School of Mechanical Engineering
Honours Student Project Exhibition

MechExpo 2012 Project Guide

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The School of Mechanical Engineering welcomes you to the annual student Project Exhibition, MechExpo. On display are Level IV student projects dealing with both research and design.

The projects are initiated either by one of our industry partners, student(s) or by our staff and deal with topics ranging from system analysis and design to experimental investigations of fundamental research problems. Students enrolled in our five programs; mechanical, mechatronic, aerospace, sustainable energy and sports engineering, contribute to this exhibition. On a number of occasions in the past student solutions have led to patentable systems. Although some projects are undertaken by individual students, most are group projects involving up to ten students and represent in excess of 300 hours work per student.

The School of Mechanical Engineering would like to thank all contributing organisations for their support and we look forward to further strengthening industry involvement in our final year projects in the future.

We hope you will enjoy the exhibition and take the opportunity to discuss with students and staff any aspect of the projects that you find of interest.

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Head, Mechanical Engineering
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00
Sustainable Marine Current Energy

Students: Rosemary Claire Hallam, Joshua Robert Harley-Hill, Benjamin John Murphy, Ashraf Salha, Philippa Grace Williams & Melissa Wei-Li Wong
Supervisors: Dr Antoni Blazewicz, Dr Brian Kirke, A/Prof Richard Kelso & Dr Zhao Feng Tian
Sponsors: VEHTEC, Santos & Victor Harbor City Council

It is widely known that renewable energy technology is becoming increasingly important to society. Marine current turbines are examples of such technology, and operate by converting the kinetic energy of ocean currents into electrical power. The Sustainable Marine Current Energy project aims to identify combinations of design features which improve the performance of these devices through the design, manufacture and testing of a prototype device.

The project focus was to determine the performance increase associated with the inclusion of a channeling device, as well as the inclusion of ‘tubercled’ blades which incorporate the hydrodynamic properties of whale flippers through biomimicry. Therefore, a marine current turbine was designed which featured interchangeable tubercled blade and channeling device designs so that multiple configurations could be analysed. In-situ testing of the design was carried out to determine the comparative performance of various blade and channeling device combinations through an analysis of power coefficient, stall effects and tip speed ratio. This exhibition will report on the project’s results, and showcase the future commercial potential of the turbine design.

01
Does wind turbine noise really annoy people?

Students: Isaiah Michael Borgas, Benjamin Chladek, David James Holland, Louise Alison Nguyen & Matthew Yip
Supervisors: A/Prof Con Doolan & Dr Danielle Moreau

Wind turbines are viable sources of renewable energy however, concerns have been raised about the noise produced by wind farms. Previous studies indicate that noise generated by wind turbines may cause annoyance to nearby residents. The findings of these studies suggest that amplitude modulation is the primary feature of wind turbine noise that incites annoyance in humans. This project aims to determine if various depths and frequencies of modulation are directly related to human annoyance. To satisfy this aim, wind turbine noise was synthesised from recordings, with frequency and depth of modulation set as controllable parameters. Variations of this signal
were used as stimuli in a listening test, conducted in accordance with the Adelaide University Human Research Ethics Committee, to determine a range of depths and frequencies of modulation, that were found to be most annoying by participants. Results from this study will provide better understanding on the psychoacoustics of noise annoyance to humans caused by amplitude modulated sound.

# O2
Design and Build Submarine (Dynamics and Control)

**Students:** Alan Bauman, Matthew George Dawson, Joshua James McLaren & Michael Valenzisi  
**Supervisors:** A/Prof Andrei Kotousov & Dr Antoni Blazewicz  
**Sponsors:** Babcock & ASC

ASC and its subsidiary Deep Blue Tech (DBT) have joined Babcock, a key partner of ASC in the Australian Defence Industry, in sponsoring the 2012 Design and Build Submarine project. The long term objectives of this project are to expose students to modern naval design concepts and build a knowledge base of advanced submarine technology at the University of Adelaide. Progress has been made towards these objectives through the continued development of an autonomous submarine venture initiated in 2011.

The project’s aims for 2012 included the detailed hydrodynamic and manufacturing design of a nose cone and control surfaces, enabling the submarine to be efficient during underwater operation. The control surfaces have also been designed to achieve a level of manoeuvrability required to carry out potential missions. A dynamic model has been developed and work has begun on an autonomous control system. Once this system is completed, the submarine will be able to operate under its own control. The design process was supported by mathematical analysis and computational fluid dynamics (CFD) simulations, which model the flow around the submarine.
The overall submarine’s underwater performance was analysed using CFD and the propulsion system was analysed experimentally using a custom designed test apparatus and methodology. The methodology was developed in such a way that it can be applied in the analysis of propulsion systems used in future years. The results were utilised in the development of the dynamic model, which in turn was used to tune the control system of the submarine and will ultimately help achieve complete autonomy during operation. This exhibition will demonstrate the project’s achievements as well as the plans for the continuation of the autonomous submarine venture.

02
Design and Build Submarine (Mission and Design)

Students: Kevin Bock, Nicholas Stanley Davis, Paul Michael Kinlough, Phillip Thomas McKenzie & Jay Stevens
Supervisor: A/Prof Andrei Kotousov
Sponsors: ASC, Babcock & AUES – Adelaide University Engineering Society

An unmanned submersible project was initiated in 2011, with a long term goal being to develop an autonomous and configurable platform that can perform a wide range of practical underwater missions. This year, the design and fabrication of the main subsystems and demonstration of their functionality are the primary goals which will provide a solid foundation for future developments. These main subsystems include, but are not limited to: ballast tank with emergency surfacing system, surfaced communications, modular mission packages and a mission control computer with visual recognition software.
Working under the supervision of Deep Blue Tech. & ASC engineers and sponsored by Babcock Ltd and the AUFS, the project addresses the needs of the defence industry to train high quality engineers to support the ship building industry in South Australia as well as the future plans to build and assemble a new generation of submarines.

03
Air Powered Motorbike

Students: Michael Donald Peter Bolzon, Joseph Frank Giovinazzo, Clinton Nero Leonardis, Isaac Jacob Saridakis & Thomas Patrick White
Supervisors: Dr Antoni Blazewicz & A/Prof Colin Kestell
Supervisors: Engine Air, Motor Trade Association, Festo, Chubb Fire & Safety

Over the last decade, research into the transport sector has identified automobiles as one of the leading contributors to greenhouse gas emissions. As a result Western countries have begun producing electric and hybrid-electric vehicles, which can be expensive to the average consumer in third-world and emerging nations. Compressed air vehicles may provide a cheap and simple alternative as a zero-emission transport, with commercialization of compressed air cars already begun in India. However, due to the low efficiency and energy density of the technology, vehicle range is greatly limited by the volume of air storage, preventing production of compressed air motorcycles. If this can be addressed, compressed air motorcycles could become a cheap alternative to motorcycle fleets in high population density Asian countries, where highly polluting two-stroke engine motorcycles dominate the roads. The 2012 Air Powered Motorbike Project aims to design and build a fully-operational compressed air powered motorcycle and test it for commercial viability. At the 2012 MechExpo, the Air Powered Motorbike team will present a summary of the design process and results from performance testing, as well as live demonstration of the motorcycle during operation.
04
Hybrid Kinetic Motion Analysis of Fast Bowling in Cricket

**Students:** Samuel John Arnold & Simon Felix Thwaites  
**Supervisors:** Mr. William Robertson & Dr Paul Medwell

Swing bowling in cricket has mainly qualitative techniques towards coaching; this project has attempted to attain quantitative results relating the seam position of the ball, in reference to its line of flight, with the position of the hand/wrist of the bowler during ball release.

A prototype goniometer has been designed and built which will assess the adduction/abduction and flexion/extension of the wrist of the bowling arm. This information, coupled with the seam position given from the OptiTrack 3D motion capture system, will hopefully give a better understanding of what wrist position is required to produce optimum swing. Depending on the reliability and the correlation of data, it is hoped this pilot study could be extended for future in-depth analysis.

In addition to this, bowling workload will also be investigated with the use of a Kistler Force Platform. Athletes will be required to undergo a high work load regime; looking for signs of potential 'buckling' via increased ground reaction forces. This will potentially identify a threshold at which the risk of injury increases, enabling bowlers and coaches insightful information as to the appropriate length of a given bowling spell.

05
Study of variable speed drive technology for air conditioning system

**Student:** Ling Liu  
**Supervisors:** Dr Ley Chen & A/Prof Eric Hu  
**Sponsors:** The University of Adelaide & Adelaide Airport Limited

The project is a cooperative project between the University of Adelaide and the Adelaide Airport Limited (AAL). The project aims to understand the principle of Variable Speed Drive (VSD) for air conditioning system and measure the performance of VSD to prove it is Energy-Saving.

