needed asset replacement are around AU$5 billion. Maintenance costs over the same period are estimated at some AU$2.5 billion. Elsewhere, the USEPA estimates that the US public water sector will require US$335 billion of capital investment over the next 20 years to sustain essential service levels. US studies also indicate that the average cost per failure for large diameter pipes exceeds US$500,000.

In response to these cost drivers, and to meet demands for reliable water supply services, Sydney Water has engaged UTS to develop a Rapid Response Thickness Tool (R2T2) for internal condition assessment of critical pipes. R2T2 can rapidly assess large regions of pipes (>10 meters/hour) and is aimed at inspecting a water pipe as soon as a break occurs and before repairs are initiated. Data collected will make it possible to take action to avoid repeat breaks in the same region. The focus of this capstone thesis is the design and development of the sensor module used in R2T2. A number of concepts have been explored and a prototype has been built and evaluated in the lab as well as in the field. Based on extensive testing, a detailed design of a robust field deployable model has been completed and sent out for manufacture.
Deep Learning in Robotics - (12cp)
James Unicomb - S17-269

Supervisor: Professor Gamini Dissanayake
Assessor: Dr Ravindra Ranasinghe
Major: Mechanical Engineering Major BEBBus and BEBSc

Machine learning is a subfield of computer science that uses statistical techniques to give systems the ability to learn from data. The ease of use and development of hardware and software has made machine learning algorithms easily accessible, and it has lead to an increase of use in both research and industry. The contribution of work presents two applications that use machine learning for robot localization and control.

For monocular camera localization, we extract ground edges using a convolutional neural network. Use of the CNN makes it possible to extract ground plane edges under significant changes to scene illumination. We develop an algorithm for estimating the 6-DoF (Degrees of Freedom) position of a monocular camera in an indoor environment. The algorithm uses an Extended Kalman Filter (EKF) within the distance function framework, a constant velocity motion model, and a pre-built map with ground plane edges as features in the observation equation. The EKF can fuse information from any other sensors such as wheel encoders of inertial measurement units, if available, and reject spurious observations.

For autonomous control of a drone, data collected from a car with an expert driver and bike rider is used to train a network to steer and detect collisions. The network can generalize and is shown to be effective in environments not in the training data.
The construction industry is the backbone of the economy, and national development. The infrastructure created by this industry is indispensable, and continually seeks to improve the well-being of society through the provision of its goods and services.

Traditionally, the construction industry has been conservative, limiting their ability to innovate, and boost productivity. However, the industry's adoption of additive manufacturing has highlighted its commercial viability, and potential to revolutionise existing processes. This fabrication technique is explored due to its innate ability for non-conventional designs and scalability, especially in the areas of manufacturing and assembly. This trend complements the growing use of pre-fabricated or bespoke components for construction as it reduces costs in manufacturing and increases efficiency during assembly.

Manipulators have revolutionised industry, incorporating advances in technology to automate tasks, thus increasing productivity in laborious and repetitive processes that require high precision. Its prevalence in industry is shifting the role of a typical industrial manipulator to accommodate for novel tasks in construction, providing economic benefits where productivity is low, or where the safety of workers are compromised. However, the main impedance for technology adaptation is the low tolerance for mistakes, namely the significant time taken to manufacture parts, and material waste if mistakes do occur.

The addition of vision based sensing to additive manufacturing addresses these issues as it enables the system to perceive, and possess an awareness of the environment. This provides a means to influence future actions based upon higher level reasoning. Integrating this concept with fused deposition modeling, enables pre-planned trajectories to be altered online based upon the information ascertained to improve the manufactured structure.

This report encompasses an exploration of techniques used in image processing and mapping based upon an eye-in-hand configuration, and online manipulator control. The literature review examines methods implemented in research, constructing the basis of the experimentation conducted. The outcomes from the experimentation will be discussed, highlighting the significance of closed-loop control in automated fabrication for construction, and formulates the intended future works which aim to extend the possibilities of robotic fabrication.
Early detection of paint defects during vehicle manufacture leads to a reduction in costs, energy consumption and the number of vehicles that fail late-stage quality control tests. Automotive manufacturers including Ford, Volkswagen and BMW, have factories around the world currently using a system to autonomously detect defects in the paintwork of vehicles. This detection is done early on during manufacturing using an array of cameras and structured lighting. These defects are identified in each camera image and projected onto a 3D model of the vehicle so that workers can locate and fix the defects. To project these defects accurately onto the model, an accurate estimate of the position and orientation of the vehicle with respect to the camera array needs to be known. The current process finds a 2D transformation between each new image and a reference image for each camera. This transformation is applied to each defect before projecting it onto the 3D model. While the pose offset of the vehicle is a 3D transformation in the world frame, the current process can only give a 2D approximation in each camera image.

My work aims to provide an accurate, global estimate of the vehicle’s lateral rotation and translation on the conveyor belt using RGB images from the camera array and a CAD model of the vehicle. The system first extracts prominent edges from the RGB images of each camera. A cost function is formulated to minimise the distance between each pixel in these edge images and the projected surface of the CAD model. The transformation estimate from this optimization procedure is used to reproject the 3D model back into the RGB images at every iteration. The system repeats this process until a final rotation and translation estimate has been found. The system is evaluated on simulated data and real-world images from the manufacturing plants.
The Exploration, Design, and Experimentation of Solar Concentration and Tracking Systems. - (12cp)
Thang Nguyen - S17-054

Supervisor:  Professor Jianguo Zhu
Assessor: Dr Gang Lei
Major:  Mechanical Engineering Major BE and BEDipEngPrac

Most of the world’s current energy supply is generated via fossil fuels such as coal, oil and natural gas, with the ever-growing concerns over climate change, rising prices and constant tension between countries over the dependence of fossil fuel imports. Renewable processes like solar power generation is a great alternative to supply energy to the grid, which do not rely on the use of limited natural resources or fossil fuels for operations. With the emergence and advancements in home battery storage systems, this allows solar power processes to provide energy to the grid during high demand periods like peak hours or seasons. The reduction in the production of greenhouse emissions is achieved by relieving the operational hours and demand of fossil fueled power plants.

As the efficiency of solar cells increase over the progressive decades, coupled with the gradual decrease in cost of manufacturing. The way we harness solar radiation should be explored in a broader context, many intricate and complex designs have been engineered but none are commercially viable for household integration. For a unit to be commercially viable, a more efficient way of collecting energy through photovoltaics is required to effectively maximize the collection of solar irradiance.

