Faculty of Engineering
and Information Technology

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ABSTRACTS

CAPSTONE PROJECT PRESENTATIONS

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Coordinating Construction Activities Using Flow Line Scheduling (6cp)

Peter Antoniou -A12-006

Supervisor: Hiyam Al-Kilidar
Assessor: TBA
Major: Civil Engineering

As the complexity of construction projects increase the techniques facilitating activity coordination have largely remained governed by activity based scheduling (ABS). This methodology is mainly suited for scheduling projects containing discrete finite activities, which neglects taking into account complexities of construction projects where spatial complications and trade coordination requirements exist. This results in overly optimistic or unrealistic schedules which are difficult to monitor and control during the construction phase.

This project examines an alternative flow line scheduling (FLS) approach and comparatively analyses performance against ABS. The application of FLS in the Australian construction sector is investigated by modeling two real-world industrial projects of varying sizes that were scheduled using ABS. The capabilities of FLS allowed for the identification of clashes and provided opportunities to optimise workflow between construction locations. The theory assumes trades operate under a continuous production rate through construction zones which is determined through an iterative Last Planner System (LPS) process.

Using Vico Control 2009 software, the project models FLS from equivalent ABS to determine the reduction in schedule duration, probability of reaching planned completion and associated cost implications on the preconstruction schedule. This is achieved through schedule optimisation techniques and a comparison of ABS supported Project Evaluation and Review Technique (PERT) and FLS supported Monte Carlo Risk Simulation (MCRS) risk assessment techniques. Furthermore the model is extended into the project control and monitoring phase where an earned value analysis (EVA) is undertaken to evaluate the percentage variance in estimated cost at completion (ETC) and forecasted completion date.
An Interactive Media Tool for Developing English Literacy (12 cp)

Dominic Argente -S11-004

Supervisor: Lian Loke
Assessor: Julia Prior
Major: ICT (Software)

Literacy is a core life skill and is at the heart of basic education. In contemporary society, the importance of literacy has been recognised and its meaning has been expanded to encompass the core skills required by a person to function effectively within society. It goes beyond the ability to read fluently, encompassing more complex aspects of comprehension, analysis, synthesis of information, and the judgment of texts.

Teaching literacy has always presented a problem to educators and there currently is a push to integrate interactive technologies, such as tablet computers and mobile devices, to help support a child’s education. While most of these projects have focused on mathematics or phonetic and vocabulary development, there is a lack of applications aimed at mid-primary school level children. Ages 8 - 10 are particularly important years in literacy development, as there is a shift in “learning how to read” to “reading to learn” that many children do not cope with, resulting in the phenomenon known as the “Fourth Grade Slump”.

This project seeks to explore the use and development of interactive technologies in supporting a child’s literacy development and address the problem of the Fourth Grade Slump. It uses a multidisciplinary approach, using aspects of software engineering, interaction design and literacy education to create a developmentally appropriate application for children. The project will produce a proof of concept that will be implemented on an iPad iOS platform and discuss the implications of future educational app development.
Real Time Shape-Based Object Recognition and Learning Through Point Cloud Library (12cp)

William Bond -S11-006

Supervisor: Alen Alempijevic
Assessor: Nathan Kirchner
Major: Mechanical Mechatronic Engineering

Robotics are programmable to be capable of decisive thought, and so can be programmed to deal with a variable environment such as the real world. Sensing is a key factor in being able to analyse a real world scenario. Just as humans rely heavily on eyesight, one of the most interesting sensors available to robotics are visual sensors such as image, and infra-red. Devices like the Xbox Kinect sensor are capable of passing through a cloud of 3D virtual points – a point cloud.

Willow Garage has been creating an API that has many functions to extract data from an input of a point cloud. Using this API with the point cloud from the Kinect, it is possible to analyse an input cloud to determine viewable objects. A plane object separation function is run to find the nearest table surface, then all clusters of points that were within a specified range of the surface are stored as individual objects. These individual objects are looked at one by one to determine what that object is, and if it has been seen before. If the object is new, it is then learned into the system. If the object is recognised, the descriptors (length, width, height, basic type, location, orientation) of that object are relayed out of the program for use in other programs.

It has been found that with 99% accuracy, the objects basic shape type can be determined (box, cylinder, sphere, or other) by fitting basic object templates to the input object, and comparing the percentage fit.

Object learning allows the processing time for an input to be brought down, as the input does not have to be continually relearned. It has been found that an object will be remembered with 95% accuracy in the same or similar orientation. This means that all objects have the potential to be recognised and learned, increasing the robots efficiency and accuracy in object detection.
Characterising the Effects of Trampoline G-forces on the Human Body (12cp)

Kenneth Bondoc -S11-008

Supervisor: David Eager
Assessor: Chris Chapman
Major: Mechanical and Mechatronics

The hazards associated with trampoline usage have been extensively researched in biomechanics and within the product safety and injury prevention community. To-date little research has been published on the biomechanical benefits associated with trampoline usage. Apart from the obvious benefits associated with cardiovascular exercise, balance, muscle strength and reducing body mass there are a number of lesser-known benefits such as detoxification due to cyclical G-forces assisting the lymphatic system circulation.

The primary aim of this research project is to measure the cyclical G-force loading experienced by a trampoline user under various conditions to investigate what makes a trampoline ‘fun’. The experimental apparatus incorporates a tri-axial accelerometer system coupled with a high-speed camera to examine the correlation between G-force loading and displacement. Both G-force and displacement data are measured simultaneously in real time when triggered by the movement of the trampoline user.

G-force loading of two ‘control’ users is recorded on a variety of trampolines including the standard spring trampoline, multi-level spring trampoline and spring free trampoline. For each of these trampolines, the G-force loading is recorded on a number of different locations from the centre to the edge of the trampoline surface. Other variables measured include variation in participant weight and jumping form. The data obtained is analysed qualitatively and quantitatively to characterise the performance of each trampoline.

A survey is conducted on a range of volunteers under mirrored experimental conditions. The survey is used to obtain subjective feedback on the motions and emotions felt whilst using trampolines. The feedback received from the survey is correlated with the G-force characteristics of the trampolines to find what influences the ‘excitement’ factor of trampolines. This project provides a great understanding of the biomechanical benefits of trampolining that will lead to product design improvements using measurable criteria.
Grasp Location Selection for a Domestic Service Robot (12cp)

Lachlan Bourke -S11-009

Supervisor: Nathan Kirchner
Assessor: Alen Alempijevic
Major: Mechanical & Mechatronic Engineering

As the development of robotic technologies increases, so too does their usefulness and ability to help us with various tasks. There is an increasing need in Australia for robots that can assist humans in the domestic environment, as we have an ageing population and the cost of care is increasing. An elementary requirement for many of these robots is the ability to manipulate common household objects, as this is one of the most common tasks that humans perform. Object shape is one of the key factors in deciding how we can grasp an object, but as there are many different shaped objects in the home environment, the tasks of finding the most suitable way to grasp an object is a complex one.

This project analyses various grasp selection techniques and presents a model-fitting method that integrates the creation of a virtual object and 3D geometric analysis to find a suitable grasp location. The proposed method takes advantage of an object identification technique developed by a colleague that specifies a simplified shape and dimensions representing a desired object, which allows for more intelligent assumptions during the grasp validation stage. The object is then represented in a 3D occupancy grid, with voxels searched for an acceptable pose location. This method has been designed for integration with the RobotAssist platform existing architecture to increase the number of household objects the robot can manipulate.

From the results of preliminary experimentation, the grasp selection method developed in this project shows significant signs that it, with further development, could lead to a large increase in the number of objects the RobotAssist platform can manipulate.
Crack, Dent and Hole Detection in Non-Ferrous Tube Using Eddy Current Techniques (12CP)

Jarrod Brazenall -S11-010

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

Non-destructive testing has a broad range of application in science and engineering. The ability to investigate the properties of a material without affecting the materials usability or intended purpose serves as an invaluable tool in evaluating the integrity of a material, system or structure. The eddy current tester uses the interaction of eddy currents that are affected by changes in the electrical impedance of a conductive material to determine information about the material structure and properties.

Changes in the electrical impedance of a material result from both application significant and non-significant sources. It is therefore desirable to be able to discriminate between the different sources of these impedance changes in order to detect undesirable material features (defects), while ignoring any features that have no impact on the materials usefulness. The purpose of this project was to design and build a prototype eddy current ester, capable of detecting defects in non-ferrous metal tube using an encircling coil type sensor, and to be able to differentiate between three common defect types; a dent, a crack and a hole.

The proposed eddy current tester consists of a PC based human machine interface connected via universal serial bus to a microprocessor, which samples the resistive and inductive changes in the coil impedance generated by the test sample. The user is able to discriminate between defect types by selection of test frequency and control over the amplitude and phase of the coil impedance response. The tester is able to clearly distinguish between a dent and a hole or a dent and a crack in the test sample. The tester has limited application for distinguishing between a hole and a crack.
Currently, the prefabricated timber construction industry in Australia and New Zealand is fragmented, specifically in the non-residential market. There is a need for fabricators, designers and other supply chain entities, to align themselves and collaborate with each other. The prefabricated timber supply chain is not structured with the client in mind and this leads to decreased value and quality. The specific timber structures that will be critically analysed are timber-concrete composite (TCC) floors. These floor structures are demonstrating reliable structural properties that are competitive with traditional reinforced concrete, prestressed concrete and steel structures.

Through a literature review, the business principles in structural contingency theory and supply chain management will be synthesised. The aim of this literature review is to understand how an organisation adapts to the external environment by changing its structure. This knowledge will then be expanded and applied to networks of businesses in supply chains. As TCC floors are not in mainstream construction, the supply chain will need to adapt to the changes in supply and demand as TCC floor products enter the market.

A thorough case study will focus on TCC floors and the issues with these structural elements in the industry. The aim of this case study is to understand how the performance of prefabricated TCC elements can be improved in terms of time and cost right across the supply chain. This capstone project provides a unique perspective of an entire supply chain and showcases potential future growth opportunities in the use of prefabricated TCC floor structures in the construction industry.
Building Materials and Architecture in Ancient Structures of Kathmandu Valley (6cp)

Pradip Chapagain -A12-026

Supervisor: Rasiah Sri Ravindrarajah
Assessor: TBA
Major: Civil Engineering

The composition and the performance of any infrastructure largely depend on the type of materials and methodology used during its construction phase. It is vital to choose such type of building techniques in order to get satisfactory and effective lifespan of the structure. Furthermore, the architecture of any building also reflects its superiority as well as the appearance as it serves as the first-impression factor.