For the second aim of the project, it is required to take one specific Air Handling Unit (AHU) from AAL as a case study, get the detailed data of it and do some calculations, finally compare the power consumption results with last years’ data of the same unit and get the conclusion that energy can be saved by installed VSD on the AHU.
Advanced Oceanic Power Harvesting for Autonomous Undersea Sensors: A Feasibility Study

Students: Elena Price Busuttil, John Patrick Hickin & Fangzhou Sha
Supervisors: A/Prof Amir Anvar & Mr John Van Velzen
Sponsor: Defence Science and Technology Organisation (DSTO)

Underwater sensors systems are an emerging industry which is driven by the ability to measure and record data such as temperature, salinity, pollution and acoustics. Generally underwater sensor systems are powered via a primary alkaline battery system which limits operating times and poses and environmental risk.

A feasibility study was conducted into potential energy sources within the oceanic environment and existing wave energy harvesting mechanism designs. From this we were able to identify waves as a suitable energy source oceanic environment from which the development of concept solutions could be adapted. Through the concept solution generation and final design analysis, two device designs were produced including a surface buoy and a heaving point absorber. The surface device is optimised to extract energy from shorter wave period choppy characteristic though the use of a series of carefully oriented linear generators. The heaving point absorber exploits the longer period swell through the use of a ball and screw mechanism and a rotary generator. Laboratory and oceanic testing was conducted to validate both mechanisms ability to extract a minimum of 20 Watts.

Integration of the surface buoy and the heaving point absorber design has been investigated to facilitate power generation over a wider range of conditions experienced within the oceanic environment. Automation systems have been developed to manage the power generation, storage and supply,
with remote system diagnostics capability via radio frequency and satellite navigation tools.
The exhibition will provide an overview of the devices, including the research, designs, testing and performance. Both devices will be included in the display.

10

Students: Guangxi Liu, Jiawei Lu, Sean David Robson & Stevan Rokvic
Supervisor: A/Prof Amir Anvar
Sponsors: Defence Science and Technology Organisation (DSTO), GHD, Noarlunga Model Aero Sports Inc. & Ampurta

The aim of this industry funded project is to utilise a catapult launched UAV for deploying communication micro-sonobuoys in a maritime environment. Remote communication is difficult to achieve with underwater systems as electro-magnetic waves disperse in water. Micro-sonobuoys can be used as a communication link between above water and below water systems. The ability to remotely communicate with underwater systems will reduce the expense of monitoring and maintaining underwater systems, such as sensor networks. Intelligent deployment requires automatically detecting the target location, which may be achievable with a technique called Simultaneous Localisation and Mapping (SLAM). The project is sponsored courtesy of DSTO, with additional support from GHD, Ampurta and Noarlunga Model Aero Sports Inc. The 2012 team is the first of three years to achieve successful flight of an airframe and deployment of a payload. The 2012 revision of the catapult launcher is designed to launch a significantly larger aircraft. The focus of the project is to achieve autonomous flight and payload
deployment from a catapult launcher. The exhibition will be a display of project's accomplishments.

11
Intelligent AUV Robotic System Operations

Students: Zulhasnor Bin Hassan, Chen Jia, Muhammad Dzarfan Muhaiyuddin, Rong Pan & Huimei Zhou
Supervisors: A/Prof Amir Anvar & Dr Tien-Fu Lu
Sponsor: Defence Science and Technology Organisation (DSTO)

Testing and gauging Autonomous Underwater Vehicle (AUV) missions through observations and experimental trials prove to be time consuming and costly, therefore Defence Science and Technology Organisation (DSTO) Australia has sponsored this project to build a simulation platform for the AUV. The overall system of AUV consisted of five important subsystems that are, Inertial Navigation System (INS), Machine Vision, Sonar, Communication (underwater and on surface) and also Simultaneous Localization and Mapping (SLAM) trials. Simulation of the AUV can be used as a method to understand the behavior of the AUV and also test out the new ideas/theories to the AUV, thus give opportunity to further refine the AUV technology and its operations underwater.

The project has managed to build the simulation of each subsystem in AUV and also the simulated 3D environment of AUV underwater using Simulink in MATLAB Software. The project focus was to construct a simulation of AUV’s subsystems and integrate them into a single simulation platform using Graphical User Interface (GUI). Results of the simulation will be generated in term of graphically and 3D animation. Testing and experiments of AUV from several researched sources were analysed and studied in order to build the AUV’s simulation.

The exhibition will demonstrate the 3D simulation of AUV along with the simulation of each subsystem.
12
Intelligent System of Systems Robotics for UAVs and AUVs Swarm Operations: A Feasibility Study

Students: Ahmad Afiq Azmi & Ahmad Hafizuddin Mohd
Supervisor: A/ Prof Amir Anvar
Sponsor: Defence Science and Technology Organisation (DSTO)

Swarm robotics (system of systems) is the coordination of multiple simple robots and it is mainly used to perform complex actions and operations that are beyond robot individual capabilities which is included with the application of robotics within Oceanic environments. We explore and design a system where multiple robots or in this case ‘open robots’ can interact with each other, process data and information and provide feedback to controller or human operator(s) in the loop. We demonstrate the robots operation in simulation environment and then analyse the system to test its capabilities before applying them into real robots. In this project, we apply Simultaneous Localisation and Mapping (SLAM) concept in developing the system model design. SLAM is a powerful tool used to locate the robots’ location and also to create map of the new environment. We also perform real time testing on the open-robots community and compare the results with the simulation. Real life implementation of this swarm networking system may include with maritime robotics community that consists of Maritime Unmanned Aerial Vehicle (M-UAV) and Automated Underwater Vehicle (AUV) with human-operators in the loop that perform certain tasks for example search and rescue mission, maritime security, environments study and exploration and also perform underwater repairs within oceanic environment. This exhibition will demonstrate the work done and progress of the project.
13

Design and Build of a High Endurance, Autonomous, Maritime UAV Capable of Deploying Payloads

Students: Bronte James Jachmann, Mitchell Don Leslie & James Alexander Schulte
Supervisor: A/Prof Amir Anvar

In an increasingly robotic world, autonomous systems are providing increased safety and effectiveness while reducing costs and risk to human life. The aim of the Project 1346 is to design and build of an autonomous, high-endurance, maritime UAV with the ability to deploy payloads. It is envisioned that the UAV will have applications in both humanitarian; i.e. Search and Rescue missions, and Defence applications; i.e. Maritime surveillance.

The project aims to create a versatile system capable of being rapidly deployed from on board an at-sea vessel. The Maritime UAV will be entirely autonomous and capable of carrying out missions of up to 2-hours with a two kilogram, deployable, payload. Furthermore, the project intendeds to focus on increasing efficiency through advanced control, novel structural design and implementation of innovative power systems.

The exhibition features the full-sized working model, with a flight simulator that will allow you to take control the aircraft in a virtual world. Also on display will be a number of test flight videos and a range of information regarding the aircraft and its systems.
Intelligent Submersible-Manipulators for Oceanic Robotic Research

**Students:** Mohd Aizat Farid Bin Hasan & Zulzahran Bin Zulkifli  
**Supervisor:** A/Prof Amir Anvar  
**Sponsor:** Defence Science and Technology Organisation (DSTO)

Due to the restricted human’s ability to work underwater in deep oceanic environment for extended amount of time, an alternative way to assist human-operator(s) with underwater operations has been addressed. It is to build the Intelligent Submersible Manipulator(s). However, due to its high cost, the use of robotic manipulator in underwater operations is limited. For this reason, the Defence Science and Technology Organisation (DSTO) take the initiative to sponsor our project to investigate, design and develop a new inexpensive and lightweight prototype of submersible manipulator. The project will detail in the manipulator’s feasibility study, design and concept, as well as to implement manual and automatic control system. Apart from that, this project will also be involved in a number of testings and improvements of the manipulator. The development of this manipulator will assist human-operator(s) with several shallow oceanic underwater applications such as underwater sampling, search and rescue mission and other applications. This manipulator has been designed to move according to control-signals which would be directed and managed by human-operator(s). When compared to previous project’s manipulator model, our design has achieved several improvements which include smaller in size and possesses higher degree of freedoms (6 DOF). These improvements will increase their functionality and reliability during oceanic underwater operations and at the same time ensuring the efficiency of the shallow oceanic underwater operations. The exhibition will provide an overview of the manipulator design as well as the control system. The manipulator prototype will be on the display during the exhibition.
Intelligent UAVs and AUVs Condition Monitoring Systems (Mark II)

Students: Tao Du, Kwok Yui Goh & Zhefei Zheng
Supervisor: A/Prof Amir Anvar
Sponsor: Defence Science and Technology Organisation (DSTO), Rockwell Automation, Allen-Bradley & NHP