The project explores and examines existing solar concentrating collector and tracking technologies to produce a prototype that demonstrates the final designs concept. A full documentation of the research and development process is supplied in the report. The project aims to provide a viable solution that will relieve growing energy fees on the average household whilst reducing the production of greenhouse emissions.
The Analysis of Fire Protection Systems in Buildings with a Focus on the Further
Development of Fire/Smoke Curtains- (12cp)
Jonathon Lamotta - S17-091

Supervisor: Dr Zhen Luo
Assessor: Associate Professor JC Ji
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Fire protection systems are vital to the safety of the people and inhabitants of the buildings that they are installed in. With the fire engineering industry increasing, and with fire safety being more important than ever, it is essential that technology in this discipline is constantly developed.

This project aims to analyse current fire protection systems in commercial buildings, particularly fire and smoke curtains. Through this analysis, a number of downfalls and common causes of the failures of fire/smoke curtain systems, have been identified. In most of these instances, these failures could be prevented.

Obstructions are one of the main causes contributing to the failure of fire/smoke curtain systems. The exploration of this issue has led to the development of a device which senses, detects, and notifies building occupants to remove obstructions which are in the deployment path of the fire/smoke curtain. The implementation of this autonomous device to new, and existing fire/smoke curtain systems, greatly reduces the chances of system failure in the event of a fire – meaning that it could potentially save lives. A prototype has been created and developed with the aim of providing a solution that is economically viable, can be easily installed to any system, and is aesthetically pleasing – something that is not currently present in the market.

The ultimate goal is to develop the sensing device to a point where it provides maximum range and coverage of the space in the deployment path of the curtain. Once the device is capable of this, the aim is that it can then be retrofitted to work with all system types, in conjunction with any existing size fire/smoke curtain, or installed as part of a new system.
Integrating Hydraulic & Regenerative Brake Systems on Electric Vehicles - (12cp)
Daniel La Mela - S17-058

Supervisor: Mr. Jon O'Neill
Assessor: Dr Terry Brown
Major: Mechanical Engineering Major BE and BEDipEngPrac

Energy generated through slowing down any vehicle is energy dissipated by heat and noise, lost to the system. In Formula SAE, fuel and energy usage has always had a major influence on points. Creating an efficient system without the loss of performance has become a major design goal for any team.

The conversion of UTS Motorsports from internal combustion to electrical motors has seen the team earn its first trophies in their entire competition history, winning Efficiency. The concept of the team is to increase the speed of the car, thereby decreasing lap times, garnering more points during the dynamic events of the competition without sacrificing efficiency of the battery pack. Implementing regenerative braking into the vehicle will allow for the vehicle to recapture energy and either have a lighter accumulator or tune the vehicle to draw more current to go faster without increasing energy usage.

Formula SAE have regulations that dictate the use of regenerative braking and its interaction with the hydraulic brake system. The issue therefore arises with the UTS Motorsports team who utilize single motor rear wheel power application with four-wheel braking, in which the hydraulic system must be separated into two separate systems, in the case of UTS Motorsports, front and rear hydraulic circuits.

Utilising first principles of energy and motion, simulations will demonstrate the advantages to be gained if brake regeneration were to be implemented into the vehicle. A solution for the brake application is a simple mechanism that allows the front brakes to be applied in conjunction with the rear regenerative brakes, before the application of the rear hydraulic brakes, maintaining vehicle stability throughout the braking zone.
Science, Technology, Engineering and Mathematics have become almost essential to living and functioning as a member of society in Australia and schools have been encouraged to incorporate STEM learning into their curriculums. However, there has been an increasing skills gap for the engineering and science industries since the late 1990s. This is counter intuitive to the importance placed on STEM through the education system. This work hypothesises the gap is perpetuated through stereotypes which can be challenged through experts engaging with students rather than presenting content alone without context.

A primary school program was developed to investigate a way to counter the damaging stereotypes that discourage children from pursuing careers in STEM and to think that these areas are uninteresting, career limiting and only for 'smart’ students.

The program encourages students to think differently about STEM and challenge these stereotypes to redefine their understanding to incorporate creativity, empathy, strategy and fun as apart of STEM. This was done through a simulated engineering experience where the students created a solution to a design problem with the assistance of industry representatives who acted as mentors, to provide expertise and break down barriers preventing and limiting the skills of students pursuing STEM.

The hypothesis was proven in part as the teachers and industry representatives responded to the program incredibly well with the aims of the program being exceeded and the majority of students indicating a complete positive change in perspective. The difficulty was in the logistics of the program and the changes in the original plan due to classroom needs and time constraints, which caused limited testing of the hypothesis.
Daily Activity Classification based on Machine Learning Techniques - (12cp)
Zhengjie Huang - A18-403

Supervisor: Dr Yi Zhang
Assessor: Dr Junyu Xuan
Major: C22028 Exchange undergraduate

The continuing increase in longevity is leading to a significant rise in the ratio of old-age dependency. It is estimated that 20% of the world population will be over 60 years old by 2050. As the accessibility of robust sensors increases, the smart home is becoming a solution to help monitor the health condition and intervention of the old.

This project aims to construct an intelligent system for classifying daily activities based on smart home-related sensor data. The system includes three parts. A data pre-processing model is developed to conduct data collection and feature extraction. A daily activity classification model follows, in which a neural network-based classification model is used to classify data samples based on knowledge learned from a training dataset. Then, a data visualization model is developed to display analytic results, including both classification outputs and pre-processed data samples. Comparative experiments are designed to examine the performance of the proposed system, with certain existing classification methods, including a hidden Markov algorithm, a conditional random field algorithm, and a naïve Bayesian algorithm. The results demonstrate that the system not only can conduct the task of daily activity classification with a satisfied accuracy but also can be used in setting-generalized environments which paved the way for its commercialization.
Artificial Intelligence for Cancer Treatment and Diagnosis-(12cp)
Juan Martinez De La Pedraja Garcia - SU17-031

Supervisor: Associate Professor Paul Kennedy
Assessor: Dr Jinyan Li
Major: C22028 Exchange undergraduate

Currently, according to some estimates diagnostic errors contribute to approximately 10 percent of patient deaths, which explains the interest in incorporating new technologies into this process. With the significant developments made in the last decades, Artificial Intelligence (AI) has arguably become a good candidate for this task. Specifically, our project involves using Machine Learning (a subfield of AI) to improve childhood cancer treatment and diagnosis.