There are various examples of the structures that got into collapse without any major natural event just because of the inefficient material properties and fault in construction. There have been many discussions in various conferences/seminars of the experts to address such type of failure.

This project mainly focuses on the building materials used in the ancient structures of the Kathmandu valley, the capital city of Nepal. It also relates the construction period and traditional techniques to the major social and political changes that occurred in the valley. The project not only addresses the materials and specific structure but also reflects on the pros and cons of the m.

Apart from that, the project continues with introducing the architectural style adopted in some structures and the influence of that use in the society. The co-relation between the adopted technique and the religious community of the valley also comes into account in many stages of the project. It will give an insight of various materials along with their use and historical period addressing the issues in appropriate format. Separate case studies will be presented in project to provide a clear concept of the facts.

This project thus provides a significant understanding of the building materials and architectural style chosen in the monuments of the valley.
Robotic Vehicle Implement with Robotic Arm Capable of Collecting and Transporting Objects to Designated Area (Robotic System) (12cp)

Yu Wen Chen -S11-020

Supervisor: Sarath Kodagoda
Assessor: TBA
Major: Mechanical and Mechatronics Engineering

The main objective of this project is to design and build an autonomous robotic system which will be able to pick up and transport objects to the designated area with an implemented robotic arm.

During the initial phase of the project, research was conducted to gather relevant data and information on the related topic. The research involves studying on the behavior and characteristics of the robotic system, design process of the robotic structure, and materials required and its availability. Measurements were taken from the I-Robot and concept sketches were drawn to gather idea of the initial design of the robotic platform. Then, a detailed 3D CAD sketched was produced using Solidworks to specify all the dimensions and stress analysis simulation for manufacturing. An assembled robotic platform was then delivered by the end of Capstone Project Part A to build on top of the I-Robot.

In Capstone Project Part B, the I-Robot Create was programmed using embedded C to perform the designated movements. The Arduino Mega electronic board was used to control the movement of the I-Robot using serial communication. However, I also contributed in the programming of the robotic arm and assisting with the design of the circuit. Since the output pins provided by the Arduino board was insufficient to control 5 servo motors of the robotic arm, the outputs were wired in series using an additional bread board. By the end of the Capstone Project, the functionality of the robot will be tested and a final report will be delivered.

As a final year Mechatronics student, designing and building the robot in the project will strengthen my knowledge and skill in the Mechatronics field and provide me the basic concept in performing further investigation and verification of improving robot and making it more economical.
Socio-Hydrology: Understanding the Co-Evolution of Coupled Human-Water Systems to Facilitate Long-Term Predictions and Comparisons of Water-Cycle Dynamics in Water Catchments

- Case Study of the Sacramento River Watershed in California, USA (6cp)

Mia Christensson -A12-031

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Major: Civil and Environmental Engineering

Water has throughout history been the most vital element governing human settlement patterns and the success of a developing civilisation. Natural water systems have since ancient times been altered to suit human needs, resulting in a complex coupled human-hydrological system comprising both physical infrastructure, such as dams and canals, and the economic, policy and legal frameworks that governs water availability, usage and pricing.

Socio-hydrology is a new science, with the intent at observing and understanding the scale, dynamics and co-evolution of coupled human-water systems. This will be done by firstly, studying the water sources, allocation and uses throughout a catchment including historical developments, and secondly, by analysing the self-organisation of people in the landscape with respect to people’s access and proximity to water resources (which are highly affected by socio-economic, legislative and technological factors). This knowledge can then help in making long-term predictions of future human-water pathways.

The aim of this Capstone project was to use some Socio-hydrology techniques to assess the co-evolution of coupled human-water systems in a real catchment by performing a case study of the Sacramento River Watershed in California, USA. The Socio-hydrology processes that were in focus for this research based Capstone project and the assessment methodology of the case study are:

a) Process Socio-Hydrology

To obtain relationships of current patterns of environmental flows, human water extractions, and the environmental state of the system that are already present in current literature.

b) Historical Socio-Hydrology

To trace the history of co-evolution and develop relationships and analyse the long-term trends between patterns of environmental flows and the state of the system, and similarly for human water extractions and the environmental state of the system using historical data, including (fuzzy) soft data from historical archives.

Findings of this assessment can be used later for performing a full Socio-hydrology study within the catchment and across different catchments in the basin, including using coupled hydrologic models.
Evaluation of Surface Coatings and Steels to Improve Demoulding of Liquid Silicone Rubber (12cp)

Justin Clarke -S11-021

Supervisor: John Dartnall
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Major: Mechanical and Mechatronic Engineering

Liquid silicone rubber (LSR) is a popular material for manufacturing soft and flexible products through the process of injection moulding. This is because it provides a unique range of properties, such as high tensile strength, elasticity, and heat and chemical resistance. A recent advancement is the creation of ‘sticky’ LSR that bonds very well with plastic, allowing the two materials to be firmly joined together to produce a finished product. This is especially important for medical devices, because there is the risk of bacteria growth between any small gaps between the silicone and the plastic. The use of ‘sticky’ LSR eliminates this risk due to the very strong adhesive bond produced.

However, this presents a significant problem to injection moulders, as the ‘sticky’ liquid silicone rubbers also bond with the steel of the injection mould. This causes the products to be difficult to remove from the mould, or even break during the removal process. To address this, this study aims to evaluate a range of surface coatings, that when applied to the steel of the mould, prevent the ‘sticky’ LSR from bonding to the steel. Also, a range of steels will be evaluated to see how much the ‘sticky’ LSR bonds to them as well.

This study was carried out at Bennett Precision Tooling Pty Ltd, a leading specialist in the design and manufacture of LSR injection moulds. A sample product was designed and moulded to test how much force was required to remove the product from moulds coated in each surface coating and or made from each steel. Recommendations are made for which ones are suitable for stopping the ‘sticky’ silicone from bonding to the mould.
Augmented Reality For Remote Labs(12cp)

Alexander Constanti - S11-022

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Supervisor: Steve Murray
Assessor: Zenon Chaczko
Major: ICT Software Engineering

Augmented reality has been used in the past to aid the teaching of students. It has been used to display invisible forces that must be pictured and understood. In the past, civil students have been taught the idea of tension and compression using only diagrams or visual demonstrations, but never have they been brought together. This paper discusses the results of the merging of these two concepts into an augmented reality visual display.

The remote labs beam rig was chosen as it was already set up, included a camera feed and only required the addition of the augmented analysis. Two tools were implemented as part of this project.

The first visual aid demonstrates the parts of the beam that are in compression and tension. This is done thorough shading the exterior of the beam blue when in compression and red when in tension. This also helps the students to understand where the beam changes from tension and compression. This was chosen as research has shown that many first year civil students struggle to grasp this concept.

The second visual aid overlays the linear model over the beam, depicting the predicted deflection. This has been done to allow the students to better visualise the actual limitations of the linear model. This was implemented as research had also shown that some students had found it difficult to understand just how inaccurate the linear model became as the deflection increased.
Configuration and Commissioning of a Modular Engine Testing Rig (12cp)

George Debattista -S11-028

Supervisor: Peter Tawardos
Assessor: Guang Hong
Major: Mechanical Engineering

Combustion engines are an important component to many mechanical systems in society. As such, there is a great demand for research as to engine emissions, power, durability and fuel economy. In order to conduct this research, testing apparatus must be configured in order to perform this function, specifically an engine dynamometer, as well as engine monitoring equipment. Engineering students gain particular use from these studies, as it enables them to learn in a practical nature the efficiency of a petroleum engine undergoing the otto cycle, as well as what input parameters they may change in order to effect the engine outputs. A successful testing laboratory should also be able to interchange engines; as to evaluate the differences in configurations such as connecting rod lengths, piston diameters, compression ratios and other possible built differences.

The aim of this project was to create a modular engine testing laboratory, capable of testing high revolution motors, testing the effects of engine modifications as well as effects of changes to the input parameters.

The process of configuring this laboratory involved understanding the problem at hand, addressing lapses in current testing capacities, and determining the greatest achievable engineering solution given the project’s time and budget constraints. This involved completely dismantling an existing testing rig, reconfiguring and rebuilding components, re-assembling the components, and adding additional control measures. This approach also meant that the revised testing laboratory needed additional configuration of the testing control means, as well as other adjustments deemed necessary throughout the process.
Numerical Modeling of Direct Ethanol Injection in a Spark Ignition Engine (12cp)

Damian Dedich -S11-029

Supervisor: Guang Hong
Assessor: Phuoc Huynh
Major: Mechanical Engineering

Ethanol is a renewable fuel source, and when blended with gasoline fuel, can be used in unmodified gasoline engines to help reduce emissions and aid in the avoidance of engine knock. The evaporative cooling ability from directly injecting ethanol and its high octane rating can be very useful in suppressing knock. The aim of this project is to develop a numerical model using the commercially available CFD-Ace software in the engineering faculty, which will be ultimately used to investigate the fuel spray, evaporation and mixing with gases of ethanol or other fuels directly injected in the combustion model.

The model is a cylinder piston system with simplified model of fuel injection from the top of the cylinder. The turbulence model that will be used for the CFD modeling in this project is going to be the Standard k-ε model. The K-ε model is one of the most common turbulence models and was chosen as it is recognized and appropriate to use with high Reynolds numbers. The stochastic model is modeling the turbulent dispersion in which the computational parcel is tracked through a sequence of turbulent eddies whose size and strength is estimated from local turbulent mean kinetic energy and dissipation rate. The Taylor Analogy Breakup (TAB) model is a classic method for calculating droplet breakup, which is applicable to spray droplet dispersion in spark ignition engines. The transient process is modeled through the equation of motion for a piston moving at 3500RPM. The angle theta (θ) for one degree of movement was substituted in the motion equation for the frequency multiplied by the revolution (2π) multiplied by the time needed for the crankshaft to move through one degree crank angle. The motion equation was then simulated for 180 Crank angles making the piston move from bottom dead centre to top dead centre with each time step taking 0.0000475sec. The process is modeled from the inlet valve closing to just before ignition of the fuel takes place.