Unmanned Aerial Vehicles (UAVs) and Autonomous Underwater Vehicles (AUVs) operate and perform tasks in hazardous oceanic environments while under the control of a human operator. Despite their increased capabilities and prominence in usage, UAVs and AUVs are still susceptible to failure in various oceanic operation scenarios. This project aims to design, build and implement an Intelligent Condition Monitoring System (ICMS) compatible for usage in both vehicular module robots. The design involves three stages: Diagnosis, Prognosis and Remedy. Firstly, Diagnosis performs real-time analysis on UAV Structural Health Monitoring, AUV Navigation Monitoring and Battery Monitoring on both vehicular platforms. Secondly, Prognosis involves data processing and damage detection, and a decision-making process determining severity of fault through computer logic. Thirdly, Remedy is a solution module presented though a warning system and monitored through a Graphical User Interface (GUI) display panel. This device enables key subsystems to be constantly monitored while detection of failure can be addressed immediately to increase survivability and prolonging service time of both robotic vehicles. A prototype model of the Intelligent Condition Monitoring System (ICMS) as well as the details of the design concept, experimental results based on actual testing in collaboration with other Oceanic robotic projects will be displayed in this exhibition.
Automated C2 and Navigation System of Thermal Submersible Robot Glider for Deep-Sea Applications

Students: Zhongyi Wu, Mohd Naim Bin Yusof & Luqman Bin Zulkiply
Supervisor: A/Prof Amir Anvar
Sponsor: Defence Science and Technology Organisation (DSTO) & Chem- Supply

Thermal gliders are designed and built to be used in deep oceanic environments. It uses the thermal energy and would operate on the bases of the temperature difference of ocean instead of the mechanical energy. Therefore, thermal glider does not consume fuel so that the oceanic research cost can be reduced significantly, and in this case, the underwater operation time can extended. As a significant growth of need on oceanic study, Defence Science and Technology Organisation (DSTO) has sponsored this project to design a submersible thermal glider robot. The external system of thermal glider in this project has already been designed and constructed. The internal systems and sub-systems are under laboratory and trails phases. The other object of the project is to build an automatic control system, to allow thermal glider moving along the desired pathway, recording and sending out or receiving the information from and to operator(s). The Thermal Submersible Robot Gliders has a number of Oceanic applications including with Underwater Oceanic Environmental Study, possible Search and Rescue Missions, Underwater Mining Explorations, and Defence Applications.
Mapping Swarms

Student: David Michael Whitman
Supervisor: Dr Steven Grainger & Toby Lightheart

Simultaneous Localisation and Mapping (SLAM) is an algorithm used within robotics to build virtual maps of unknown environments. SLAM presents a unique challenge in that a robot's localisation is required to build a map whilst a map is required to localise the robot. This 'chicken or the egg' scenario has been a significant challenge to overcome since the concept was introduced to the academic community in the late 80's. The most effective SLAM methods available generally require expensive equipment, such as LIDAR and Stereoscopic Cameras. A mobile computer, acting as the robots controller, is also usually required to process the information from image/scanning sensors so that the map can be built and visualised. It has only been in recent years, with the emergence of 3D Image Depth Sensors, such as the Microsoft Kinect, as well as laptop computers with the necessary computing power and battery life that SLAM can be applied inexpensively in a multi-robot scenario. This project has developed a swarm of three robots equipped with Microsoft Kinects, which are used for mapping the environment. These robots have wireless communication capabilities allowing the robots to communicate while also allowing a user to monitor the swarm’s activities remotely.

Golf Swing Weight Transfer Analyser

Students: Justin De Blasio, Tze Shaun Lee & James Scott Olavesen
Supervisor: Mr. William Robertson & Dr Paul Grimshaw
Sponsors: Golf Biodynamics & The Physio Clinic

The game of golf has been an increasingly popular sport over the past century with the number of amateur players increasing in Australia and the United States. With the vast majority of these participants being a part of a higher age bracket, it is well known that the players have inefficiencies in their swing technique which can ultimately lead to injury. Therefore, a need to measure the efficiency of one’s golf swing is required. Computational models have been used with the integration of three-dimensional modelling systems in order to replicate the mechanics of the swing and identify the areas of most interest. However within the golf swing analysis market, the majority of systems focus on the upper torso of the player which excludes weight distribution and transfer, one of the primary aspects of the swing. Meanwhile, systems that do incorporate such technologies are relatively expensive. In conjunction, the purpose of Golf Swing Weight Transfer Analyser is to
develop a cost effective solution to analyse the weight distribution and transfer of a player while conducting a swing. The primary goals of the project were to develop a physical system as well as software that were able to effectively evaluate a player’s lower torso swing mechanics, in order to identify how inefficiencies are occurring. This exhibit showcases the physical system of the golf weight transfer analyser as well as the software associated with it.

22
3D Augmented Reality

Students: Ankit Bhandari & John Francis Redmond
Supervisor: Dr Tien-Fu Lu
Sponsor: MatrixGroup Pty Ltd

Obtaining high quality real-time 3D surface reconstruction of indoor environments opens the door to many new, exciting and useful industry applications. This prospect has only recently become feasible due to developments in depth sensor technology and GPU processing. Furthermore, in 2011 a Microsoft Research Paper presented 'Kinect Fusion', a 3D surface reconstruction algorithm that utilized these technologies and demonstrated a significant leap in real-time surface reconstruction quality. This quality is now at a level where using this algorithm for indoor mapping is advantageous as well as visually appealing.

This project tried to incorporate this new computer vision technology and augmented reality into a complete system to remotely inspect mining warehouses and infrastructure. In order to perform 3D mapping for the system, an open source implementation of the Kinect Fusion algorithm was utilized and extended. A remotely operated rover was set up to drive the depth sensor through its indoor environment.

23
Mechanical properties of bone in the lamb after intrauterine growth restriction

Student: Ryan David Quarrington
Supervisors: Mr. William Robertson, Dr Claire Jones, Mr. Reza Zarrinkalam & Dr Kathy Gatford

Intrauterine Growth Restriction (IUGR) is present in up to 17% of Australian pregnancies, occurring when a foetus receives inadequate nutrition during pregnancy. IUGR increases the risk of developing diseases such as osteoporosis, as well as poor bone growth. Insulin-like Growth Factor-I (IGF-I) is an important contributor to childhood growth and infusion during pregnancy
may mitigate the adverse effects of IUGR on bone health. This project analysed the effect of IUGR and IGF-1 on the mechanical properties and geometric formation of the femoral bone, using a sheep model. Three-point bending tests were conducted on the diaphysis of each specimen to obtain values for stiffness and ultimate load. The geometry of the diaphyseal region was determined from Computed Tomography (CT) images of each specimen. These measurements were used for direct comparison between groups and to estimate material properties of the bone structure from the structural properties. This display will include a model and videos of the mechanical testing procedure, as well as a poster describing the outcomes of the project.

24
Interlink Decision Making Index (IDMI)

**Students:** Zhichao Chen, Zhilong Gu, Zihao Gu & Zhou Zhou

**Supervisors:** A/Prof Eric Hu

Multi-criteria decisions usually require measurement or evaluation of performance in different units and their mix by application of weighting factors. This approach leads to potential manipulation of the results as a direct consequence of the applied weightings. In this exhibition a mechanism that is the brain child of the authors, has been proposed to overcome this problem. It is known as the Interlink Decision Making Index (IDMI) and has all the desired features: simple, interlink (all criteria) and automatically guaranteed dominant influence of critical criteria (i.e. no human weighting needed). The IDMI is capable of reflecting the total merits of a particular option once the normal decision making criteria and (up to two) critical criteria have been chosen. Then, without arbitrarily weighting criteria, comparison and selection of the best possible option can be made. Simple software has been developed to do this numerical transfer and graphic presentation. Two hypothetical examples are presented in the exhibition to demonstrate the application of the IDMI concept and its advantages over the traditional “tabular and weighting method” in the decision making process.

25
Vertebral strain Measurement Methodology

**Student:** Bartholomew James Scicchitano

**Supervisors:** Mr. William Robertson & Dr Claire Jones

Spondylolysis is a defect of the vertebrae that can cause low back pain, instability and nerve damage [1]. Although not well understood [1], the cause of spondylolysis is believed to be a combination of genetic predisposition and
repetitive micro trauma to the posterior elements of the lumbar spine, specifically the pars interarticularis (PI) [1, 2]. Determining the surface strain response of the PI to various load scenarios may help to elucidate the cause of spondylolysis.

The aim of this project is to develop a digital image correlation (DIC) methodology for accurately measuring the surface strain response of the PI. DIC is an optical strain measurement technique in which images of the specimen surface are captured before and after load application. Measurements of surface deformation are made by correlation of light intensity patterns in the image sequences, and surface strain can subsequently be determined.