We will focus on Acute Lymphoblastic Leukemia (ALL), the most common type of pediatric cancer with around 300 yearly diagnoses in Australia. ALL affects the bone marrow, which is responsible for making blood cells, and is characterized by an overproduction of immature white blood cells called lymphoblasts. As a result, normal blood cells namely white blood cells, red blood cells and platelets are crowded out. Insufficient numbers of these cells lead to greater risk of infection, anemia and easy bleeding and bruising respectively.

In ALL, relapse decreases the chances of survival as standard chemotherapy becomes ineffective. Thus, modified therapy is needed for patients with high risk of relapse. In this project, we explore the use of Machine Learning to accurately predict relapse, which would ultimately result in better treatment. This study will be based on a dataset containing genetic information, which will be the basis for predictions, and cancer outcome (relapse/mortality) of about 150 patients.

The low number of samples, combined with the high proportion of non-relapse cases, means there are very few relapse examples, which complicates finding meaningful patterns to make accurate predictions. Furthermore, high dimensionality creates difficulties when trying to achieve generalizable solutions. To address these challenges, we explore the use of biased classifiers, particularly sparse linear methods; dimensionality reduction techniques, such as PCA and Autoencoders; ensemble approaches, especially bagging; resampling methods and neural networks.
Distributed Threat Intelligence Using Cloud Based Malware Protection Platforms- (12cp)
Uyen La - S17-271

Supervisor: Professor Ren Ping Liu
Assessor: Dr Priyadarsi Nanda
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

With the increasing adoption of technology in our lives, the data and information we generate through our daily interactions is a commodity that must be factored when exploring how we secure our personal and business data. This digital information we create needs to be secured to prevent malicious actors gaining unauthorised access. Distributed or ‘cloud’ computing has expanded the attack surface that threat actors can take advantage of, but also offers an opportunity to apply greater computing power into gathering threat intelligence when compared to traditional on-premise deployments.

Malware, a family of malicious software designed to undermine the confidentiality, integrity and availability of computer systems are one of the tools used by threat actors to compromise our data and information.

This project explores malware and defence systems used to develop threat intelligence that can be used to mitigate these attacks. The methods and tools available for a security engineer to collect, identify, process and action information gathered from malware threats are specialised and require technical skills to deploy into a production environment. This factor means that there has been low adoption of these tools to detect malware threats.

Developing a prototype system that utilises aspects of the threat intelligence gathering cycle has provided insights into the effectiveness of current methods of data collection and processing malware samples. Applying a distributed threat intelligence model can provide better defence against emerging threats.

This prototype composed of honeypots; threat collection sensors designed to as decoy devices on a computer network act as the gather point for malicious activity and detection software to classify the threats, provides a baseline understanding of the individual threat posed by a single action. Further processing and analysis of these events using distributed computing has allowed me to explore areas of improvement that can be applied in production environments.
Additive Manufacturing (AM) has made an immense impact on today’s manufacturing industry by opening more avenues for businesses; whether it be in the prototyping of niche designs, or in the manufacturing of usable spare parts and products for consumers.

The use of 3D printing in the process of product manufacturing is relatively minimal in comparison to use in prototyping and concept proofing. Exploring new techniques such as 5-axis 3D printing could potentially shift the scales in favor of product manufacturing as the technology develops.

The core aim of this project is to investigate and measure the benefits that can be gained by taking a conventional 3-axis printing configuration to a 5-axis one. The project will test and compare printed parts in both 3-axis and 5-axis to measure the differences in variables such as material usage, time to print and material strength. Simultaneously, it will explore whether the increased slicing complexity of the system is worth the increased performance.

The project consists of three major phases, the first being the design and build of a large volume print bed which included the addition of a new z-axis and various other mechanical modifications to increase the strength and stability of the setup. The second phase consists the use of mathematical modeling techniques to compensate for an origin shift induced by the distance that the bed was off-set from its instantaneous center of rotation. Finally, the third phase involved the testing and evaluation to compare components printed in both 3-axis and 5-axis to analyze what benefits could be gained.

The project is implemented on the Flexifab platform which allows flexibility and modularity in its design. It will allow future research to be conducted with different combinations of materials and dimensions (3D – 5D) to further explore the benefits they can bring to the table.
Design and Build of a Reflectance Transformation Imaging Apparatus (12cp)
Phillip Thien Le-Nguyen - S17-154

Supervisor: Dr Michael Behrens
Assessor: Mr. Guido Ranzuglia
Major: Mechanical Engineering Major BE and BEDipEngPrac

Over the past decade, there has been a notable influx in the demand for 3D printing. Converting an intangible digital model into a solid physical object is now an affordable and simple process. Contrastingly, reflectance transformation imaging (RTI) and photogrammetry allow for this transference of a physical object into a digital model. The capability to digitise a subject can be valuable for a multitude of applications within areas such as, re-engineering, manufacturing, archiving, analysing, visualising and re-animating the subject.

RTI is a light-based method that exploits the subject’s surface texture to highlight the subject’s intricate details. This feature allows it to be implemented extensively in fields of palaeontology, anthropology, and archaeology for the examination of artefacts. However, limitations to using RTI found that it can only capture two-dimensional perspectives of its subject, hence limiting the potential functionality. To overcome RTI’s inability to capture three-dimensional perspectives, photogrammetry has been employed. Photogrammetry is a three-dimensional reconstruction process capable of producing a three-dimensional mesh of the photographed subject. In recent years, the process of photogrammetry has developed a following amongst hobbyists, innovators, and manufacturers alike due to its open-source availability and ease of use. However, these free open-source softwares that are available to the public, can only produce an inaccurate mesh of low-level resolution in comparison to techniques using expensive laser equipment or proprietary digital reconstruction softwares used in the industry.