The outcomes of the modeling showed how the spray in the combustion chamber dispersed and reacted with the compressed air around the spray at in-cylinder temperatures and pressures just prior to the ignition of the fuel. The results of different spray angles, maximum spray depth, droplet diameter, velocity and swirling effect were compared and analysed for each of the different spray angles.

The model is verified by comparing the cylinder pressure data acquired from the experiment and predicted by the numerical model. The comparison showed a good agreement between the experimental and numerical results.
Tall Building Response to Wind and Earthquake Loading (6cp)

Jo Ann El Tahche -A12-044

Supervisor: Bijan Samali
Assessor: TBA
Major: Civil Engineering

Advancements in structural systems and materials, as well as an increase in urban population density has seen a need for taller and slender buildings.

This in turn, has posed particular design challenges, altering the physical properties and hence the response of the structure to loading. Prior to such advances, heavier and denser structures provided natural damping. Today taller/ slender structures require systems to ensure the structure's response is within allowable limits to eliminate over engineering.

Vertical loadings remain fairly constant throughout the life of the structure. In contrast lateral loads vary with height, and excessive or uncontrolled lateral deflection may cause extensive damage, as well as discomfort to building occupants. Consequently, the resistance of tall buildings to lateral loads, mainly wind loads and earthquake loads, has become the main determinant in the formulation of tall building design.

This paper presents detailed numerical models for investigating the structural behaviour of tall structure subjected to wind and earthquake loads. The structure to be considered is a tall, slender building having the shape of a square prism with section aspect ratio B:D = 1:1 and a height aspect ratio H:D = 6:1.

The main objective of this project is the design of this structure utilising Australian Standards codes AS 3600 and AS/NZS 1170. Structural Engineering software, Microstran, will be used to model and analyse the structure, and remedial actions will be suggested if it is deemed that the response is deemed excessive.

This report will detail data and calculations produced by the analysis.
Determination of the Suitability of Anionic Polyacrylamide as a Water Clarification Agent in Sediment Basins on Pacific Highway Construction Projects (6cp)

George Freeman -A12-046

Supervisor: Pam Hazelton
Assessor: Ken Halstead
Major: Civil (construction) Engineering

Currently at 52% complete, the Pacific Highway Upgrade comprises of a series of highway construction projects in North Eastern New South Wales. Totaling an anticipated length of 664 kilometers, such projects involve extensive earthworks and present environmental and statutory risks through their potential to release sediment-laden run-off into waterways. Integral to the reduction of such risk, sediment basins and, in turn, clarification agents, aid in the timely and efficacious clarification of run-off prior to environmental discharge.

At present the only permitted agent for use in Pacific Highway sediment basins is gypsum. It has been postulated that the alternative use of anionic polyacrylamide compounds as clarification agents in sediment basins may lead to enhanced outcomes in terms of its ability to clarify clay suspensions more effectively.

Experimental work undertaken in this project has demonstrated anomalies with postulated anionic polyacrylamide suitability, with anionic polyacrylamide tending to inhibit the clarification of a clay suspension when compared with gypsum, combination gypsum and anionic polyacrylamide, and non-treated control samples. Literature has reported some reasoning behind such anomalies, however it is recognized that even to-date the exact mechanisms by which anionic polyacrylamide functions is not completely understood.

The aim of this project has been to assess the affect of anionic polyacrylamide in Pacific Highway Upgrade sediment basins. An understanding of the mechanisms for clarification has been established and potential benefits and risks have been discussed. Experimental proceedings have also been developed to directly compare gypsum and anionic polyacrylamide in both laboratory and field conditions. One soil type, sampled from locality of Herons Creek, was utilized in the experiments. It is important to note that, considering the inherent variability in soil types and site conditions over the length of the Pacific Highway Upgrade, the true suitability of anionic polyacrylamide ultimately needs to be determined on a site-by-site basis.
Development of Stormwater Quality Profiles and Treatment Strategies for Selected Railway Infrastructure (6cp)

Gene Gill -A12-051

Supervisor: Huu Hao Ngo
Assessor: Wenshan Guo
Major: Civil and Environmental Engineering

RailCorp own and maintain the metropolitan rail network which includes over 1,500 km of mainline track and more than 300 stations. The infrastructure for this network includes numerous sites that are used as maintenance facilities, depots and train stabling facilities. Currently, stormwater from the rail network is discharged mostly untreated into a range of receiving environments including national parks, drinking water catchments, creeks, streams, rivers, private land, and drainage infrastructure belonging to councils and other government authorities.

Given the large expanse of the rail network, on-site investigation of stormwater quality is not always possible during the design phase of new projects. At present there is little information for drainage designers on the quality of stormwater runoff from railway infrastructure in Australia or elsewhere. This project goes partway to addressing this gap in the engineering knowledge by providing indicative stormwater quality profiles for key contaminants. These profiles will provide a vital tool for drainage designers to assess water quality issues. They also increase the potential for Water Sensitive Urban Design (WSUD) and the re-use of stormwater runoff from rail infrastructure.

An extensive review of the literature, and indicative stormwater quality testing at rail infrastructure facilities was used to develop the stormwater quality profiles and identify contaminants of high priority. The legal, regulatory, and standard industry requirements for all of the receiving environments were then examined. This examination exposed a gap between contaminants of priority in the literature and those targeted by regulatory authorities in Australia, particularly in relation to zinc and copper. The profiles and knowledge obtained were then used to develop treatment strategies for typical rail infrastructure types. The incorporation of WSUD principles into the treatment strategies developed was looked at, as were some future possibilities for stormwater re-use in the rail operating environment.
Mechanical Design and Implementation of Shoulder Robot Exoskeleton with Pneumatic Actuated Cables (12cp)

Christopher Hamid -S11-048

Supervisor: Dikai Liu
Assessor: Gabriel Aguirre-Ollinger
Major: Mechanical and Mechatronic Engineering

In society, there are a number of people who experience upper body weakness. These weaknesses can be a result of various sicknesses or medical conditions, namely strokes. For such people, it is hard to complete routine and continuous tasks in everyday life.

This project describes the conceptualisation and implementation of two consecutive mechanical test rig prototypes using a test dummy which build on previous research and designs for an assistive robot shoulder exoskeleton. The prototypes aim as a foundation to develop a fully intelligent system which can provide controlled assistance to users with upper body weakness.

The mechanical test rigs include the development of a simplified 3DOF shoulder complex and portable housing unit for electrical and pneumatic components. Arm motion is made by contraction of pneumatic muscles connected to Bowden cables on the upper arm and shoulder. Pneumatic muscles are chosen due to its high power to weight ratio, suitable for implementation into daily activity use. The pneumatic muscles are controlled with solenoid valves through a PI controller. The arm’s motion is made within a particular workspace defined by shoulder ranges of motion for typical daily activities.

Completion of both prototypes has given insight into the behaviour of pneumatic muscles in combination with Bowden cables within a shoulder exoskeleton. Issues in terms of dynamic response of the test rig and performance have been observed and given recommendations for future improvements. As the test rig has shown to operate up to 80% the defined workspace indicated, it has been concluded that the system is capable to reaching the workspace boundaries to provide a more suitable assistive solution in the future.
A Study of Mass Rapid Transit (MRT) System in Dhaka

Munmun Hasan -A12-060

Supervisor: Ken Halstead
Assessor: Patrick Kenny
Major: Civil Engineering

Transportation system is one of the most fundamental elements of the socio-economic structure of a city as it enables movement of mass people for social, industrial, educational and recreational purposes. If this system fails to render a standard level of service, problems like traffic congestion, perplexity, pollution, economical instability arises. Dhaka, the capital of Bangladesh, is one of the most densely populated cities of the world. The city with a population of almost 12 million is the administrative, social and commercial centre of the country. The transportation system in Dhaka relies upon several motorized and non-motorized mode of transport with no fixed timetable or administration. Acute traffic congestion and accident are common phenomena in the city due to the lacking of a well-disciplined and reliable mass transit system.

It is high time to develop a sustainable MRT system for the city, which will cater the need of the mass people and stimulate the economic growth. This research paper aims to highlight the problems and issues related to the present bottlenecked mass transportation system of the city. The paper summarizes the data collected from a user response survey and comment on the existing transport and modal share condition of the city.

Upon considering the current situation and after analyzing different transit systems used around the world; a Mass Rapid Transit Model consisting of several Metro Rail lines and LRT lines has been developed for Dhaka city, which can prove to be sustainable, safe, comfortable, reliable, cost effective and affordable to all range of people. The paper will depict the main features of the model and also highlight the impacts, issues and limitation of the transport model. The proposed model can be a very effective solution and can render positive ramification to the overall development of Dhaka city in the foreseeable future.
Microcontroller Implementation of a Three-phase Digital Overcurrent Protection Relay (12cp)

Joel Hudson -S11-056

Supervisor: Peter McLean
Assessor: Li Li
Major: Electrical Engineering

A critical component in modern time-graded power systems protection schemes is the three-phase overcurrent relay. Traditionally overcurrent relays were constructed from electromechanical devices, designed to trip the appropriate circuit breakers in an interconnected grid based on a combination of the magnitude of fault current detected and the time settings of the relay. Modern overcurrent relay devices use sophisticated software algorithms to perform this function and offer an expanded range of settings and time-current characteristics to the protection engineer.

This capstone presents a microcontroller based implementation of a three-phase and earth overcurrent relay, designed for application in the UTS power systems laboratory. The firmware architecture is designed to run on a fixed-point 16-bit microcontroller from the Freescale HCS12 series. The project includes implementation and testing of the architecture on an MC9S12A512 microcontroller residing on the UTS ModCon board.

Features of the relay include: three phase and earth relaying; four user-selectable IEC IDMT time-current curve characteristics; adjustable current-multiplier and time-multiplier tap settings for IDMT relaying; two definite-time characteristics per phase with user-settable current-multiplier tap and trip delay settings; a sensitive-earth mode for high-impedance line to earth fault detection; outputs for pickup and trip conditions; and fault saving for the last five recorded faults.