Pilot studies using polycarbonate specimens and then a sheep model were used to determine an optimal DIC configuration using the available equipment. The chosen configuration was then validated using strain gages.


26
Direct Injection Retrofit To a Two-Stroke Motorcycle Engine

Students: Nicholas Edward Baum, Andrew Bede Burnheim, Luke Benjamin Dix, James Maxwell Hardy & Cameron John Parsons
Supervisors: A/Prof Bassam Dally & Dr Richard Craig
Sponsors: Bunnings, AUES, ArmorAll & Miguel Bros Trailers

Low emissions and high fuel economy have progressively become significant factors in the design of internal combustion engines. Two-stroke engines are typically used in applications where high power, low weight characteristics
and mechanical simplicity are preferred. However, inefficient combustion processes in these engines results in the production of significant emissions and low fuel efficiency. While many developed countries have implemented strict regulations to control engine emissions, two-stroke engines remain in substantial use in developing countries impacting both human health and the environment.

This project aims to retrofit the two-stroke engine of a Yamaha YZ-125 racing motorcycle with a direct injection fuel delivery system to decrease emission levels and increase fuel economy while retaining the characteristic high power output. This exercise aims to demonstrate the effect of retrofitting a motorcycle engine with a direct injection system to adhere to worldwide standards in transport and motorsport.

In this exhibition, results from this project will be displayed and analysed. The final design to convert the engine into direct injection will also be displayed. Furthermore, the design of the overall system and potential improvements will also be presented.

27

A Submarine That Can Fly

Students: Lara Megan Bond, Daniel Charles Brown, Lewin Scott Day, Josheel Johari Joganathan, Alex James Laratro, Kingshuk Nandy, Michal Stanek & Chia Xiong Thong
Supervisor: Dr Maziar Arjomandi

Vehicles have been developed in the past with the intent of traversing multiple environments, such as the seaplane (air/marine) and hovercraft (marine/land). There have been several documented attempts in the past to produce a craft capable of aerial, marine and submarine movement but a successful prototype has not been produced as of yet.

A craft capable of submarine travel must be voluminous enough to float and be able to become heavy enough to submerge. In contrast, a craft capable of aerial travel must be as light as possible and capable of generating enough lift to fly. These factors are directly opposed to each other, and a fine balance between the two must be attained to achieve travel in both media. In addition to this, creating a vehicle that is stable in all of these varied conditions is a further challenge.

The project aimed to design, build and test a prototype Submersible Aerial Vehicle (SUAVE) platform capable of stable travel in both environments using a single propulsion system. A prototype vehicle has been built and tested, and much has been learned through the development and testing of the hybrid platform. At the exhibition, the project team will present the prototype
vehicle as developed, as well as present the results of testing and learning in the relevant fields to submersible aircraft design.

28
Intelligent Energy Management System for Adelaide Airport T1

Students: Miao Wang & Wei Wang
Supervisors: Dr Ley Chen & A/Prof Eric Hu
Sponsor: Adelaide Airport Limited

This project aims to improve energy efficiency in Adelaide airport T1. The air-conditioning systems consume approximately 44% of total energy. Therefore, this project analyses the operation of air-conditioning and ventilation systems in T1 and their management system. There are two issues have been found which lead to energy waste. One is insufficient CO2 based ventilation control. Several areas’ CO2 level in the airport was measured higher than 800ppm. In order to improve the sufficiency, we proposed to install CO2 based ventilation control system to additional 11 AHUs, and also install additional sensors to increase measurement accuracy. The second issue is insufficient economy damper control. Economy damper control is a function of AHU to import outside air to the cooling cycle, so that to reduce energy consumption. However, several AHUs which installed economy damper control were not operate in this mode. Therefore, we proposed inspection and maintenance of economy damper control sensors. Meanwhile, add necessary programming to the management system. Moreover, analysis of energy saving and cost saving need to be considered as further work.

30
Commissioning of a Moog Hydraulic Hexapod

Students: Philipp Maximilian Allgeuer & Thomas Rowntree
Supervisors: A/Prof Ben Cazzolato & Mr. William Robertson

A hexapod, also known as a Stewart-Gough platform, is a 6-6 parallel manipulator capable of 6 degree of freedom motion. In March 2011, the University of Adelaide in collaboration with Flinders University purchased three large hydraulic hexapods from the Melbourne Aquarium for the purpose of testing and research. At the aquarium, the hexapods were used as actuator platforms for a motion simulation ride, and served as part of a complete audio-visual attraction. The aim of this project was to assist with the commissioning of one of these hydraulic hexapods as a tool for research and
consulting. This was primarily in terms of the development and coding of the control systems, but also in terms of certain aspects of the mechanical design work. Additionally, a graphical user interface and an intuitive control device were developed to allow the hexapod to be easily and precisely controlled without the need for extra coding on the user’s part. This is not the first time a project has been undertaken to commission a hexapod for research purposes, but this hexapod’s combination of size, payload capacity and functionality sets it apart from other facilities in Australia. It is being commissioned as a state of the art multipurpose six degree of freedom test and research facility, suitable for both static and dynamic research applications. Uses of such a research facility include earthquake simulations of structures, materials testing, flight and vehicle simulations, vibrations testing of structures, and automotive safety research. The accomplishments of this project will be presented, including a display of the developed control systems in action. The intuitive control device will also be demonstrated.

A solar and wind powered aerator for winery waste water treatment plant

**Students:** Xushen Liang, Yang Luo, Jun Wang & Yichen Wang
**Supervisors:** A/Prof Eric Hu & Dr Ley Chen

With the increasing of energy price, low-carbon, the energy-saving and environmental protection is becoming a live option for new development. Advanced technology led by solar and wind power green energy program status increasingly important in the field of power supply scheme. It can be predicated that use of renewable energy sources will have an explosive growth in the next decade.
The independent wind power or solar power systems have a common defect which is the uncertainty of power source. This uncertainty would cause the imbalance between power generation and load. Therefore, a hybrid renewable energy system, specifically the wind and solar power, use the complementarities of solar energy and wind energy in different seasons, different times and different weather conditions, making this two kinds of green energy to achieve the best possible match, and store the energy into battery. The battery can provide reliable and stable power output for aerator to inhibit the growth of plant in the water. The advantages of this system are environment free renewable energy, high reliability, complementary resources as well as low operating costs.

32

The Morphing Submarine

Students:  Luke Faranda, Saksham Garg, Munawwar Ahmad Mohabuth, Nachiket Sanjay Raje, Usama Rana, Trent Elliot Sforcina & On Kit Stanley Sin

Supervisors: A/Prof Andrei Kotousov & Dr Zhao Feng Tian

Since the 1950s, the design of submarine hulls has focused on achieving optimal hydrodynamic performance while submerged. However, submarines spend a significant amount of time near the surface, for a number of tasks such as patrolling the coastline, communication or for re-charging batteries. With less design emphasis placed on improving near surface efficiency, the overall hydrodynamic performance of the submarine is compromised. Morphing is a relatively new concept that has been successfully employed in the aerospace industry. The current project conducts a pioneering feasibility study on the application of morphing technologies to submarines. Implementation of such technologies would allow the outer hull of the submarine to morph into shapes efficient for surface as well as underwater operations. It is expected that this will lead to increased travel efficiency due to a reduction in hydrodynamic drag.

Several morphing concepts were considered and evaluated using multi-phase flow computational fluid dynamics (CFD) simulations. The analysis led to the
selection of two concepts, namely cross-sectional shape adaptation and length alteration. Two different actuation systems have been designed and built to demonstrate the respective morphing techniques. The exhibition will present the main outcomes of the project focusing on the design and evaluation of the prototypes of the two morphing concepts.

33
Measuring Hydrogen For HACC

**Students:** Muhammad Farook Maideen Ismail Maideen & Jonathan Zhi Min Lim  
**Supervisor:** Dr Erwin Gamboa  
**Sponsor:** CRC for weld structures

This project is aimed to construct a test rig to determine the amount of diffusible hydrogen from weld specimens. Hydrogen diffusing from weld induces Hydrogen Assisted Cold Cracking and forms an undesirable defect on steel. Such defects could cause detrimental effects on the structure and operation of pipelines. It will lead to an oil spillage or explosion. The test rig is built from laboratory apparatus and a collective fluid is deployed to facilitate accumulation of hydrogen. Basically, a fluid displacement method is adapted. A metal piece of a specific dimension will be welded on and soaked into a beaker of fluid. That fluid allows hydrogen bubbles to rise and accumulate by displacing the fluid. The amount of fluid displaced would be proportional to the amount of gas bubbles accumulated. Furthermore, experiments would be conducted based on specific conditions and will be monitored over a period of time. The results gained would assist to initiate further investigations on reducing Hydrogen Assisted Cold Cracking in steel pipelines.