The main objective is to design and manufacture a scanning device that combines the surface texture mapping precision of the RTI along with the three-dimensional reconstruction capabilities of photogrammetry to produce an accurate, high-resolution, three-dimensional digital model. The rig is to be constructed at a lower cost compared to current scanning devices used in the industry with the intent of being commercially accessible, as well as, being portable so it can be applied in various applications.
Labelling Basketball Videos - (12cp)  
Rynaldo Zuhri - A16-049  

Supervisor: Dr Min Xu  
Assessor: Dr Zenon Chaczko  
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac  

Computer vision has become an integral part in our society. Many applications including video surveillance, face recognition, robots, drones and autonomous cars incorporates some form of computer vision. Central to many of these applications are visual recognition tasks such as image classification, localisation and detection.

Recent advances in object detection are driven by the success of a deep learning technique called region-based convolutional neural networks (R-CNN). R-CNN involves scanning an input image for possible objects using an algorithm called Selective Search, which in turn generates region proposals. Features are extracted from these region proposals and classified. Faster R-CNN is an extension of the R-CNN method with the main difference being how regions are selected to be processed and classified.

The goal of the project is to utilise the Faster R-CNN deep learning method to basketball videos for the purpose of ball detection and tracking, player detection and tracking, and player identification. Basketball games have highly non-linear target distributions with varying number of objects. Players in the same team are always visually similar and players often interact with others in complex ways. This project aims to solve this object identification problem using the Faster R-CNN method and to determine its viability and accuracy.

Basketball is an increasingly popular sport watched and played by millions of people around the world. Given the tremendous growth of this sport, this project can greatly improve the viewing experience for audiences. The development of multimedia computing and artificial intelligence technologies would support intelligent sport video analysis that are added real-time to live video broadcast, score detection and highlight video generation. Additionally, sports analytics would greatly improve as automatic player detection and tracking is critical for team tactics and player activity analysis.
Design of a Torque Sensor Calibration Device- (12cp)
Jacob Delailoa - S17-147

Supervisor: Dr Paul Walker
Assessor: Mr. Chris Chapman
Major: Mechanical Engineering Major BE and BEDipEngPrac

One aspect of measuring devices, that is often overlooked by the general public, is that they need to be calibrated either once at the beginning of there life or multiple times throughout the lifetime of the device. If not done correctly if at all the measuring device will not perform its designed function accurately and as a result any work performed with it will be inaccurate and/or faulty.

Within the university there is a need and a use for strain gauge torque sensors, whether it be for teaching or research purposes it is critical that these devices perform there function correctly and accurately. For them to do this they must be properly calibrated.

Calibration, in short, is the comparison of a known measurement with a measuring device and then setting up that measuring device to read the correct measurement when up against the known value. In our situation this means that the torque sensor will need to be supplied with a known torque, this is the basics of what the device will need to achieve, supply a known torque to a shaft with a strain gauge torque sensor fitted.

My project is the design of this flexible torque sensor calibration device, in which I employ various design and engineering techniques to create an innovative solution to the problem presented and meet all the nuanced requirements. Including be usable for many sizes of shaft and sensor, be able to apply varying and known torques as well as be practical to use. The device will fill an important role within the university and make calibrating torque sensors easier and more accurate.
A Study of Stepped Airfoils - (12cp)
Duc Bui – S17-064

Supervisor: Dr. Phuoc Huynh
Assessor: Dr. Ha Pham
Major: Mechanical Engineering Major BE and BEDipEngPrac

Since the advent of successful aviation, researchers have been constantly finding ways to enhance the overall performance of air flow over Airfoils and Aircrafts. Investigating characteristics such as lift, drag and stability has resulted in several designs and innovation in aviation. Kline and Fogleman have designed the stepped airfoils called KF-m. According to the research, the KF-m airfoil is designed to travel at low speed. However, when the angle of attack is high the wing becomes susceptible to stalling. In capstone B, I and my other group members: Jason Duong and Will Pau consider whether there are any benefits in utilizing stepped airfoils and the efficiency of the design under different angle of attack using both methods: experimental and computational. So far, our group has come up with four models: RG-15, KFm-1, KFm-2, and KFm-4. The models were designed by using SOLIDWORK and printed off by using 3D printer in UTS’s lab. Within a team, we are sharing all the ideas and information and all the data are collected from each member’s work to make up the final report. Each group member’s contribution is as below:

I have done the computational work by using ANSYS CFD for all models. Furthermore, the software provided us with lots of information and all the necessary data are collected for lift and drag of each airfoil against different angle of attack. Furthermore, the design models are printed off and ready for testing. In the experimental work, Jason..Duong and Will. Pau will also do KFm-2 and KFm-4 and I will do KFm-1. At present, we are still waiting to do tests using a Wind Tunnel. However, this work is delayed due to the construction of the Wind Tunnel instruments. Again, we are ready to conduct the experiments in the coming weeks.

In the conclusion, I believe this study will potentially bring benefits to the commercial Aircraft market.
Factors Affecting Quality of HVAC Services and their Energy Requirements in Residential Buildings - (12cp)
Manpreet Singh - S17-289

Supervisor: Dr Phuoc Huynh
Assessor: Dr Ha Pham
Major: Mechanical Engineering Major BE and BEDipEngPrac

With increase in Urbanisation over the past decade, the number of residential buildings in the big cities is increasing as well. There is a vital need to make sure that these buildings provide good living conditions to the residents. HVAC services play an important role in providing those conditions. It is a necessity for these residential buildings to have HVAC (Heating, Ventilation and Air-Conditioning) services that ensure a supply of pollutants/chemical free air, while at the same time making sure that the system is not consuming too much energy, which would satisfy the Sustainability factor as well.

The purpose of this report is to identify the types of pollutants in the atmosphere, while also taking into account the varying climatic conditions over the past couple of decades. The focus is to obtain the climate data for past 2/3 decades and use CAMEL software to calculate the energy requirements over those time periods and compare them with the current requirements. Following which, some ways to improve/reduce the energy requirements would be suggested, the data from camel will be very helpful with this, as the material and specifications of houses/buildings can be edited and compared in it.