The final product has been tested in a system fault simulation experiment in the power systems laboratory to ensure that it meets the environmental operating requirements. The project will be of benefit to power systems protection students and embedded systems students wishing to study the algorithms behind modern protective relay devices.
Progressive Collapse Assessment of Steel Frames- (12cp)

Syed Jamil -S11-059

Supervisor: Hamid Valipour
Assessor: Emre Erkmen
Major: Civil

Natural disasters such as earthquakes, as well as intentionally or unintentionally caused destructions through explosions, within the vicinity of a structure or at a close distance from the structure may lead to loss of critical members (columns). This can possibly trigger the progressive collapse of the structure. Safety of structures against such catastrophic failure is really important to prevent loss of lives and assets. This research aims to acquire the fundamental knowledge of the progressive collapse analysis and assessment of moment resisting (MR) frames.

In this report various methods are employed to investigate the potential progressive collapse of steel frames taking into consideration methodologies and approaches prescribed by some design guidelines such as GSA (2003) and DoD (2002). In the first part of report, the design strategies and methodologies are briefly described and classified in relation to the current important topic facing the world with regards to the major issue of progressive collapse analysis of buildings. Further, the potential progressive collapse of generic steel frames with two, four, eight stories is investigated using static and dynamic analysis taking into account geometrical and material non-linearity.

Over the last two decades, highly advanced computer software aided simulation has made it quite possible to conduct dynamic and static analysis to analyze structural capacity and behavior under abnormal loading scenarios. Hence, ANSYS package is used for modeling and analyzing the structure and results are used for calculating the demand capacity ration (DCR) as well as dynamic amplification factor (DAF). The design strategies and methodologies are briefly described in the report as well.
E-WASTE DISPOSAL & RECYCLING: A CONTINUING PROBLEM FOR THE 21ST CENTURY? (6cp)

Francesca Joesoep -A12-069

Supervisor: Pam Hazelton
Assessor: Anne Gardener
Major: Mechanical

Electronic waste, referred to as e-waste, is a growing worldwide problem, that is predicted to increase as a result of short consumer life of the products, changes in features and increase in capabilities. A vast majority of e-waste ends up in landfill with other municipal solid waste. This is poor practice, as e-waste contains high levels of hazardous waste and substances, including mercury, lead and phosphor, which can leach out and affect humans and the environment.

Recycling e-waste is difficult, due to the complexity of the design, the different material compositions and the high levels of hazardous material requiring strict safety guidelines. As such, many recycling company’s and organisations in developed country’s transport e-waste to less developed countries, such as China, India and Africa.

Efforts to stop the illegal dumping of waste have found it very difficult, a reason proposed being that there is a lack of agreement between countries or organisations about a specific definition of e-waste. At present, global standards for its disposal and recycling have not yet been formulated. Policies that are implemented within countries also have been found to have a lack of enforcement.

It is a requirement that parties are required to collaborate in order to stop e-waste from becoming a growing problem. Academics and governments need to work together to develop a standardised definition for e-waste and standardised method of measuring e-waste generated.

With the involvement of manufacturers and other stakeholders, policy and realistic strategies can be developed, where consumers can get involved by actively recycling their e-waste and making informed choices.

E-waste is an issue which requires global action, as without adequate measures in place, it will be a continuing problem for the 21st century and beyond.
Study of Permeability and Uniformity of Pervious Concrete Slabs (6cp)

Mohammad Kaabi -A12-072
Supervisor: R Sri Ravindrarajah
Assessor: TBA
Major: Civil Engineering

In today’s environmentally conscious world, it falls on civil engineers to provide sustainable solutions to environmental challenges. Pervious concrete is one of these solutions. It reduces storm-water runoffs as well as filtering the water at the same time before it reaches groundwater. At the present time, a lot of research is undertaken by UTS to better understand the properties and characteristics of pervious concrete and create a product just as versatile as the conventional concrete.

Pervious concrete is a composite material consisting of coarse aggregate, cementitious material, and water. It is different from conventional concrete in that it contains no fine aggregates in the mix. The aggregate usually consists of a single size and is bonded together at its points of contact by a paste formed by the cement and water. The result is a concrete with a high percentage of interconnected voids that, when functioning correctly, permit the rapid percolation of water through the concrete. Unlike conventional concrete, which has a void ratio anywhere from 3-5%, pervious concrete can have void ratios from 15-40% depending on its application (Mulligan 2005).

This project consists of 2 main parts. Literature review of pervious concrete and its various characteristics and properties; and an experimental investigation which is undertaken to study some samples of pervious concrete slabs and determine their permeability and uniformity properties. 12 pervious concrete slab specimens were selected and 3 commercially available pervious concrete slabs were obtained for this study. The permeability rate and uniformity of various slabs were determined and compared to obtain the best combination of void content, strength and ease of maintenance.
The Response of Tall Buildings Subjected to Wind and Earthquake Excitations (6cp)

Joshua Kleinhans -A12-080

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

Wind and earthquake actions have the potential to significantly impact the stability of structures by affecting the integrity of various individual elements within a structure. Without adequate analysis a structure is susceptible to severe deflections, accelerations and torsional effects as a result of the above applied forces. This Capstone Project specifically investigates these effects within the limitations of the Wind and Earthquake Design Codes (AS NZ 1170.2 & AS1170.4). Therefore the project will involve the analysis of a purposely chosen 199 metre tower standing in Sydney which is therefore susceptible to the full extent of wind actions.

In addition it is accepted that Sydney and Australia does not have a large history of severe earthquakes, the most well known being the 1989 Newcastle Earthquake and 1988 Tennant Creek Earthquake. Despite this, earthquakes are not insignificant to Australian engineers especially since knowledge of earthquakes carries significant advantage particularly regarding designs located in seismic zones outside of Australia.

This Capstone Project is centered around the calculation of the above imposed actions and the creation of a three dimensional structural model of a steel framed structure which is further detailed in the report. The Structural Modeling Program, Microstran is employed to analyse the resultant effects of separate critical wind and earthquake loading cases in combination with the typical permanent and imposed loads in accordance with ASNZ 1170.1. Detailed in the report is data and calculations produced by the various forms of analysis of the structural model, including building and member deflections, estimated accelerations, natural frequency and maximum inter-storey drift. These results ultimately have allowed for the response of the structure to be measured allowing for the wind and earthquake actions and their relationship with the structure to be explored.

The Capstone recommends remedial actions against the imposed wind and earthquake actions on this structure if deemed excessive, outlined in the results section of the report.
Smart Phone for Telematic Systems (12cp)

David Klempfner -S11-064

Supervisor: Zenon Chaczko
Assessor: Robin Braun
Major: Information Communication Technology Engineering

Mobile phones have revolutionized the way we go about everyday life. Mobile phone technology has increased dramatically within the last ten years, and we are at a stage now, where mobile phones aren’t only used for messaging and calling, they can now be used to tell you your location, play music, and also to interact with microcontrollers which can then be used to control almost any digital system.

This capstone project exploits the ability of Android smart phones to interact with the open source Arduino microcontroller to solve two main problems:

1. Car Keys/Remote control locking – With the “Remote Key App”, locking/unlocking/starting a car is done via the phone’s Bluetooth connection to the Arduino board. This removes the need of carrying the car key and remote, all that is needed is an Android phone.

2. Driver nomination for speeding fines – State parliament has recently been discussing the issue of companies not identifying the driver after a speeding fine from a speed camera has been issued. This is because the fine is a relatively small price to pay compared to having the employees lose their license which would lead to a decrease in productivity. The “Trip Logger” of the “Remote Key App” logs who was driving when, and where. This saves a local copy which can be useful for road trips where the car owner doesn’t remember who was driving when, and the data can be uploaded via 3G to a web server making it possible for management to have logs to show when it comes time to nominating a driver for the speeding fine.

This project is relevant to ICT Engineering as it involves software development, including GUI implementation, as well as embedded system design. It also involves hardware modification, and telecommunications using the Bluetooth protocol.
A Study on How the Apple Ipad Effects Personnel Efficiency in Construction Project Delivery (12cp)

Rory Lemon -A12-086

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

In the current information age, enterprises in the construction industry are faced with the challenge of selecting and implementing the most appropriate methods of information management on construction projects. Within an industry that demands high quality, competitive margins and tight schedules, there is a strong need for operations to be managed efficiently.

Recent advances in mobile communication technology have seen tablet computers become widely adopted within business. The Apple iPad® (“iPad”), considered the catalyst to the revolution, is being utilised as an information management tool within the field. Through the development of communication systems, and understanding the effects using an iPad has on personnel efficiency, business executives can now look at new ways of optimising their competitive edge.

The research conducted specifically addresses the mobile information needs and communication demands of engineering staff on construction sites; for example the need to review design drawings or conduct Quality inspections. The fundamental issue is to identify what the usefulness perspective of mobile computing for construction operations consists of; relating to both technology and the different groups of people who are supposed to use it.

Mobility of project data and individual adaptation of information are technological aspects emphasised and discussed in the context of adding value to delivering construction projects. The sociotechnical introduction and user adoption of mobile computing involves balancing various perspectives and agendas inherent at different organisational levels, in order to achieve an acceptable outcome for all actors involved.

A trial conducted on the Hunter Expressway construction project saw iPads deployed amongst engineering staff. Observations, data logging and questionnaires were used to collect information pertaining to the effectiveness and usability of iPads for information management in the field.

The findings of the trial indicate that using iPads increase personnel efficiency, in the context of information and operation management, and contribute to a notion of continuous improvement in construction project delivery. The implication of this study enables executives from Abigroup Contractors, a leading construction company in Australia, to instigate the development of a deployment strategy for iPads across the organisation.
Patient handling is a major challenge for both patients and caregivers. Discussions with professionals from health and disabled care service providers, Greystanes Disability Services, Spinal Cord Institute, Patient Handling and the Prince of Wales Hospital identified a number of limitations with existing hoists. These limitations include difficulty of use, safety concerns for both patients and caregivers, the restriction that a mechanical frame and a linear actuator offers and a lack of safety measures and monitoring units. This has been known to lead to short and long term injuries to caregivers, worsening injuries for patients and in the most extreme cases, fatalities.

The intention of the intelligent patient hoist project is to substantially reduce or eliminate the risks posed to both the patient and their caregiver in a common hospital bed-to-wheelchair and wheelchair-to-toilet transfer scenario. The project aimed to achieve these goals by automating and mechanising the process of transferring patients. The method adopted encompassed programming of an environment sensing and analysis system, obstacle avoidance utilising potential fields, comprehensive product research and procurement of a patient hoist, a motor controller and appropriate motors suited to the hoist’s safe work loading (SWL).