34
Drag reduction through a wake alignment device for cyclists

**Students:** Rhys William Foreman & Nicholas James Kennedy  
**Supervisors:** A/Prof Richard Kelso & Dr Paul Medwell

Drag is one of the largest resistive forces on a cyclist (~90%) and like most bodies through fluid, a wake is left behind as the cyclist moves. Another cyclist following in this wake is able to save energy due to a reduction in drag and therefore required power. Maximising the energy saved can allow for faster times in events such as a team time trial or team pursuit. This project
aimed to develop a device capable of sensing the position of a cyclist relative to the wake of a leading cyclist, and provide adequate feedback to the rider. The wake behind a cyclist was modelled using wind tunnel testing and computational fluid dynamics. This model was then used to predict the pressure and velocity of the air stream at specified heights and distances behind the leading rider. This information was then used to design a device capable of sensing the wake and providing feedback depending on the cyclist’s current location. The handlebars and data processing software will be on hand during MechExpo.

35
ASRI MSLV

Students: Saman Aghdam, Benjamin Adam Lee & Dilan Dushmantha Wijedasa
Supervisors: Dr Steven Grainger & Dr Matt Tetlow
Sponsors: Australian Space Research Institute & The Sir Ross and Sir Keith Smith Fund

The Australian Space Research Institute (ASRI) Multi-Stage Launch Vehicle (MSLV) is a continuing project which aims to increase the performance capabilities of current ASRI rockets by developing a two-stage rocket consisting of a Zuni rocket first stage and a Sighter rocket second stage. Delivery of the MSLV will greatly enhance the research capability of both ASRI and the University of Adelaide, and will allow Australian and international researchers the ability to test high performance payloads, such as Scramjets, at greater velocities than those currently achievable. The MSLV requires a new avionics system to perform data acquisition, trigger recovery mechanisms and to transmit GPS data to the launch bunker. Data acquisition includes supersonic test section pressure data, 3 axis acceleration and angular rate. The 2012 team have designed the avionics software suite and completed a preliminary design for a Dynamically Stabilised Payload Bay. Flight tests have verified the operation and performance of the avionics system.

40
E-WaVe – Electric Water Vehicle

Students: Andrew Mark Jolley, Thomas John Mahoney, Scott Edmund Nankivell, Krishna Chaitanya Narapuraju & Andrew David Reed
Supervisors: A/Prof Colin Kestell & Dr Antoni Blazewicz
The aim of project e-Wave is to produce a prototype electric personal watercraft. Many people use personal watercraft, the most commonly known as the Jet Ski, but in general, these craft have a reputation for being noisy, polluting menaces. This is understandable though, as the engines on these machines have to be small and yet pump out high horsepower. The result is a noisy petrol engine resulting in fumes and fun for the user but not for those around. This project, however, aims at providing a solution for some of these current problems, but to do so without taking away the users enjoyment. This solution is an electric motor, as they are quiet, and fume free. Thus, we have designed a proof of concept design of an electric Jetski.

**CFD Modelling of Fire in Aircraft Cargo Holds**

**Students:** Robin Glynn Garvie & Guo Ren Koh  
**Supervisors:** Dr Zhao Feng Tian & A/Prof Bassam Dally

Fire in aircraft is an especially dangerous phenomenon, specifically in the cargo hold which is generally inaccessible during flight. This project aims to develop a fire model based on computational fluid dynamics (CFD) techniques. These models will later be used to investigate some vital characteristics of fires in aircraft cargo holds.

Two fire models, a heat source model and a combustion model, were developed using the CFD software, ANSYS CFX. A soot model was also implemented in the combustion model. A room fire experiment was used to validate the models. The project then progressed to a stage to validate an aircraft cargo hold fire. This was done based on past experimental studies in literature. Both the combustion and soot models from the previous validation were utilised in this case. The cargo hold fire validation model was then transported to a more current aircraft cargo hold geometry, a Boeing 707, where similar results were produced.
Collaborative Autonomous Underwater Vehicles (Marco Polo)

Students: Cameron James Edwards, Peta Johannsen, Tony Loi, Zhao Joe Lu & Miteshu Varun Ramnarain
Supervisors: Dr Steven Grainger & A/Prof Colin Kestell
Sponsor: Norwood Swim School & eLabtronics

Defence and oil industries are displaying an increasing interest in the development of swarms of Autonomous Underwater Vehicles (AUV), to complete missions collaboratively. This project looks at two vehicles working together to complete a mission. Swarm technology allows for a more rapid completion of missions, and the opportunity to have an expensive, smarter AUV and a number of cheaper, less capable AUVs to complete a mission. The spread of expensive equipment across multiple AUVs means that the loss of an AUV is less detrimental. This project demonstrates the principles associated with Swarm technology at a fundamental level. A basic collaborative system and mission were designed to demonstrate the feasibility of very basic collaboration between two vehicles, Marco and Polo, in the controlled environment of a swimming pool. The basic mission consists of Marco using a higher-level processor to search for an object of interest, using image recognition. This AUV is then able to communicate the location of this object to Polo using an optical signal. Polo then travels to the object of interest and deploys a payload. The mission designed emulates that of a counter-mine mission. However, this mission can be modified to simulate many other real scenarios.

Mechanism to apply pure moments and controlled axial load to a lumbar spine

Student: Scott Caddick

There are many medical procedures to reconstruct damage spine elements, such as slipped discs and damaged vertebrae. In order to achieve the best results these medical techniques, along with new ones, must be tested. Currently in the Adelaide Royal Hospital there is an INSTRON materials testing machine, with special components for spine testing. However this machine has proven difficult to use and so a simpler rig is sought after simple spine testing. Current work in the lab tests the lumbar spine region, so in the
I aim to build a mechanical rig to test the lumbar spine region. The rig must apply pure moments to the spine, in flexion/extension, lateral bending and in torsion. Results from the rig will then be compared to that of the INSTRON machine in a simple test.

44
Canoe/Kayak devices for training and measurement

**Students:** Kimberley Alice Andersen, Luke Demetriou & Craig Anthony Rowbottom  
**Supervisors:** Mr William Robertson & Mr. Ami Drory  
**Sponsor:** Australian Institute of Sport

The Australian Institute of Sport seeks to increase the popularity of the Olympic sport of canoe/kayaking, increasing the need for the development of training and measurement devices relevant to the sport. Subsequently, the AIS has teamed up with the University of Adelaide to achieve this goal. The project is divided into three parts; a power ergometer, an assisted and resisted training system and an accelerometer based measurement system. The power ergometer aims to increase and measure athlete’s power and analyse stroke technique off the water. The assisted and resisted training system aims to increase athlete speed and power on any lake or flat-water area. The measurement system seeks to determine athlete performance markers, such as stroke rate and count, based on accelerometer data. Finally, the three projects will use common techniques to create graphical user interfaces to allow coaches and athletes to view and analyse acquired data. This exhibition will display components of each of the three subsections, how they integrate with each other, their motivation, the design process and progress to date.

50
FSAE: Active Anti-Roll System

**Students:** Daniel Gary Kotz & Brian Allan Maddocks  
**Supervisors:** A/Prof Anthony Zander & Dr Zebb Prime

The Formula SAE® Series competitions challenge teams of university students to conceive, design, fabricate, develop and compete with small, formula style, vehicles. This project aims to investigate, analyse, design and test an active anti-roll system for the University of Adelaide’s 2012 Formula SAE vehicle. An anti-roll system forms a part of the suspension components
to help reduce the roll of the vehicle under load, such as that experienced through cornering. The anti-roll system has two main functions, the first to reduce the body roll of the vehicle and the second to tune the handling performance. Using hydraulic actuators, motion sensors and a controller an active system automatically reacts to minimise the body roll as the vehicle is driven through different loading situations and improve drivability of the vehicle.

51
Hypersonic X-plane Design and Analysis (Red Team)

Students: Lachlan Hugh Ambrose, Ashley Robert Chadwick, James Jarvie Connor, Julian Jaber, Alana Jade Overmeyer, Samuel Edward Paull, Taree Jolene Schilling & Mark Thomson
Supervisors: A/Prof Con Doolan, Dr Zebb Prime, Mr. Ashley Rowlands & Dr Matt Tetlow

The growth of the hypersonic research industry is restricted by the lack of testing options available. Above five times the speed of sound, the only viable test methods are hypersonic wind tunnels or an aircraft platform. Current wind tunnels cannot provide all the necessary conditions, while test vehicles are largely expendable and limited to one-off tests. These factors mean that the growth of knowledge of the hypersonic regime has been limited since the late 1960s, with the cancellation of the American X-15 hypersonic research program.