The second goal would be to extensively study articles published by AIRAH to explore various pollutants present in the atmosphere, the types of diseases that they can spread and the harm that those pollutants can cause to the HVAC equipment (like shortening the lifespan). Following which, study of the current methods, of treatment/purification process of the outside air before it enters in a building and also study of the methods of securing/protecting the equipment from the pollutants, will be performed and new/improved methods would be suggested. This study can help bring sustainable solutions in the industry of building services.
Pressure and Flow Analysis of a Centrifugal Impeller - (12cp)
Steven Tran - S17-039

Supervisor: Dr Phuoc Huynh
Assessor: Dr Ha Pham
Major: Mechanical Engineering Major BE and BEDipEngPrac

Centrifugal fans are widely used in the industry to transfer air and gas through a ducted system. The manufacturing of different fans is based on previous models which follow the principle of similitude where fans share geometric, kinematic and dynamic similarity. Most impeller designs are achieved from empirical methods with experiments focusing on fan performance, however there is a lack of development in analysing the pressure and flow distribution through the impeller blades.

The main objective is to focus on the static pressure and flow generated by various blade shapes which will be analysed to build on our understanding on pressure distribution, and flow pattern. This is aimed by using CFD simulations to generate models and varying operating conditions to study the airflow through the impeller passages. The volute design remains constant as to focus on the blade design effects. To check the consistency of CFD simulations, I aim to construct and conduct tests on a base model. Pressure probes are fitted at different points along the impeller blade as well as the volute using a minimalised approach. Fitting probes on a rotating member has not been done as most pressure sensors are bulky or require constant connections which are impractical to fit on the impeller blades without impeding the flow.

The model is still under construction and I have yet to conduct experiments to compare simulated and experimental results.
Effective and efficient maintenance of rolling stock (trains) is a difficult task with many variables, that requires significant planning. This planning must be informed with quality information, in order to make justifiable decisions. As the train is a complex machine, there are many different components from different suppliers, with ranging levels of information available. Combined with an uncontrollable operating environment it is difficult to accurately predict the effective life of a component, which leads to a maintenance plan relying on extrapolation and estimations.

If you attempt to account for worst case scenarios, you would be replacing componentry excessively, limiting the utilisation of the components service life. Each component will have a unique service life, regardless of tolerance at manufacture. To make reliable and accurate predictions on each components service life, real time information, of that unique component, is required.

Condition monitoring is a method of providing useful and dynamic information, enabling informed decisions. Condition monitoring utilises sensors in order to track changes in relevant parameters of componentry, such as: temperature, vibration, pressure, speed, current or voltage. This data can be processed and analysed to produce accurate, high resolution predictions of componentry service life.

My research explores condition monitoring within the context of Sydney Trains, Fleet Maintenance. Within my thesis, I will:

- Demonstrate basic proof of concept analysis, using existing data from on-board systems,
- Identify barriers to implementation of condition monitoring,
- Discuss how evolving technologies are making condition monitoring more achievable,
- Outline data collection, handling and storage, and
- Explore non-technical aspects important to extracting value from a condition monitoring system.
Development of an Assistive Intelligent Weight Lifting Apparatus- (12cp)
Anthony Leo - S17-094

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

The increase in all-day access gyms across Australia has led to the increase in unsupervised hours where people are performing high-risk weight lifting activities. To minimise the possibility of injuries, a personal trainer would be required to provide continuous support and supervision of each individual within the gym. However, the resources required to accomplish this is infeasible. To work towards the goal of providing a safe, injury-free workout environment, I have developed an assistive, intelligent, weight lifting apparatus. This system provides unobtrusive, continuous supervision of the user with the capability of safety-locking the lifting bar should the user exhibit unsafe lifting practices.

Machine learning is a subfield in computer science using statistical values we can give the system the ability to learn from the data produced within its environment. Support vector machines are supervised learning models which analyses classifications and mathematically draws a line between different classes which can pre-emptively identify weather the user fails or not when lifting.

Programming systematic failure conditions in both Arduino and MATLAB using the user’s inputs from the sensor-fusion between a 9-axis IMU sensor which measures acceleration, tilt and bearing. With the Kinect sensor which gives rgb colour, depth imaging and skeleton/ joint tracking. Leading to the design of algorithms utilizing the varied inputs processed in MATLAB to identify input patterns that will flag the mechatronic weight lifting rig to activate the electromagnetic braking which this has not been done before in the current market. Using the afar mentioned techniques the electromagnet engages when a failure condition is met thus immobilizing the weight safely and protecting the user from injury. The result of this study will show proof of how mechatronics can better everyday activities to improve health and wellbeing.
Ritesh Kumar - S17-095

Supervisor: Associate Professor Shoudong Huang
Assessor: Dr Liang Zhao
Major: Mechanical and Mechatronic Engineering Major BE and BEDipEngPrac

Commercial and personal applications of Micro Aerial Vehicles (MAV) are widening, and thus there has been growing interest in aerial robotics from researchers, industry and consumers in recent times. Such applications of aerial robotics include search & rescue operations, monitoring and exploration. To fully realise the potential of MAVs in applications highlighted above, MAVs must be able to operate autonomously and explore unknown and Global Positioning System (GPS) denied environments while dynamically avoiding obstacles.

Autonomous flight remains an active area of research as there are numerous challenges to be addressed. One such challenge is the development of an optimal sensor suite and computation unit capable of performing real-time dense mapping. Monocular camera and an inertial measurement unit (IMU) is the minimally viable sensor suite required for mapping and localisation to enable autonomous flight.

This project aims to design and develop a mapping platform which consists of a visual inertial sensor suite and Graphical Processing Unit (GPU) for mapping on micro aerial vehicles. The scope of works is limited to handheld mapping platform which would enable researchers at UTS: CAS (Centre of Autonomous Systems) to log data, develop and evaluate their algorithms while eliminating risks associated with utilising a MAV. The developed solution features a Nvidia Jetson TX 2, USB 3.0 Point Grey camera, DJI A3 flight controller, and Robotic Operating System (ROS) framework which is widely utilised in robotics research community.

The content of this report details the component selection, development of the handheld unit and the overall system integration. Supported by initial literature review, which examines current approaches for real-time mapping and localisation, and similar systems. System evaluation against the set objectives is discussed, followed by recommendations to improve system capabilities and utilising this body of work for future works of developing a MAV mountable mapping platform.
MyCourse Enrolment Template - (12cp)
Levina Wong - S17-106

Supervisor: Mr. Chris Wong
Assessor: Dr Xiaoying Kong
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

The UTS FEIT course templates are entirely dependent on the subject and course information stored in the UTS systems and how this information is stored. Currently, there is no auto-generated FEIT course templates as the UTS staff are required to manually create these. Furthermore, this means that when a subject, major or course is updated or altered, staff must iterate through all affected templates to ensure they are correct and subsequently republish these templates to UTS Online for public access. This is a time consuming and inefficient technique and our aim is to recreate how the subject and course information is stored as well as simplify modifications of templates by automating changes throughout the system.