Research into the environment sensing and analysis component of an intelligent patient hoist led to the use of a Microsoft Kinect to identify, analyse and deal with potential hazards posed to both the patient and caregivers. The contribution of this research in the field of mechatronics combines many facets of multidisciplinary engineering study. The significance of these achievements to the mechatronics field pertains to the reusability of detailed findings, methods, analysis and the corresponding resultant of the project.

Xing Lin -S11-073

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

Deep excavations in urban areas often require lateral supports for retention of soil on the sides. The retaining structures used in these projects are commonly referred to as shoring. Unlike conventional retaining walls, which are often relatively rigid and mainly rely on self-weight and/or soil weight to resist overturning and sliding, the shoring system is slender and relatively flexible and can be supported by either earth pressure acting on the embedded part, bracings, anchors or a combination of these.

Conventionally, the stability and structural design of shoring systems are based on numerical analysis, whereas the lateral displacement and settlement are estimated using empirical methods. The development of powerful computers and rigorous geotechnical modeling software in the last few decades made comprehensive numerical analysis of shoring possible.

This project provides an overview of commonly used shoring and lateral supports. An in-depth literature review concerning a wide range of design aspects is also presented to demonstrate the methodologies used in the design. In order to link theories and real world problems together, the project also studies a deep excavation project completed in Sydney CBD area. A typical section of shoring is selected for computer analysis using the Beams on Elastic Foundation model (WALLAP) and the Finite Element method (PLAXIS). The study consists of the comparisons between the two models as well as investigation of the effects of different material properties.

The main findings of this study include:

• Beam on Elastic Foundation model predicts greater maximum shear force and bending moment.

• The resulting shear force, bending moment and lateral displacement of shoring are less sensitive to the variation of soil friction angle than cohesion.

• Although PLAXIS provides more rigorous analysis, the results should also be examined more closely to identify any potential errors and practicality of the results.

• The increase of shoring bending stiffness reduces lateral movements, but it also results in the larger bending moment acting on shoring.

The findings of this project can be taken into consideration by practicing civil engineers, when designing a proper shoring system in urban areas.
Investigation into improving Western Sydney Transportation; A tunnel extension for the M4 and efficient use of Parramatta River and bus services - (6cp)

Hiep Lam Chan Mai -A12-097

Supervisor: Jack Wang
Assessor: TBA
Major: Civil Engineering

Sydney’s western suburb motorists currently face crippling traffic congestion on arterial roads, namely the M4 Motorway. The M4 is an instrument primarily implemented for the purpose of enabling movement of large numbers of vehicles between urban centres, allowing social and business activity to flourish. The consequences of congestion work to counteract said purposes; increasing travel times and costs, air pollution, health concerns and capital costs to businesses among others, which contributes to the deterioration of costs and standard of living in Sydney overall. Congestion is defined as excess demand for road travel (OECD, 2006) or infrastructure capacity. According to the Bureau of Transport Statistics, demand for road infrastructure will ever rise with the population of Sydney predicted to reach 6 million by 2036, thereby exacerbating the predicament. Therefore this paper aims to determine the feasibility of a group of solutions to alleviate congestion in the Western Suburbs.

This paper is a feasibility study for a set of proposed solutions; extending the M4, improving ferry efficiency and bus services, to improve traffic congestion from the Parramatta vicinity to the CBD. Government publications were used to provide an overall scheme and criteria for consideration in the solutions. Journal articles on tunneling, congestion and reports from various government bodies helped to design the unique solutions as well as deduce costs and benefits. Finally public surveys were distributed and collected to add the stakeholder dimension into this research, to truly understand the needs and acceptance of the public of the proposed solutions.

As a result, this project yields the costs of tunnel extension for the M4, proposed ferry changes and bus efficiencies. Further an accurate cost of congestion based on the ARRB Congestion Model (ACM) was calculated to reveal the costs passivity on this matter. Overall, the results dispel common belief that tunneling is discouragingly expensive, and that the implementation of ferry and bus solutions are not beyond achievable cost wise, in the near future. However, it is important to note that due to the limitations in this study, further research is required to truly determine the viability of implementing said solutions. This project has shown that the solutions are worth further investigations.
Dynamic Reconfigurable Real Time Embedded Signal Acquisition System (12cp)

Jon Maloney -S11-078

Supervisor: Steve Murray
Assessor: David Lowe
Major: ICT

In many systems there exists a need to adapt to changing environments. Dynamic reconfiguration provides a means for a system to asynchronously adapt to these changes. In computing systems schedulers are used to manage changes in system resource requirements. In this paper, stimuli which prompt adaptive changes are modeled as asynchronous events in a task schedule. Traditionally static schedulers are used to manage schedules that have extremely low frequency adaptive changes. As the frequency of these events increases it becomes more and more appropriate to use dynamic schedulers.

Adaptive changes are tracked in the frequency domain. Frequencies of the changes are either matched to an appropriate scheduling algorithm or the scheduling algorithm adapts to the changing frequencies. Performance of the scheduling algorithm is measured by its utilization factor, ability to meet deadlines and power consumption.

An online static schedule generator is developed to automate the reconfiguration process of low frequency adaptations. The evaluation process goes beyond simulation. Scheduling algorithms are implemented and evaluated on a custom built evaluation board using microchip’s pic24fj64ga004.
Loading Capacity of Reinforced Concrete Deck Slabs Strengthened with Externally Post-Tensioned Fibre Reinforced Polymer Rods (6cp)

Bradley Martin -A12-099

Supervisor: Hamid Valipour  
Assessor: Shami Nejadi  
Major: Civil Engineering

The increase in traffic volumes and truck axle loads on aging bridges and roads infrastructure has been a worrying trend for a number of years. Further to this, a large portion of bridges in Australia and around the globe are approaching the end of their service life. These two factors coupled with environmental degradation, is causing the deterioration of this vital infrastructure. As a result of this, there is an increasing demand in Australia, and abroad, for cost effective technologies that can restore degrading infrastructure by increase the strength and serviceability characteristic of bridges to ultimately extend their working life.

The use of fibre reinforced polymers (FRP), in the form of both sheets and bars, has been widely investigated for the strengthening and restoration of reinforced concrete bridges. A team on UTS researchers, lead by Dr Hamid Valipour, has proposed a novel solution for the strengthening for reinforced concrete bridge decks in the transverse direction by means of externally post tensioned FRP bars. By inducing a compressive force within the deck slabs with the introduction of the post-tensioning system, theoretically, the slabs will exhibit an improvement in both their strength and serviceability characteristics.

As a part of my capstone project, I have carried out a parametric study of the proposed strengthening system by developing and analysing two dimensional, Non-Linear Finite Element (NLFE) models with the FEA program ATENA. My report will provide a background on the strengthening reinforced concrete with FRP through a literary review, discuss the merits and limitations of using the NLFEA software nominated and present the results on the parametric study with comment on the most optimal situations where this system may be applicable.
Retaining Wall Design Incorporating Sensitivity Analysis (6cp)

Christopher McLelland - A12-102

Supervisor: Hadi Khabbaz
Assessor: Bezhad Fatahi
Major: Civil

The goal of this project was to create a program, which would make the design of retaining walls easier by highlighting the influential factors in retaining wall design (sensitivity analysis), regarding its stability. Other objectives that were to be achieved in the creation of the program were that it;

- Works for cantilever, embedded and gravity retaining walls.
- Works in a variety of soil conditions.
- Is relatively simple to use.
- Outputs the factor of safety ratios for each wall.

The need for the creation of Simplified Retained Soil Design (SRSD) was because there was a lack of similar, simple to use programs that perform a sensitivity analysis.

The method used to create this program was to apply a combination of knowledge from geotechnical engineering, sensitivity analysis and programming. Practical experience of the construction of retaining walls has also been incorporated in this project. The combination of all that knowledge has been used to form a series of statements, functions and equations that create the program which is SRSD.

The outcome of this project is a useful program that allows for the quick and simple design of a retaining wall to suit the soil conditions. It has value in industry as a quick method of determining the stability of a retaining wall. It also has value as an educational tool to demonstrate the effects of various soil properties and wall dimensions.
Modelling of Composite Beams in Vibration Analysis (6cp)

Edward Nehme -A12-109
Supervisor: Emre Erkmen
Assessor: Hamid Valipour
Major: Civil Engineering

Composite beams that are composed with two or greater elements are currently being used to span large openings. When elements such as steel and concrete are interconnected they act simultaneously having a larger load carrying capacity.

There are many examples of composite beams such as: reinforced concrete beams (RC), composite beams with concrete slabs, stiffened RC beams with high tensile materials such as steel, also profiled composite beams.

Composite construction is referred to the ability of two-load carrying members being connected forming one single unit. The connections are vital in forming composite behaviour between each member. These systems are widely used in the construction industry as they are seen to be of the highest quality.

The main focus of this capstone project is to assess composite interactions between steel and concrete members. Microstran is used as the chosen computer program to analyse composite behavior. The steel-concrete composite beam is analysed when different amounts of connections are added to the beam and trends in results are discussed. The results for changes in deflection and frequency within the beam are used to analyse the composite interaction between both members.

When modelling composite beams using finite element software, analysts find it often convenient to connect two standard Euler-Bernoulli beam elements at the nodes by using master-slave type kinematic constraints to express the degrees-of-freedoms of one of the members in terms of the other. However, this type of modelling leads to eccentricity related numerical errors and special solutions that avoid eccentricity related issues are not available in most of the structural software.

This project studies the effects of these errors on the dynamic response of composite beams.
What does Green Cost?-Cost and Benefits of Green Buildings (6cp)

Carl Nelson -A12-110

Supervisor: Pam Hazelton
Assessor: Anne Gardener
Major: Civil Engineering

The aim of this research initiated by the question Morris & Fray, 2004 “What does green cost” is to determine the long term benefits of green buildings compared to the initial savings of market buildings.

The study provides an insight into the benefits and costs of “green buildings” and their future feasibility. Using comparative case studies from Australia and the USA the research examines the goals of the rating systems such as Green Star and LEED (Leadership in Energy and Environmental Design) and demonstrates the financial and community benefits including the environmental benefits. It examines case studies from the United States and Australia to show that when sustainable design is considered from the outset of a project the costs incurred are minimal when compared to overall construction costs.