The objective of this project is to provide a conceptual design for a reusable air-launched hypersonic X-plane, called HARVe (Hypersonic Air-Launched Reusable Vehicle). The goal is to investigate the feasibility of creating a hypersonic test program in South Australia with a vehicle that is reusable. The HARVe platform must be able to carry a payload up to a test condition of Mach 8 at an altitude of 26 kilometres for one minute after being air-launched from a subsonic platform, and then safely deliver the payload to the ground. The exhibition will display the work and final results on the design of the vehicle and test program.
The Multifunctional Lift Design project involves the development of a prototype lifting attachment to a vehicle hoist. Molnar Hoists have sponsored the project, which aims to produce a design to cater for three wheeled and unique chassis layout vehicles. The attachment will be adapted to an existing Molnar Hoist. Currently there are no hoist designs or special attachments purely for these vehicles; there is then an opportunity for a new multifunctional design.

A hoist or lift is a vital piece of equipment in a vehicle workshop, as it provides a safe and efficient way to raise and lower a vehicle for service and repair. Vehicles with unique chassis layouts, such as golf cars, quad bikes and three wheeled mowers, prove difficult to lift for the necessary services and repair.

The key aspect of the project was to carry out thorough industry and market research to confirm which vehicles are in demand to be hoisted. The results from this in-depth research signified the direction that was taken in the Conceptual Design stage of the project. This led to a detailed hoist adaption which was adjustable as well as removable, still permitting use of the base hoist for four wheeled vehicles. The design was optimised through the use of Finite Element Analysis and a prototype was manufactured and tested.

The fully functional prototype will be on view to demonstrate the ease of attachment to the existing Molnar Hoist, and the adjustment for a specific wheel size.
53
Solar Thermal Air Conditioner

**Students:** Jason Anthony Abela, Charles Anstey, Andrew Paul Mickan & Amelia Tess Simpson  
**Supervisors:** Mr. Gareth Bridges, Mr. Andrew Allison & A/Prof Eric Hu  
**Sponsor:** The University of Adelaide (School of Mechanical Engineering)

In the hot summer months in Adelaide electrical demand arising from air conditioning units often approaches 50% of the total load. The high demand on the electricity grid contributes to carbon emissions and often results in blackouts.  
This project investigated the feasibility of an absorption refrigeration cycle driven by solar energy. It continued on from previous year's work, with the aim to construct a prototype capable of delivering space cooling for domestic application.  
Absorption refrigeration uses thermal energy to drive a refrigeration cycle and hence can use solar heat, whilst traditional compression cycles use electricity, a largely non-renewable source. Optimization of the collection of solar energy has been considered also, with the implementation of solar tracking.  
Initially the project this year sought to implement the absorption system designed and developed in previous years. However budget constraints have led to the investigation of an adsorption refrigeration cycle instead.  
The adsorption cycle works on an intermittent basis whereby the refrigerant transitions from an adsorbed to a desorbed state with the addition of heat. Transition in the reverse direction produces the desired cooling effect. This exhibition will display the work completed this year.

54
Light and Efficient Ornithopter (LEO)

**Students:** Caroline Chiaw Chai, Ho-Cheer Lam, Vu Nguyen, Danny Nguyen, Vinh T Tang, Jonathan Jun Min Yeap & Li Jin Kenneth Yeoh  
**Supervisor:** Dr Ley Chen  
**Sponsor:** Adelaide University & Laucke Flour Mills Pty Ltd
Have you ever imagined a robotic bird soaring overhead? Come and see LEO! You will not be disappointed when you see the prototype, and understand the state-of-the-art design and manufacturing processes that went into LEO.

The Light and Efficient Ornithopter (LEO) is a first for the University. Sponsored by Laucke Flour Mills, the aim of the project is to design and build a prototype flapping-wing aircraft that flies like a bird.

Most existing ornithopter designs are incapable of achieving realistic bird wing motions, and are largely limited to vertical flapping. The LEO prototype, however, has been designed to incorporate fundamental avian characteristics, including wing twist, an elliptical wingtip path and segmented wing flapping, making it more bird-like in nature.

The project received assistance from MapleTree Investments, IMP Printed Circuits and Technology Education Centre to see it through the design and manufacturing phase. Do drop by to see LEO in action.

55

BlueBottle Navigation and Control

**Students:** Lewis John Bails, Jonathan Paul Lines, John Noonan, Steve Pavloudis, Benjamin David Schulz & Andrew Vaughan Wheatland

**Supervisors:** Dr Steven Grainger & A/Prof Colin Kestell

**Sponsor:** WaveRider Energy

Autonomous Underwater Vehicles (AUVs) are at the forefront of scientific underwater exploration. Tasks involving underwater exploration and equipment inspection can now be done autonomously. An AUV is an untethered, submersible vehicle that can be programmed to complete underwater tasks utilising on board navigation and information systems. Sponsored by WaveRider Energy, the BlueBottle AUV aims to navigate in
The BlueBottle submarine uses an inertial measurement unit, acoustic distance determination and visual odometry to determine position and orientation, which are essential to autonomous navigation. The inertial measurement unit uses a dead-reckoning technique to determine position and velocity, which can introduce drift in the estimated position and velocity. To bound this error, a single acoustic transmitter, single hydrophone system has been developed, which determines the distance between the AUV and a known point. Three degree of freedom monocular visual odometry, which extracts information from a camera to determine velocities, also aims to bound this error. An extended Kalman filter was created to optimally combine the measurements from each of the above navigation systems. Software and hardware has been developed to integrate subsystems into a remotely operated vehicle and allow for further development into an AUV. The BlueBottle has been extensively tested, in a wind tunnel and in water up to a depth of 10m. The exhibition will demonstrate the development of the BlueBottle submarine and associated subsystems.

Design of a novel energy system for Kangaroo Island involving wind power, hydrogen and battery backup

**Students:** Kimberley Chare Yiing Kueh & Jin Han Lim  
**Supervisors:** Prof Graham Nathan & Dr Rob Dickinson  
**Sponsor:** Hydricity Systems Australia

Kangaroo Island (KI) is Australia’s third largest island and is currently relying on an aging submarine cable connected from the mainland for its electricity supply. An opportunity to introduce renewable energy systems arises when
KI's energy demand is seen to steadily increase and the proposal for a cable upgrade was rejected due to high costs. The objective of this project is to design a reliable and economical power supply system to KI using wind energy, hydrogen storage, and battery backup. The present project is a continuation of the work done in the previous year, where it was found that the displacement of the underwater cable usage with renewable energy systems is feasible and economically viable.

This year’s project identified Penneshaw as the proposed location of the wind turbine site and a function to derive wind speeds at the location was produced. In addition, it also aims to design a system based on wind energy, conversion of electricity to hydrogen, hydrogen storage, exploitation of the hydrogen as fuel, conversion of hydrogen to electricity, and battery backup by performing a complete assessment with MATLAB. In this exhibition, the group will present results obtained and the methods used to derive wind speeds at Penneshaw.

56
CFD analysis of the wind over Kangaroo Island for wind power performance assessments

Student: Manogna Maduri  
Supervisor: Prof Graham Nathan & Dr Rob Dickinson

The project involves Computational Fluid Dynamics (CFD) analysis of the wind over Kangaroo Island which is used in assessing wind power performances. The main aim is to evaluate the wind flow behaviour over the two existing Bureau of Meteorology (BOM) stations and potential wind farm site on Kangaroo Island using CFD modelling. The two locations with the BOM sites are Kingscote Airport, and Cape Willoughby and the site of interest is Penneshaw. This is to improve the predicted wind performance analysis done in 2011, based on the flat boundary layer approximation, with that at the actual wind farm site. Also, different to last year, this year the focus is on 2D modelling the areas of Kingscote and Cape Willoughby coupled with actual wind data to predict the magnitude of wind at Penneshaw. This is an extension of the project 1280. Design of a Novel Energy System for Kangaroo Island involving Wind Power, Hydrogen & Battery Backup. Using the data from the afore mentioned project, a wind resource analysis by accounting for short-term variability in wind flow on Kangaroo Island, where the data will be modelled at 5-minute intervals instead of the 30-minute intervals done in the previous year. The poster and exhibition will show the outcome of the project.
Design and Analysis of a Hypersonic X-Plane (Blue Team)

Students: Matthew Yue-Hon Chan, James Middleton Griggs, Daniel Hew, Vijay James Hillier, Stephen George Hubbard, Timothy James Larden, Robert John Pallotta & Ric Zong Yang Porteous
Supervisors: A/Prof Con Doolan, Dr Zebb Prime, Ashley Rowlands &Dr Matt Tetlow

Hypersonic technology has seen slow development in recent years due to a lack of efficient testing techniques. Hypersonic wind tunnels are costly and provide test times of less than a second. Current hypersonic test vehicles, such as HyShot and HiFire, are destructive and provide results at unrealistic conditions. The Design and Analysis of a Hypersonic X-Plane Project aims to address these issues by developing a ground launched, reusable hypersonic test vehicle which can test variable payloads at conditions of Mach 8 and 100 kPa for 60 seconds, with a weekly turnaround.