The project focuses on three main components, the data, application and user interface. These components can be translated into our three-tiered architecture that implements a data layer, application logic layer and interface layer. This project uses an agile iterative process that incorporates feedback from the curriculum administration to ensure that the system meets the evolving requirements.

Due to the restricted nature and security constraints of some of the information required for the project, the collection and organisation of data was largely manually completed through what was provided to us by staff and what was publicly available online. This data has been stored in a SQL database that we have also created. To view, modify and update this data, an application programming interface (API) was created with a RESTful architecture. The purpose of this is so that our system can be easily integrated and reused. The user interface which is connected to the database through the API, is the third component. This is where users can view and edit the FEIT course templates as well as access and modify data as required. Modifications are saved in the database and as result allow for an automated course enrolment template system.
MyCourse UTS FEIT Course Templates – (12cp)
Tess Dunlop- S17-089

Supervisor: Mr. Chris Wong
Assessor: Dr Xiaoying Kong
Major: ICT Engineering major BE(Hons), BE(Hons) DipProfEngPrac

MyCourse is a new online system that gives the UTS admin staff, students and prospective students the ability to view course, major, choice and subject information. Currently the FEIT course templates are manually generated by copying and pasting subject information into different excel sheets each representing a course. This process can be long and tedious especially when there is a need to change the information of one subject. To do this the admin staff need to find every course template where that subject is featured and copy and paste the new information into that template.

The MyCourse system aims to automate these processes using a RESTful API backend and a SQL database built behind a web user interface which allows the admin staff to edit subjects or any other information just once and have the changes automatically appear on all the affected templates. The project design components can be translated into our three-tiered architecture that implements a data layer, application logic layer and interface layer. This project uses an agile iterative process that incorporates feedback from the curriculum administration to ensure that the system meets the evolving requirements.

When developing MyCourse we were faced with a few security restraints in relation to UTS data access which was required to create our database. To overcome this, we were required to do a large scale data scrapping of all the information we could find online. This was assisted through online tools but was mainly done through manual data entry. This data was then stored in the SQL database which was used as the main source of data to generate the automated course templates.

The modularity and implementation of web APIs throughout the system was done with the purpose of maintaining easy future integration and reuse. The user interface which is connected to the database through the API, is a component that can be easily changed or modified in the future. It also allows for easier integration with existing programs and software that is currently in use by UTS admin staff such as CASS.
Development of a Robotic End Effector for the Removal of Wine Barrel Bungs to Automate Wine Testing and Monitoring - (12cp)

Cameron Andrew - S17-082

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

Wine making is a fine art that requires huge amounts of experience and dedication. The art of wine making has largely adhered to its traditional roots, which has meant that the industry has largely relied on manual production processes.

During the wine making process barrels are stored for extended periods to age, periodically the wine is tested to ensure that it is developing correctly. It is at this time that wine makers need to go through the onerous task of removing the silicon bung that seals wine barrels. Traditionally the bung is removed manually by hand by the wine maker, proving even more difficult if the barrel is in a difficult place to reach such as the wine barrel storage racks.

A solution to automating the removal of the bung is to use a robotic manipulator with a specially designed end effector. As there is already a number of suitable manipulators on the market, it was the purpose of this capstone to develop an end-effector that could remove the bung reliably and efficiently. This began with the process of testing the theoretical forces required for the bung removal and then went on to prototyping and testing. Through the project two prototypes were made and tested with the final optimized iteration of the design taking place as a 3D model.

The developed end effector was demonstrated to successfully remove the bung from the wine barrel with consistency, while maintaining a physical design that met the criteria of the environment it will be operating in.
Visual Positioning for a Wine Barrel Bung Gripping Device- (12cp)
James Chuter - A17-165

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

The Australian wine industry is expanding significantly due to increased demand for export products. This has led a market leader, Penfolds, to investigate the opportunity of automation in wine processing. Historically, wine processing has been a manual and laborious task focused on tradition and craftsmanship; however, this change in market demand has influenced the shift to automation. Automated monitoring and adjustment of the wine fermentation process will improve the cost effectiveness and increase the production capacity.

Part of the processing involves the removal and replacement of the wine barrel sealing bung. A mechanical gripper, for a robotic manipulator end effector tooling, has been developed to perform this task. This current project involves the investigation and development of a visual positioning system to autonomously localise the manipulator and mechanical gripper in the desired position to perform the process.

The visual positioning system uses ellipse detection algorithms based on optimised Hough Transforms to identify the barrel’s bung hole in an image. Localisation of the gripping device is performed by calculating the geometrical error between the seen ellipse in the image and the circular form of the bung hole in the target image. Robotic manipulation is performed to minimise this error and correctly position the gripping device.

The addition of automated visual positioning of the gripping device will allow future development to fully automate the bung removal and replacement process.

The full feedback system, including image processing and robot control, has been implemented for a Sawyer manipulator and FLIR Blackfly camera using MATLAB’s Robotics System Toolbox and Rethink Robotics’ Intera Software Development Kit.
Exploring how 3D printing can enhance and augment traditional manufacturing processes.

Over the last few years, the manufacturing industry has begun to see a major shift, as new technologies force growth from traditional means of production. This introduction of the digital age creates new capabilities in process and production, which can evidently be seen with the introduction of additive manufacturing. Additive manufacturing, more commonly understood as 3D printing, has begun to show its immense impact on each stage of the product life cycle.

The intent of this project is to investigate how it would be possible to use available 3D printing technologies to improve or enhance the thermoforming manufacturing process. The thermoforming, and more specifically vacuum forming process, is a tried and tested manufacturing technique that has been widely utilised since the 1960’s. The limitations of vacuum forming as a modern manufacturing process are typically due to the costly method of producing the tooling moulds and patterns used for the practice. Resolving this would potentially enable manufacturing companies to extend their production abilities further with low or on demand production runs and just in time engineering.