References

Influence of Polypropylene (PP) Fibre Inclusion on Shear Wave Modulus of Cement Treated Kaolinite (8cp)

Vincent Ng -A12-113

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

With our societies expanding ever outwards to new lands away from ideal founding land, construction on problematic soils is an emerging challenge for civil engineers. A popular ground improvement technique employed to deal with problematic soils is deep soil mixing (DSM) - whereby the in-situ soil is blended with cementations and/or other reagent materials to improve the properties. An improvement in the stiffness of soil is the purpose of this investigation into shear wave modulus.

Various studies have shown strength benefits of adding PP fibres to soils, especially problematic soils exhibiting low strength or high settlement. An investigation into the stiffness of these mixtures was proposed by Dr Behzad Fatahi to find the benefits of adding PP fibres to different proportions of Kaolinite and cement. Measuring the time of which a wave travels through a medium of known distance results in a velocity reading that can be correlated to the stiffness of the material. This concept is utilised in Bender Element testing which is the main measurement apparatus of this investigation.

The results show a characteristic rise in shear wave velocity as the cement in the clay mix is hardens- stiffness rising. The benefits of adding PP fibres are however non conclusive as a reduction in stiffness is recorded as higher proportions are added to the cement clay mix. Further testing with strict mixing procedures would reap more reliable and accurate results. The investigation outlined, although inconclusive, provides valuable recommendations for further research into this testing procedure.
Investigation of Flint Glass for Partial Replacement of Fine Aggregate in Fly Ash Cement-Based Mortars (12cp)

Anthony Ngadimin -S11-162

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

Australia’s affluent and growing economy contributes notably to growth in waste generated. It is predicted that by 2016 Sydney’s landfill capacity will not suffice, thus, forcing it to redirect its waste to neighboring states. At the end of 2000, Sydney also faced a shortage in sand supply. Decoupling waste generation from economic activity is an effective way of conserving natural resources. Glass recycling constitutes converting glass waste into usable products; however, only a third of the glass waste generated is recycled with the remainder disposed of in landfill. This study aims to harness the availability of excess glass waste as a novel fine aggregate for inclusion in construction materials to aid as partial substitute for sands, which are in short supply, thus, reducing the volume of waste directed to landfill and reducing the consumption of natural sands, thus, conserving a valuable natural resource.

The performance of flint glass (FG) as a partial replacement of fine sand in cement-based mortars at addition levels of 5, 10, and 15% is reported. Compressive strength of FG mortars was evaluated at ages of 7, 28, and 56 days to assess strength gain relative to maturity in addition to strength activity index (SAI). At 28 days, the SAI of 10% FG mortar was found to be 103% of control mortar (devoid of FG), while at 56 days the SAI of 15% FG mortar had increased to 110%. For a fixed FG addition, a reduction of 0.05 in w/cm signified an increase in SAI to 125% at 28 days. In contrast, an increase in w/cm of 0.05 contributed to a decrease in SAI to 91%. The use of FG as a partial substitute for fine sand in mortars demonstrates higher compressive strength; however, this is increase is w/cm dependent.
Thermo-Mechanical Analysis of Steel Structures Which Deals With the Effect of Fire

John Phung -A12-127

Supervisor: Hamid Reza Valipour
Assessor: Shami Nejadi
Major: Civil Engineering

The concern for fire safety of steel structures has been an issue in the past and present, and with the collapse of the World Trade Center in the past decade it has brought greater attention to structural integrity of steel structures in fire. The provision of design standards in the area of structural fire engineering can only provide a guideline to fire design according to proposed fire scenarios. In reality the variability of fire characteristics, structural assemblies and type of construction materials presents numerous parameters to consider when investigating the fire durability of structures.

The approach of designing based on past experience, standards and experimental investigations known as performance based approach have been and are still currently widely adopted in fire engineering. With the recent advances in computer simulation, the approach to simulate steel structures in fires has been increasingly adopted due to various advantages it presents.

This capstone will investigate the behaviour of steel members and frames at elevated temperatures using the finite element software ANSYS. Within the scope of the capstone’s objectives, the finite element analyses conducted are three dimensional and considers different thermal regimes and support boundary conditions. In light of increasing interest in structural fire engineering, the investigation of various structural configurations will reinforce and present a further understanding of the behaviour of steel members and structures when subjected to fire.

This capstone comprises of various stages, which most importantly are the finite element analysis stage that verifies the software and model and extends the analysis of thermal loading to more complex steel structures such as portal frames and multi-storey frames. Based on the analysis conducted ranging from simple steel members to steel frames, it has been found that excessive deformation of unprotected steel commonly occurs at temperatures greater than 500oC due to occurrence of material nonlinearities.
Numerical Investigation of the Effect of Average Grain Size on Wave Induced Liquefaction of Sand (6cp)

Richard Price -A12-130

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

Soil liquefaction is a phenomenon whereby a body of soil, usually however not exclusively cohesionless, suddenly and without warning loses a majority of its strength and stiffness entering a fluid-like state. Marine sands are subject to ongoing differential pressures caused by wave loading which can increase in amplitude during a storm event. The resulting increase in cyclical shear stress ratio can initiate liquefaction-type failures in the seabed at levels of shear stress far below the soils ultimate strength. These failures can potentially impact off shore structures such as caissons, gravity platforms and piles by reducing the integrity of foundations or at worst instigating submarine landslides.

Recent years has seen the topic of liquefaction gain popularity and there exists many studies on the theories required to predict the cyclical shear strength of sand. One such study by Ishihara and Yamazaki (1984) presents a simplified analytical method for predicting the depth and extent of liquefaction failure based on waves generated from design storm conditions and the relative density of the seabed. A simplified method is valuable for determining when and if more resource demanding approaches are required. Within the realm of the current understanding of liquefaction theory this capstone seeks to expand the scope of the analysis to include for the effects of average grain size and provide some limiting correlations to soil input parameters. A sensitivity analysis is performed to quantify the contribution of grain size to liquefaction resistance and the results verified against recent and similar studies.

It is found that the inclusion of the effect of grain size likely has great significance on a sands’ cyclic shear strength. Predictions of volumes and extents of a liquefied soil mass using the developed model could vary by orders of magnitude in comparison to predictions made based on relative density alone. Without increasing the complexity of the original analytical procedure the expanded model can be expected to provide a more practically realistic result when considering areas of the seabed at risk of liquefaction.
Human Skeleton System for Rehabilitation (12cp)

Md Akhlaquor Rahman -S11-091

Supervisor: Adel Ali Al-Jumaily
Assessor: Ahmed Al-Ani
Major: Mechanical and Mechatronic Engineering

In Australia, a major cause of disability is the stroke. It is the second highest cause of death after coronary heart disease. A stroke patient with disability requires physical rehabilitation. The major aim of this project is to design and implement a post stroke therapeutic device for rehabilitation of the hand motor function for stroke patients as human hands play a vital role in daily life activities of a person.

While various devices have been developed for arm function rehabilitation after stroke, limited research has been done on the rehabilitation of hand motor function. Additionally most of the current devices developed for hand function rehabilitation can only provide assistance for unilateral training while bilateral training has also shown positive outcomes in hand function rehabilitation.

In this project, a post stroke therapeutic device has been designed for hand motor function rehabilitation that a stroke survivor can use for bilateral movement practice. The device is designed to be portable so that the user can engage in other activities while using the device. The control system of the device was developed using open source microcontroller platform with wireless communication facility.

A prototype of the device was fabricated that can fully flex and extend metacarpophalangeal (MCP), proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints of the fingers and interphalangeal (IP), metacarpophalangeal (MCP) and trapeziometacarpal (TM) joints of the thumb of the left hand (impaired hand) based on the movements of the right hand (healthy hand) fingers. Out of twenty-one degrees of freedom (DOFs) of hand fingers the prototype of the hand exoskeleton allowed fifteen degrees of freedom (DOFs), with three degrees of freedom (DOFs) for each finger and three degrees of freedom (DOFs) for the thumb. In addition testing of the device on a healthy subject was conducted to validate if the design met the requirements.
Modelling of Composite Beams for Static Analysis using Microstan (6cp)

Rabib Rahman - A12-132

Supervisor: Emre Erkmen
Assessor: TBA
Major: Civil Engineering

Throughout history civilization has advanced significantly in terms of industrial applications. This has contributed to the creation of unique structures including high rise buildings, long span bridges, high ways, retaining walls and many more uniquely shaped and sized structures. Structural engineers have enabled these structures to be built to stand and serve humanity. Structural engineering application has also developed over the period due to the industrial and technological advancements. Earlier structural engineers were limited to analyzing the structures using the conventional analytical methods including Slope Deflection, Moment Distribution, Finite Elements and etc. These applications can provide accurate approximations however can be time consuming specially due to the complexity of contemporary architectural designs. This methodology was offset with the emergence of Commercial Design Softwares including Auto Cad, Revit, Microstran and many more.

Structural Engineers predominantly design Columns, Beams, Retaining Walls and Slabs of the overall structures. They prefer materials like concrete, Timber and Steel as these are globally available and popular. The Engineers determines the materials for the structure according to the type of loads, expected use, the surrounding environment, available funding, aesthetic requirements and etc. Each of these materials provides various mechanical and physical advantages which allow fulfilling the desired service and strength of the structures. Most structures today are designed as composites in order to take advantage of all their enhanced properties. The concrete beam with steel elements is an example of a typical composite structure. Concrete provides significant compressive strength however its minimal tensile stress resisting capacity can be offset with the use of steel due to its high tensile capacity. Therefore Engineers prefer to design all concrete structures using steel reinforcements.

This thesis provides brief back ground on the application of structural engineering. Moreover it demonstrates the fact that a more accurate deflection of a composite beam due to a concentrated load can be determined by using a larger number of rigid connections within the composite beam when designing on the Microstran software. Furthermore larger number of rigid connections also allows both materials to deflect in a similar manner hence actually behaving as a composite.

This thesis can be valuable to the structural engineering industry as it will provide engineers with a methodology of acquiring a more accurate set of design results contributing to more efficient designs using softwares specially microstan.
Determining a Tire’s Influence on Vehicle Handling and Limit Performance (12cp)

Peter Ringwood -S11-094

Supervisor: Terry Brown
Assessor: Nong Zhang
Major: Mechanical Engineering

The performance and handling of a vehicle operating at its limit is highly non-linear and of intense interest in the field of motorsport. With recent top tier endurance racing events being won by time differences as little as 0.0160%, the need for high levels of vehicle performance is paramount.