The focus of this project was a preliminary design of such an X-Plane. The aircraft was analysed to show its performance characteristics about an optimised trajectory. Additionally a preliminary cost of the development and operation of the aircraft was estimated.

Overall, the project demonstrated that a reusable hypersonic aircraft is both technically and economically feasible. A scale model of the X-Plane, The UA-X1, will be on display along with simulation software that will demonstrate the results of the project.
61
Increasing energy efficiency at Barossa Valley winery warehouse

Students: Da Ares Huo, Sean David King & Sicong Ma
Supervisors: Dr Ley Chen & A/Prof Eric Hu

The Orlando Wines winery is located in the Barossa Valley, where the wine is stored and distributed through two warehouses. The wine is stored in two air conditioned warehouses and is required to be stored at 15°C to ensure maximum quality. Maintaining the warehouses at exactly this temperature is not possible and it is acceptable that the temperature can reach up to 20°C. Due to the climate conditions, this temperature is maintained without air-conditioning through the months May to September. The air conditioners are required to run at only half capacity during October and April, and full capacity from November to March. The project focus will be mainly through the November to March period.

The aim of the project is to increase the overall efficiency of these two warehouses. Solutions to increase the overall efficiency includes changing current lighting system to LEDs, installing motion control for lights and increasing the capacity of the transformer. Analysis and modeling will be given with the assist of software such as Excel, ANSYS and Design Builder. Energy saving strategies will be concluded and based on the results from analysis and modeling and pricing specifications supplied by Orlando Wines.

62
Cycling Aerodynamics

Students: James Kennion Chataway & Timothy James Morrow
Supervisors: A/Prof Richard Kelso & Dr Paul Medwell

In the world of competitive cycling a strong emphasis is placed on developing new techniques to analyse and improve the aerodynamic performance of a cyclist and their apparel. Typically this is done by either placing the item by itself in a wind tunnel, place a cyclist in the wind tunnel wearing the item or to model the system using CFD. However all of these methods have their own inherent drawbacks affecting the accuracy or consistency of the results. Hence, a test rig comprised of a mannequin in a cycling pose fitted with sensors could consistently give accurate measurements of the test rig's head, torso and total drag.

One of the objectives of this project was to develop a test rig to fit a mannequin such that consistent and repeatable drag measurements of the helmet and body can be made. This allows the aerodynamic interaction between the helmet and the cyclist’s body to be analysed. This test rig was
then used to investigate the effects of trip wires and other helmet modifications on the overall drag on the rider using the new Thebarton wind tunnel. Detailed aerodynamic analysis of these modifications can contribute to the development of the next generation of high performance cycling helmets.

63
Seed Sorter

**Students:** Muhammad Afifi Shakir Mahmood Sabri, Ahmad Aiman Zainal Abidin & Megat Mohd Hazwan Zamir Zairi

**Supervisor:** Dr Tien-Fu Lu

**Sponsor:** The Plant Accelerator

With the increase of research in plants and their growth, The Plant Accelerator research centre located at the Waite Campus of the University of Adelaide has sponsored this project which is aimed to sort and count plant seeds including barley and wheat seeds according to their quality and sizes. A sorting device is therefore designed and fabricated to fulfill the requirements. The sorting device contains a sorting mechanism and a counting mechanism.

Sorting mechanism consists of machine vision and mechanically-operated chute. As for the machine vision, webcam is adopted to capture images and programs developed in MATLAB are used to sort the seeds according to their sizes and quality. Once a seed is being identified, according to its size and quality, signals are sent to servo motor to direct the chute to designed corresponding angle. The seed then slides into the corresponding container. The servo motor is controlled by programs developed in MATLAB and through Arduino which is an open-source electronic prototyping platform allowing users to create interactive electronic objects. As the servo motor moves, the developed programs will record the number of seeds dropped into each container. The desired result is the separated seeds in containers with
known numbers of the total seeds in each container. The performance and accuracy of the device have been estimated and calculated before the final design is chosen. The actual accuracy will be experimentally verified after the device is fabricated and integrated. The exhibition will demonstrate and report on the functions as well as the performance and accuracy of the device.

64
Fire modelling in aircraft cabin

Students: Ping Dai, Li Wei Jiao & Lide Tong
Supervisors: Dr Zhao Feng Tian, Dr Lei Chen & Dr Paul Medwell

Flight accidents are always accompanying fire and cause a lot of damage. In order to understand the fire development in aircraft cabin, the volumetric heat source (VHS) model based on computational fluid dynamics (CFD) techniques has been used to predict fires in terms of airflow patterns, temperature distribution and smoke spreading. However, VHS is simple and not able to describe fire development accurately. Combustion or reaction model can give better simulation results. In this paper, both VHS and combustion model are developed using the commercial CFD software ANSYS/CFX. Steckler’s experiment and Full-Scale Flammability Test Data for Validation of Aircraft Fire are two validation cases to evaluate both models. Then the combustion model is applied in the Boeing 737 cabin to describe the fire development.

65
High Performance Electric Motorcycle

Students: Lachlan John Flynn, Andreas Philip Henschke, Robert Gordon Huddleston, Thomas Daniel Preece & Owen Bernard Riley
Supervisor: Dr Ley Chen
Sponsors: Lynas Auto Group, Jamestown Engineering and Manufacturing (JEM), Webb’s Tyre Service, SolidWorks & Sims B & P Pty Ltd Engineering

This Final Year Project involves the research, design and development of a High Performance Electric Motorcycle (HPEM) that would be a commercially viable alternative to the combustion performance variants. As the environment is a major concern to the current population, and the generation of electricity can come from renewable sources, the use of electricity in transport is an important step in development.
This project proposes to retrofit an electric motor and batteries to a commercially available performance motorcycle. We see this as the stepping stone between the current electric motorcycle range available for commuters and the high end electric motorcycle racing. It will give the consumer the chance to play their part for the environment but still feel and look as though they are riding a combustion performance motorcycle. The final product will indeed ride similar to that of an equivalent combustion powered motorcycle at a fraction of the cost for the consumer.

66
Design and Manufacture a Air Moisture Condenser

Students: Raymond Tsin Kiat Liew, Wei Xue Lim, Tze Herng Ng& Perng Yih Tan
Supervisors: Dr Erwin Gamboa

In 2012, University of Adelaide has planned to implement on the success of previous group from 2010 in designing and manufacturing a passive air moisture condenser. This air moisture condenser with its basic condenser structure, insulation control, water extraction and most importantly its air delivery system relies upon fluid dynamics principle to extract water vapor through high humidity ambient air in the atmosphere. These requirements of the system can be achieved by using a vortex tube to significantly reduce the operating costs and complex configurations. Furthermore, the project has assessed the use of vortex tube with further implementations on the device, focusing on coil as the water condenser to optimize the volume production. Multiple scenarios were analysed using the achievable system models developed by the 2012-team members to investigate the effect of variations in volume and duration of water production in order to achieve the feasible goals. Major goals include 2 litres of water production in 24 hours, purifying water to drinkable quality and using vortex tube as the major medium delivery to efficiently condense water from air moisture. In this exhibition, the 2012 team will present the design, development and results of the project.

67
Low cost laser distance scanner development

Student: Qing Wan
Supervisor: Dr Tien-Fu Lu

Laser light is ideal for measuring distance due to its strongly directional and monochromatic natures. With the rapid development of modern electronic
technology and the ever-improving performance of optoelectronic devices, laser range finding has become one of the most popular technologies being used for distance measuring. As a method to collect real-world data and construct digital images, laser scanners have a range of applications in many fields such as entertainment, medical, manufacturing and archeology. The intention of the project is to study and understand the working principles of laser distance measuring devices and to develop a low cost 3D laser scanner for indoor and potentially outdoor robotic applications. The device works on the principle of active triangulation: it shines and moves a continuous strip of laser across the subject and use cameras that sit on a predetermined location to detect the reflected laser light. A computer then processes the captured images, calculates distances based on the angle of laser reflection and then constructs 3D model of the object or the environment.