This project explored if it is currently feasible to update the costly, and often labour-intensive process of mould production using additive manufacturing. The progress developed throughout this project has led to an increased understanding of how currently available, inexpensive 3D printed materials react in an industry standard manufacturing environment. Understanding of the process and requirements for success has been achieved through physical testing on industry standard machinery. This project required extensive modification of a low-cost desktop 3D printer to allow for budget materials to be printed and used as a suitable means of vacuum forming tool production. These moulds have been optimised and tested alongside currently existing materials to understand their limitations and feasibility.
Redesigning a Teaching Rig to Improve the Student Learning Experience in the UTS Subject Dynamics and Control - (12cp)

Anthony Burgess - S17-305

Supervisor: Dr Marc Carmichael
Assessor: Dr Terry Brown
Major: Mechanical Engineering Major BEBBus and BEBSc

The challenge of teaching students difficult concepts in engineering has been present for many years. Control theory in particular has been misunderstood by many engineering students around the world. This project sought to address this challenge with the UTS subject ‘Dynamics and Control’ by redesigning an existing teaching rig to improve the student learning experience.

This study involved deriving the transfer function of the teaching rig to be able to build a user interface to demonstrate in class the various concepts of PID control. This study required incorporating analytical, numerical and experimental techniques to find the mathematical model of teaching rig, this mathematical model was then transformed into the Laplace domain to find the transfer function of the overall rig. A graphical user interface was developed using the language ‘Python’ to allow the rig to be controlled to show the various aspects of control engineering covered in this topic.

The project was planned in such a way that the teaching rig user interface can be simply implemented, and with the intention to be an open source project in the future. The open source direction is to encourage engineering students to build a similar rig to help them understand control theory.
Development of Microgravity Instrument for Astrobiology & Regenerative Medicine (12cp)
Anthony Kirollos - SU17-050

Supervisor: Dr Joshua Chou
Assessor: Dr Gyorgy Hutvagner
Major: Biomedical Engineering Major BE and BEDipEngPrac

Gravity has many important effects on cells and introducing microgravity allows scientists new way to study cell-micro and mecahnobiology. The lack of gravity leads to different intra- and inter-cellular communications by altering genetic expression, cell growth and shape and mechanosensitivity effects to name a few. How cells and tissues adapt to the microgravity environment is crucial in humanity’s effort to travel in space for extended periods. However not all research and experiments can be performed in space and therefore mimicking space conditions on earth is ever more crucial.

This project aims to develop a random positioning machine (RPM) instrument that will provide continuous random change in orientation relative to the gravity vector. The RPM will generate effects similar or comparable to the effect of true microgravity and this will be used to study the response of cells. In addition, algorithms will be developed to mimic the different gravities from different planets. The parts and components to the instrument will be designed using CAD software, in addition to the UTS Protospace to 3D print the components and assemble the device together. The cellular response will be tested on either bone cells or cancer cells to study the effects of the RPM on cellular response. This project represents the challenges and excitement of modern biomedical engineering and combines them with a modern scientific approach allowing for an overlap in disciplines.
In recent years, different types of security and service robot or system have been developed and introduced in various fields, especially for the indoor case, where the exploration of those automation systems not only improve the quality of our lives but also bring safety and convenience, assisting people to create a more convenient living space.

The objective of my project is to develop a gas detector robot, which will help aging group, who have a relatively higher risk to suffer hazardous events than normal people, to detect the hazardous gases. Most of the existed household detectors are fixed in one certain place on the wall or at a corner, which always causes some delays from the gas arisen to being detected. However, a robot will monitor the air condition of the entire house and detect the harmful gas more rapidly.

The system contains two main parts. First, the car will be based in a remote car equipped with an obstacle-avoiding system and Wi-Fi module to enable it to cruise at home automatically without a cable or manual control. The car will be controlled by an Arduino Board.

Second, an electronic nose module (also known as E-nose) will be mounted in the car to take samples and recognize the hazardous gases. For the gas classification, I mainly used Principle Component Analysis and Support Vector Machine algorithm. During the self-navigation, this E-nose will take samples and analyze them. Take inflammable gas ethanol for example, if there is a jar of ethanol or alcohol spilled, which make the concentration of ethanol over the threshold in that area. Hence, when the robot runs near the source, once it takes a sample, it will notice the hazardous gas here.
Biomedical signals are electrical signals that could be acquired from any physical activity of an organ. Electromyography (EMG) signal is a kind of biomedical signal that measured the electrical currents generated in the muscles due to the contraction and relaxation. Nowadays, the implementations of biomedical signal-based approach to diseases diagnosing were widely used in medical or hospitality. Variety of analysis tools were developed to improve the efficiency and accuracy of diagnosing diseases.

However, development of using EMG signal should be focusing on making the instruments and control system better in term of productivity or cost. The implementation of biomedical signals is important to data to improve any analysis to make a system better in functionality to benefit the industry. For example, the detection of the dynamic environment condition was used to implement a safety consideration for an industrial robot that causes risk in the workplace. As we came into the century of having better specification and accessibility of latest technology, the big data required more signal to be used to develop a better world.

This project will give a solution with control technique and performance analysis to improve the flexibility of implementing robots in the different sector such as manufacturing process that has not been automated yet. This may able to popularising the application of robot arms in manufacturing industries and improve the flexibility of control by replacing the mechanical controller.

Besides, this project will also show a brief analysis of different methods or techniques in detection, decomposition, processing and classification while designing a better controller. As classification process involve methods of machine learning, this project includes analysis of common machine learning methods that chose by other researchers, such as neural network, linear regression, and other. Hence, this project will offer the best effort for further development in the implementation of EMG signal into controlling devices.
Asthma Management - (12cp)
Krystal Tran - SU17-034

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

Asthma is a respiratory condition defined by the inflammation and narrowing of the airways impeding the breathing ability. Currently one of the leading challenges faced by asthma sufferers is management and health literacy. Unfortunately, society is restricted by gaps in health literacy, causing countless complications and impacting the efficacy of treatment through both asthmatics and their carers intertwined. The evolution of technology has manifested a significant aid to educational capabilities with an array of portable technological devices, incorporating the internet to provide a library of information. Digital literacy allows for user-friendly and greater accessibility of medical resources for a wide demographic. To overcome the limitations faced by sufferers and their careers, whilst utilizing technological development for its educational potential, it was appropriate to create a gaming application, aimed at a young target audience, to enable early learning and a strong foundation surrounding health literacy, regarding causation through to treatment.