As with the field of aeronautics, a vehicle’s response to control surface inputs allows a driver to adjust and control vehicle attitude. Unlike in aeronautics, the dominant external control surface affecting a vehicle’s attitude is the control surface formed between the tire and road surface. Almost all vertical, lateral and longitudinal forces that driver and chassis experience must be reacted through the tires contact patch to the road surface.

This Capstone provides a study of the impact that the tires have on performance. The tires are first analysed in isolation to other major vehicle systems and then paired with a full vehicle model. Both the isolation and complete model studies rely upon validated computational models in place of physical testing, allowing for performance and handling simulation of a wide range of vehicles.

A point mass model has been used for isolated studies whilst a more involved model has been used for the detailed studies. The more involved model includes semi-empirical tire models for each corner, coupled with both kinematics models of vehicle’s suspension, and semi empirical aerodynamic models. This allows for a complete vehicle model for use in steady state analyses of both vehicle performance and vehicle response to handling inputs.

Main findings of this Capstone include kinematic vehicle setup parameter sensitivities, for use when tuning a specific vehicle, as well as parameter sensitivities of design variables, for use when more design freedom is available.
Redesign of Induced Draft Fan Vane Linkages at Wallerawang Power Station (12cp)

Rainer Scheurer -S11-149

Supervisor: Terry Brown
Assessor: John Dartnal
Major: Mechanical Engineering

This project aims to investigate the causes of low reliability of the mechanical linkages between the actuator and inlet guide vanes of Induced Draft Fans at Wallerawang Power Station. The findings of an investigation of current issues were used to redesign a new set of parts with that will increase reliability of the ID fans.

The reason for undertaking this thesis is to provide Delta Electricity with a cost effective solution to replace the existing parts with a new set of parts, which have been designed specifically for the operating conditions at Wallerawang Power Station. It is anticipated that Delta Electricity will financially benefit by reducing annual production losses and save on maintenance costs due to the ID fans. The importance of high reliability is highlighted through the recent Gen-Trader contract. Delta Electricity is obligated to pay fines to TRU-Energy for not meeting generation availability levels set out by the Gen-Trader contract.

Redesigning of the parts involved investigating previous design weaknesses, such as high rates of wear, a review of literature to learn about failure prevention design, Computer Aided Design (CAD) to model the new parts and Finite Element Analysis (FEA) to ensure the strength and vibration characteristics of each part are sufficient. The new linkage parts are planned to be in operation until the planned closure of Wallerawang Power Station in 2029.

The Final design concept is based on a set of linkages already in use at Mt Piper Power Station. The linkage comprises of a combination of custom designed parts and commonly available off-the-shelf products. If Delta Electricity chooses to install this design, the initial capital investment would be estimated at $64,000. The payback period is under 23 months, with a total estimated saving of $530,000 by 2029, not including potential loss of availability fines.
Timbre; The Application Of Ecologically Sustainable Design Principles In Modern Australia (12cp)

Vanessa Sewell -S11-102

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Major: Civil and Environmental Engineering

The building of a family home is regarded as the great Australian dream. It often implies that the home will incorporate all the luxuries that we expect with 21st century living, from appliances to entertainment. Yet when Green Design is mentioned in a domestic build it is often seen as either being basic in modern technology or a luxury tag for the wealthy.

This project challenges both of these perceptions and looks at applying the principles of Ecologically Sustainable Development (ESD) and Life Cycle Analysis (LCA) to a new build. This build is based on a real world model of a family home in a semi-rural property called Timbre.

An ESD construction is carefully harmonises economic outlay, environmental performance, social responsibility and practically to “to ensure that (development) meets the needs of the present without compromising the ability of future generations to meet their own needs”. (Brundtland, 1987)

The growing societal awareness of man’s increasing ecological footprint has meant that the availability of green materials and technologies is now greater than ever before.

Despite this, a house is often the largest purchase that many will make in their lifetime, and there is a view that that green buildings, particularly in a domestic setting, require a significantly greater fiscal outlay, putting them beyond the reach of everyday Australians.

ESD designs are typically approached in an ideal scenario. This project addresses constraints such as client requirements and land restrictions to in the aim of conducting a real-world analysis as to the viability of constructing a residential ESD building. The final building design is to be aesthetically pleasing, environmentally sound and fiscally responsible home.
Comparison of Slope Stability Computational Method of Analysis - (12cp)

Mingying Shan -A12-145

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Assessor: Behzad Fatafi
Major: Civil Engineering

Slope stability analysis should be performed carefully to assess the safe and economic design of slopes. Therefore, calculation of factor of safety (FOS) plays a key role in slope stability. The report demonstrates the comparison of different methods, the limit equilibrium analysis (LEA) and the finite element method (FEM) to determine the FOS. Both methods have extensive applications in industry practice. Software programs SLOPE/W and PLAXIS are two common packages currently employed in Geotechnical Engineering projects within Australia. The SLOPE/W and PLAXIS are used for the LEA and FEM, respectively. In this study, three cases have been considered for the sake of comparing the results. The cases are: slope stability analyses of a homogeneous embankment, an embankment with a surcharge load and an embankment with an embedded retaining wall.

As a result of advancement of digital technology, an increasing number of geotechnical engineers eager to use the FEM based programs instead of LEA due to higher accuracy and versatility. The FEM is more powerful than the LEA since it can accept more parameters for analysing complicated problems. Although the LEA may lead to numerical inconsistencies and computational difficulties, it is still the most widely used in the world owing to simplicity of operation and more experienced in the industry.

There are some differences between these two methods. Young’s Modulus and Poisson’s ratio should be considered by the FEM whereas the LEA does not require these parameters. Furthermore, the FEM can analyse slope by applying the phi/c reduction approach. By contrast, LEA is based on analysis of using equilibrium equations. Finally, for heterogeneous and irregular geometry soil, FEM provides priority to apply.

The study provides the conclusions and recommendations on the basis of results from applying both software packages for the industry. Then it also demonstrates which method is more accurate and applicable.
Australia has a vast number of aging timber bridges, many of which were built in the late 1800’s and early 1900’s. A number of these bridges remain structurally sound, only requiring maintenance and replacement of the decking. With an increasing focus on environmentally suitable construction solutions, Engineered Wood Products (EWP’s) are growing in popularity. This project’s aim is to investigate an EWP decking system for new structures in addition to a replacement solution for these for-mentioned ageing bridges.

Stress Laminated Timber (SLT) systems have been widely implemented throughout the world and provide a structurally sound decking solution for bridges. This technology forms the background of the current research whereby the structural feasibility of stressing Cross Laminated Timber (CLT) – in substitution to solid wood boards – with Laminated Veneer Lumber (LVL) webs in “T” beam and cellular systems are investigated. This research focuses on serviceability testing to identify the system’s behaviour under line loading to characterize the system stiffness and pad loading to understand the load distribution ability of the system. The test data is used to produce a numerical model. The structural feasibility and viability of this solution is also assessed.

The project includes a review of SLT technology and discusses the potential of CLT’s application in bridge applications. Laboratory tests have been completed and analysed comprehensively. This analysis includes the system stiffness and load distribution. A numerical model has been developed and the accuracy and reliability of its predictions are analysed. Recommendations for system improvement and further research are also put forward.
In recent years, organisations have increased focus on being environmentally friendly and to provide sustainable solutions for managing water in the urban environment. Pervious concrete is a solution that can help manage storm water runoff.

Pervious concrete is composite material consisting of coarse aggregate, cementitious material and water. It is different from conventional concrete since it contains no fines in the initial mixture. The result is a concrete with a high percentage of interconnected voids around 15%-40% and when functioning correctly, permit the rapid percolation of water through the concrete.

Pervious concrete has many environmental benefits such as storm water management, minimising site disturbance by using less site area for drainage, local materials can be used, recycled content can be added and reduces heat build up due to the increase in void content.

There are a number of challenges such as the lack of consistency in the slab, difficulty in maintenance and higher costs. To overcome these difficulties a more controlled method is proposed such as creating pre-cast slabs in a controlled manufacturing or laboratory environment.

This project consists of a undertaking a literature review and an experimental investigation of slab samples to study of the drying rate of pervious concrete slabs and its effects on clogging. Evaporation is the main mechanism through which temporarily stored runoff is released, but it is neglected as a design practice due to limited knowledge and apparent insignificance. The objective is to determine a relationship between void content and drying rate.
Analysis of Multi-Storey Frames Subjected to Wind and Earthquake Loads (6cp)

Alyce Smith -A12-149

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Major: Civil Engineering

External wind and earthquake actions acting on tall slender buildings can have dire effects on the structural integrity of a building if it has not been designed correctly. Buildings are all around us in Sydney and everyday are being subjected to some sort of wind load. Although earthquakes are not predominant in Australia, this load action is applied to further analyse the response of slender buildings under this load along with wind loads.

This capstone project is an investigation into the response of tall buildings when subjected to external forces such as wind and earthquake actions. A 45 storey concrete building with a height of 190m was designed in a computer software program, Microstran. This allows full scale time history analysis to analyse the effects of wind and earthquake loads in separate cases and will allow the presentation of shear force and bending moment diagrams along with the deformed shape of the building. The Australian Standard, ASNZ1170 Part 0, 1, 2 and AS1170 part 4 is used to determine which load combinations and parameters are needed to be incorporated in the proposed building model. Extensive calculations have been conducted in order to determine which loads need to be applied on the building model and where. For the purpose of this project, the most critical wind directions, namely, South and West have been considered in the analysis as these loads cause the largest response of the building.

The effects of wind and earthquake actions on the building in regards to occupant comfort are also considered. If a structure has not been designed correctly, imposed actions can make the building resonate and cause large movements, therefore causing human discomfort. If the analysed model is determined as not suitable for human comfort, or the deflections are too large, relevant auxiliary devices to reduce the impact of extreme loadings on buildings will be considered.
Robotic Vehicle Implement with Robotic Arm Capable of Collecting and Transporting Objects to the Designated Area (Robotic Arm) (12cp)

Shun Tse Teng -S11-118

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Major: Mechanical Engineering

The primary objective of this project is to design and build the robotic arm, which can be assembled with the mobile platform on I-robot create. Specifically, this robot possesses abilities of transporting the object to the designated points. The robotic arm is compatible for difference applications as long as modify its original design in accordance with different requirements.

During the prototype phase, there were some unexpected problems arise with regard to the consistency of design elements, programming issue, and power supply problems. Although the computer aid design facilitated the design processes through the accurate dimension and analytical functions, most difficult issues were conducted to the manufacture and resource aspects associated with the prototype development. Meanwhile, the programming of microcontroller played a significant role for robotic performance. Once the program has the errors occur, it would straightly relate to the functionality of whole system.

In order to solve the mechanical issues, the 3D CAD models have to be modified and reanalysis its stress components. From the previous experience, every change in the design was referred to the industrial standards and specifications. Moreover, the programming of robotic arm was based on the Arduino development kit, which the programming language of this microcontroller has a highly similarity with embedded C. Since this board can be simply used to interface with robotic arm, the problems among the serial communication can be eliminated.

Finally, the achievements of this project included the mechanical design and stress analysis for robotic arm, integration between mechanical and electronic components, and perform the C programming to control the robotic arm. This project was not merely focused on the design of mechanical structure, but also associated with the implementation of mechatronic knowledge. As a result, the design processes of conducting these technical tasks could examine our knowledge base and engineering discipline with both theoretical principles and practical skills.
With an increasing concern for the shortage of fossil fuels, engineers are seeking ways to improve the efficiency of combustion engines. There have been many developments over the recent years, all with the aim to improve efficiency in order to extend the time we have before fossil fuels are depleted. There have also been developments in alternate fuels to reduce our dependency on fossil fuels. Some of these alternate fuels include electricity, hydrogen and ethanol. However because electricity still relies on fossil fuels and there is no efficient way of liquefying hydrogen, ethanol is the most popular as it is most sustainable.

This project is part of a research project in the Faculty of Engineering & IT at UTS, aiming to experimentally investigate direct injection of ethanol fuel applied to a port injection gasoline engine. It is believed that this new fuelling method will make the use of ethanol, as a renewable fuel, in motor vehicle engines more effective. A 250cc motorcycle engine from a Yamaha YBR250 has been modified to include a direct fuel injector and electronic throttle control. The engine test rig also includes a dynamometer to measure engine performance and a gas analyser to measure emissions.

Experiments have been conducted to investigate the engine performance affected by the percentage of ethanol fuel and spark timing. Results showed that the engine performance (power) was improved with the increase of ethanol fuel percentage. The spark timing at which the engine torque is maximized was identified and exhaust emissions (CO, CO2, NOX, HC, NOX) were reduced in some of the engine conditions with the increase of ethanol fuel percentage.
Investigation of Low Shear Strain Modulus of Cement Treated Bentonite with added Polypropylene Fibres (6cp)

Queenie Trinh -A12-165

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

This Capstone Project sets out to investigate the effects of Polypropylene (PPP) Fibres on low shear strain modulus within cement treated Bentonite. The Bender Element will also be used as a non-destructive test throughout the course of the experiment, simulating shear waves and passing them through the sample to obtain the shear wave velocity to which the shear strain modulus can be found. The samples had three varying cement contents; 30%, 40%, and 50%, to which three different percentage fibre mixes of the clay’s dry weight were used: 0.1%, 0.2%, and 0.5%. The mixes were subsequently placed into disposable moulds at ambient temperatures under sealed conditions and then placed into water baths for curing after having been extracted.

The samples were tested every day over a period of a week with the Bender element and then twice per week afterwards over a course of 28 days. The PPP fibres within cement treated soil samples had resulted in an increase of shear wave velocity.

The application of such an experiment is in the use of ground improvement techniques, namely that of Deep Soil Mixing (DSM), as it involves injecting cement slurry through a mixing shaft into the soil. This will strengthen the foundations of soft soils and in turn improve not only the bearing capacity but reduce settlement that is inherent with soft soils.
Influence of Carpet Fibre Inclusion on Shear Wave Velocity of Cement Treated Kaolinite (6cp)

Kwok Kin Tsang -A12-167

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

Deep Soil Mixing (DSM) is a ground improvement technique broadly used to stabilise soft soils to improve bearing capacity and reduce settlement. The process requires injecting cement slurry into the in-situ soil using a rotating mixing shaft. Variations of low strain shear modulus will be our main focus in this Capstone Project.

This experimental Capstone Project explores variations of the low strain shear modulus in cement treated Kaolinite bonded with Carpet Fibers using Bender Element. In this project, carpet fibres were introduced in soft soil treated with Portland cement. Analysis of the samples’ shear wave velocity was performed to obtain low shear strain modulus. Q38 Kaolinite clay was chosen along with Carpet Fibres for the experiment. The clay possess of a characteristic of moisture content 1.5 times of its liquid limit suitable for mixing and moulding. Samples were categorised into three level of cement content, including 10%, 15% and 20%, and three mixes of carpet fibres including 0.5%, 0.75% and 1% of the clays dry weight were employed. The mixes were placed into disposable moulds at an ambient temperature under seal condition and after they have been extracted, the samples were placed into a water bath for curing. Samples were tested with the Bender element three times on the first week and once per week afterwards. The results show that the shear wave velocity of the treated soil increases by cement content. Moreover, results show an early stiffening when carpet fibres are added to the mixes.
A Subsequent Study into the Risk Paradox Surrounding the Risk Management of Children

Lance Vourloumis -A12-170

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Assessor: Chris Chapman
Major: Civil and Environmental Engineering

An analysis and investigation into the risk paradox surrounding the risk management of children at physical play was conducted. The risk paradox states that one’s perception of risk is affected with the elimination or lowering of a particular risk, and that if the risk perception of a particular activity is lowered due to any circumstances or countermeasures, then one will compensate this by taking increased risk. The risk paradox applies to virtually anyone in any society, and particularly to young children, where children at such young ages have different degrees of freedom from their parents. The purpose of this project was to determine the extent to which children demonstrate the risk paradox and hence examine other factors affecting children’s risk taking behaviour.

Regardless of the many applications and affecting parties the risk paradox deals with, this project focuses on the risk paradox affecting children at play. Accepting and undertaking activities involving risk possesses an immense number of benefits for children including improved cognitive skills, social skills and future perceptions, however societies have been masked through the failure to understand these benefits, leading to the elimination or prevention of risk in play. The investigation involved interviewing the families of 35 children between the ages of 5 and 10 years of age. The data obtained was analysed and categorised into factors affecting children’s play, risk compensation, as well as the parenting characteristics which affected a child’s risk taking behaviour.

The families which were interviewed comprised of children within the public and private school sectors within the general public of the same district with strong cultural diversity. This was used to argue how the children in these sectors have been taught to perceive risk, but at the same time, be a good micro representation of multicultural and diverse beliefs. Regardless of the small size of the data set, this niche was definitely a contribution to the argument being presented. It was noted that majority of the children’s parents demonstrated overprotective parenting and that many parents did not believe their children demonstrated risk compensation regardless of their level of supervision when their children were playing with accident countermeasures in place. It was also found that majority of these parents had more freedom growing up than their children, and that the most common reason for this was their changing perception of society being more dangerous as oppose to when they were children. This investigation presents the findings, discusses the results and draws conclusions about the risk paradox surrounding children.
Development of a Magnetic Footpad for a Bridge Climbing Robot Tasked with Remote Inspection (12cp)

Wilson Xu -S11-128

Supervisor: Dikai Liu
Assessor: TBA
Major: Mechanical

The inspection of the Sydney Harbour Bridge (SHB) is a dangerous task currently performed by experienced workers who are subjected to numerous risks including falling, heavy traffic and constant exposure to lead based aints. The team at the University of Technology, Sydney (UTS), has been working with the RTA on the Bridge Climbing Robot (BCR) project to eliminate these risks through the implementation of an inchworm climbing robot to carry out remote inspections of the SHB.

Research into existing adhesion systems for climbing robots showed that their designs were limited to use on smooth and controlled surfaces. Since the SHB has highly irregular and uneven surfaces which would render these existing systems inoperable, the need arose for a footpad design which would provide the BCR with the adhesion required for operation on the SHB in any configuration and orientation.

This Capstone Project investigates the use of magnetic adhesion, in particular the use of permanent magnets, as a design solution. Research into the application of magnetic adhesion and reconfigurable end effectors resulted in a complete detailed design of a magnetic footpad which allows adhesion to riveted surfaces such as those found on the SHB.

A prototype proof of concept footpad was built to test and verify the viability of permanent magnets as a means of magnetic adhesion. These test results were utilised to understand the limitations of magnetic adhesion and set the design requirements for the final detailed design.

Although limitations in time and production resources did not allow for the fabrication of the final detailed design, based on the test results from the proof of concept tests conducted with the prototype, the performance of the final detailed design was hypothesised to meet the design requirements.

A Basis for Exploring the Effect of Robot Gaze on Human-Robot Interaction (12cp)

Louella Yu -S11-130

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Major: Mechanical and Mechatronics

Social robotics is a research and market field that has experienced intense growth in recent decades. This has led to a marked increase in the interest of making human-robot interaction (HRI) a more natural experience and the need to see robots more as a ‘social partner’ rather than a machine. Based on the idea that humans are the ‘ideal social partner’, it becomes important to explore human-human interaction, and how this can be incorporated into HRI. This capstone explores the area associated with subtle non-verbal cues such as gaze-direction and eye movements, and their effect on HRI.

In order to perform this exploration, there is a need to create a robot head that can convey perceivable gaze and eye movements. This new robot head should satisfy the constraints of the RobotAssist project as well as the requirements to carry out HRI experiments based on robot gaze. This capstone engages in research to design and
manufacture a robot head. The result is an iconic, anthropomorphic figure that successfully conveys gaze cues appropriate for HRI experiments.

This capstone also reports the research undertaken to create and test the feasibility of performing HRI experiments on the effect of robot gaze on human observers. This was done by developing a robot-gaze centred HRI experiment, and executing it on a small scale. The results of this experiment demonstrate the feasibility of performing HRI experiments using this robot head on a larger scale.

This capstone provides the basis for continued exploration in the field of HRI by creating the necessary hardware, as well as presenting background research on further experiments that can be carried out in the field.