This prototype design satisfies a variety of learning objectives whilst capturing the attention of children to fundamentally assist and enable them to manage their condition on their own. Through intensive research on literature, the concept formed addresses three main findings that were confirmed by a focus group.

1. The severity of asthma in children is dependent on the season.
2. The two locations where children spend their time daily are the school environment and outdoors.
3. Exercise is recommended to all individuals as it can improve the heart and lung function, and with proper management, it can be beneficial to children with asthma as well.

Incorporating the popularity of smartphone usage amongst children in this generation, this innovative concept could be the solution to minimizing and/ or eliminating the gaps in health literacy, educating sufferers and carers and more importantly improving their quality of life.
Application of Machine Learning in Classifying Near-Infrared Imaging of Different Colour of Spices- (12cp)
Rani Candra - S17-307

Supervisor:  Dr Steve Ling  
Assessor:  Associate Professor Steven Su  
Major:  Biomedical Engineering Major BE and BEDipEngPrac

The advancement of medical diagnostic has generated demands to determine the optical properties of bones and tissues, in the visible and infrared regions of a spectrum. Near-infrared imaging is considered as a relatively novel imaging technique in the medical industry. Equipped with high resolution of optical features, near-infrared camera offers the imaging solution to capture the near-infrared electromagnetic spectrum, as it has the ability to penetrate the object subject using a non-invasive technique.

As the utilisation of the near-infrared applications in medical industry is still emerging, it is known that near-infrared also provides a great deal of advantages in other industries, including the superiority to provide quick and precise data analysis in real time for a better decision making (Mills 2017). Moreover, as a reliable and modern technology, near-infrared only requires a little sample preparation and it does not need specific light conditions.

This capstone project will discuss the experimental techniques and resulting data on the optical properties of the powder spices. The near-infrared images, with the total of 110 images for each sample, were collected at the wavelength range of 745-950 nm, the wavelength of the near-infrared region. The data collected will then be pre-processed, extracted, and classified, in order to generate a machine learning technique to be able to classify the near-infrared colour differences. As the result of the project, the machine learning technique generated classification accuracy at approximately 85% based on the experimental products. In the future, the result of this study can be the foundation to develop more advanced near-infrared applications, especially in the medical industry.
Developing Online Learning Systems to Address Student Engagement - (12cp)
William Scuderi - SU17-035

Supervisor: Associate Professor Anne Gardner
Assessor: Professor Roger Hadgraft
Major: Mechanical Engineering Major BE and BEDipEngPrac

Learning is a social experience that puts the student at the centre. They become part of an ecosystem that includes their peers and instructors. For a student to progress through a course and make the most out of their time at university, they must make use of this ecosystem, by both accessing it and giving back to it. Without access to the greater student network, a student’s only source of progression at university is via their instructors. This limits the opportunity to build their own circle and develop non-technical skills that are welcomed by industry upon transitioning from university.

Current learning management systems used in educational institutions do not reflect the idea that learning is a social experience. The rise of social media has had an impact on other industries. An example of this is in e-commerce sites, where users share product and service reviews to the benefit of the next consumer. The delay in integrating social functionality into online learning platforms has resulted in a wide range of third party tools being adopted by students to allow them to meet the outcomes of their course. These include file sharing services, project management tools, communication tools and video services.

This project looks at the emerging learning management systems, both dedicated online platforms as well as third party tools, and critiques their functionality in a university setting. It then makes recommendations on the future state of online learning systems at UTS for undergraduate students through interviews with both students and instructors. Furthermore, the project outlines the collection of requirements of an online learning system that would be built today, and then details the process of developing such a system through an example web application that collects and displays student assessment marks as well as acting as a useful university communication tool.
Composite material components are becoming more prevalent in the automotive and aeronautical industries, due to the increased performance of the materials over traditional homogenous metals. However, only low volume production of simple geometric composite components is being achieved due to cost inefficiencies in complex part production. Also as many materials, techniques and processes are propriety information, current research and developments are often unavailable (Lawrence, Devillard & Advani 2004).

The main objective of this paper is to provide a foundation for the extension of design and use of composite materials for cost-effective complex part design and manufacture. To achieve this, the project demonstrates the design and manufacture of a weight optimised composite material wheel for a SAE race car. This includes the investigation of: topological optimisation of wheels; weight optimisation analysis of a wheel through utilising composite materials; cost analysis of composite manufacturing techniques; Resin Transfer Moulding (RTM) manufacturing; final prototype production; and validation testing. It is hypothesised: composite materials can be used to improve the design and manufacture of a weight optimised wheel for an FSAE race car that maintains the same mechanical properties as existing designs, while remaining cost effective for low volume prototyping.

Comparative testing of the prototype wheel with existing wheel designs has provided Finite Element Analysis (FEA) and physical testing results validating the beneficial anisotropic and mechanical properties of composites to achieve a weight optimised solution. Also, the adaptation of the RTM process has been used to demonstrate that a cost-effective complex component can be manufactured using composite materials.

This paper provides the proof of concept that will allow further research to be conducted on improving materials and manufacturing methods of composite materials to achieve cost effective wide spread adoption for complex part production.
Design and Testing of a Flexible Multilevel Power Converter Prototype - (12cp)
Ma. Cansino - S17-073

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In recent years, there has been an abundance of emerging applications that require power. In addition, there is an increasing demand for electrical energy for several residential and industrial applications like traction, medicine, mining, renewable energy integration, among others. Electrical energy can be converted into another form of energy such as heat, light and mechanical, etc. In this context, power electronics converters play a key role since they allow one to manipulate the electrical energy from a given source to meet the requirements of a particular application. Power electronics converters are very promising for power system applications, hence, the need to optimise the current power converter available in the market.

The motivation of this project is due to the lack of commercial availability of a flexible multilevel power converter prototype. The aim of this project is to optimise the current power converters to improve current research and development projects aimed at reducing power loss. Likewise, this project allows students, the industry and academic researchers to test new advanced control techniques. These control techniques could potentially improve the efficiency, performance, and reliability of power converters and improve the way we harness energy sources.

This project has incorporated two design topologies namely Neutral Point Clamped (NPC), and Flying Capacitor (FC). Those two design topologies were integrated into a single interchangeable power converter prototype.

This prototype will be experimentally tested in a 3kW Photovoltaic (PV) array emulator integrated to the electricity grid. Overall, the design flexibility reduces the cost of engineering multiple prototypes.