68
High Temperature Thermal Energy Storage System

Students: Kerryn Marie Obst, Chad Phillip Taylor, Peter William Thorley & Jesse Erik Voyer  
Supervisors: Mr Gareth Bridges  
Sponsor: Gnomon Technologies Pty Ltd

One of the key obstacles limiting the development of largescale renewable energy supply is the intermittency of sources such as wind and solar. Gnomon Technologies Pty Ltd has sponsored this project to develop a proof of concept High Temperature Thermal Energy Storage System to mitigate this problem. The thermal energy storage system stores energy as latent heat until it is required, at which point the energy is recovered as electricity by a Stirling heat engine. The addition of a thermal energy storage system to current renewable energy technologies would allow the intermittent nature of the sources to be buffered by storing energy when it is in excess and recovering it when the source is unable to meet demand. This has the potential to enable renewable sources to supply reliable base load power. The goals of the project were to characterise the heat engine supplied by Gnomon Technologies and design a thermal energy storage system compatible with the heat engine. The project has been focused on the containment of the thermal mass and the heat transfer between the thermal mass and the heat engine.
69
Analysis and force modelling of permanent magnets

Students: Callan George Byfield & Daniel William Fordred
Supervisors: Mr. William Robertson & A/Prof Benjamin Cazzolato

Rare earth permanent magnets are being used for an increasingly wide range of mechanical design purposes due to their relatively low cost and ready availability. With this rising interest comes a rising need to model the force vs. displacement behaviour and resultant torque of these magnets. It’s possible to model the forces either analytically or with FEA. Computer simulated modeling such as FEA, while able to handle arbitrary geometries, is slow to calculate solutions. Analytical methods are much faster yet are restricted to simple geometries and displacements. More complicated geometries must be derived from solving integral equations. In some cases, the analytical methods have not been verified experimentally or the published literature for certain geometries has a variety of solutions. This Exhibition will detail the research and experimentation undertaken in order to better understand the interactions between permanent magnets so that they may be used to validate theoretical advances and possibly have a wider variety of purposes in the future, such as in the area of prosthesis. The main work behind this project can be split into three main areas. Primary among them was physical experimentation through the use of a custom made testing rig. This rig holds varying pairs of magnets with the resultant displacements and forces between them measured by a 6DOF load cell and a laser displacement sensor. Lastly, both ANSYS and MATLAB were used to create models to be compared against the resultant experimental data.

70
Corrosion of Collins class 70/30 copper nickel heat exchangers

Students: Izaac Tiernan Bradley & Daniel Ong
Supervisors: Dr Erwin Gamboa
Sponsor: ASC

ASC has identified corrosion damage to the auxiliary cooling systems on the Collins class submarines moored in the Port River. This project was sponsored to identify the cause of this damage and provide a possible course of action to prevent recurrence. The auxiliary cooling system heat exchanger utilizes a shell and tube design to reject heat load from the submarine into the sea. Seawater is run through tubes manufactured from 70/30 copper-nickel
(Cu Ni), which obtains its corrosion resistance from a surface-formed resilient oxide layer called a passivation layer. The Port River conditions, in which the submarines are moored, cause rapid deterioration of these tubes. The auxiliary cooling system is essential for maintaining the atmospheric temperature for the crew and cooling most of the equipment inside the submarine. Deterioration of the heat exchanger tubes due to corrosion increases costs due to maintenance and refurbishment, increased maintenance frequency and the reliability of the heat exchangers is diminished. Therefore mitigating corrosion damage will provide significant advantages to the cooling system.

The project focus was to design a testing rig to determine the rate and mode of corrosion of the 70/30 copper nickel heat exchanger tubes as a result of Port River water conditions. Following sample preparation (passivation) the tubes are subjected to different testing conditions in order to isolate the corrosion mechanisms and recreate operating conditions. Comparison of experimental corrosion rates to literature values allow the mode of corrosion to be determined.

71

Oscillating water column wave power converter for Micro-generation

Students: Craig Lindsay Aistrope, Miles William Angus, Koby Alan George Bollard & Scott Edward Jenkin

Supervisors: Mr Graham Nathan & Dr Brian Kirke

Sponsor: SEADOV

Demand for clean, renewable energy sources has led SEADOV P/L to sponsor this project to demonstrate the viability of a low cost, small-scale floating Oscillating Water Column (OWC) as a sustainable electrical energy generator. OWC technology utilizes ocean waves to pressurise air inside a chamber that can subsequently be harnessed by a turbine to generate useful electrical energy. Lab-scale experiments, conducted at the University of Adelaide since 2008, have shown a significant increase in conversion efficiency when an OWC vessel’s natural frequency is matched to that of the oncoming waves. Therefore, the project aims to design and construct an OWC vessel with an adjustable natural frequency for testing in an ocean environment and to identify the conditions at which the OWC is an economically viable source of power generation.

The project has involved the design and manufacture of an OWC vessel prototype that consists of a lightweight aluminium support frame, three chambers arranged in a triangular configuration. The natural frequency of the vessel is variable through both the variation of span and the variation of system mass. The exhibition will showcase the completed OWC vessel and provide an insight into the feasibility of the technology.
SERF - a handy helper for dirty work

**Students:** Zi Chian Teo  
**Supervisors:** A/Prof Anthony Zander

Nurses and carers risk contact with hazardous toxic waste when manually removing and disposing of faeces from a soiled person, their clothes, bedding or furniture, especially if the person is ill. Therefore, this project focuses on designing and building a prototype device capable of handling and disposing of the hazardous waste, while ensuring minimum contact, thus providing them a safer working environment. The prototype device uses the concept of a wet and dry vacuum, with a modified nozzle to ensure the device will be safe for use on the human body. Since this is a prototype, tests will not be carried out on actual faeces on the human body due to the risk of harm. Therefore surrogate faeces and surrogate surfaces were created as a substitute for testing the device. The tests indicate that the prototype device is safe for use on the human body, and is effective and efficient in removing faeces from any surface. Besides providing nurses and carers with a safer working environment, the prototype device may also make the task of cleaning up a soiled person easier, by minimising the amount of manual labor required if the person is cleaned in place rather than moved to a shower.

Heterodyne listening device

**Students:** Nicholas Peng-Hao Cheng & Wei Shern Wong  
**Supervisors:** A/Prof Benjamin Cazzolato, Dr Zebb Prime & Mr William Robertson  
**Sponsor:** Arup

Low frequency sounds emanating from sources such as rail traffic and ventilation plants are often difficult to identify as they are masked by ambient noises and may be below the audible frequency range of the human ear, which typically cannot perceive frequencies below 20Hz. Sponsored by Arup and the University of Adelaide, this project aims to develop a heterodyne listening device which allows the user to listen to sounds emanating from these lower frequency bands that would otherwise be inaudible. Such a device will enable engineers working on site to listen to these otherwise inaudible sounds in real time, allowing for quick evaluation and identification of these noises and their sources, which would otherwise require extensive post-processing. The construction of the heterodyne listening device was achieved using a digital signal processor programmed with a pitch shifting algorithm designed
using Matlab and Simulink. The device is able to receive analogue sound signals as an input, digitally shift the frequency of the signal and then output the processed signal through headphones or speakers in real time. To improve the range of signals that the device may be used to listen to, it also features several selectable digital audio filters, which can be used to attenuate unwanted noises and a gain control that amplifies the sound output. The heterodyne listening device, and its real time frequency shifting capabilities, will be demonstrated at the exhibition.

74
A techno-economic assessment of the integration of a gasified waste stream into South Australian power stations

Students: Amber Minette Kirkpatrick, Daniel James Thomas & Mark Edward Wigg
Supervisor: Prof Graham Nathan & Dr Ross Haywood
Sponsor: Hatch Associates Pty. Ltd.

Waste treatment and energy production are two key elements associated with sustainability. This project addresses both of these directly. Many municipal and industrial waste products can be converted into a gaseous fuel known as synthesis gas, or syngas. This project builds on a preliminary design assessment of a proposed syngas plant conducted by Hatch Associates, the project’s industry sponsor. Their work included the design, modelling, and costing of a gasification plant and its output pipeline. However, no previous assessment has been made of potential end-users.

The overall objective of this project was to estimate the technical and economic viability of substituting syngas for the natural gas used in three South Australian power stations, and to identify the most cost-effective approaches for doing so. The stations considered were Torrens Island Power Station, Pelican Point Power Station, and the Dry Creek Peaking Station. In addition to the technical and economic assessments, some environmental considerations have also been addressed. This series of assessments focused on retrofitting requirements and operational issues. The results of these assessments will be presented, including a discussion of potential integration points and systems, modelling of the power stations’ systems, and the impacts of the new Clean Energy Future legislation.
Design of a pumping system for agitation of lead acid cells

**Student:** Lachlan Charles Brazell  
**Supervisor:** Dr Erwin Gamboa  
**Sponsor:** PMB Defence

Diesel Electric Submarines use large lead acid cell banks as a power source during operation. PMB Defence manufacture complex, large lead acid cells for use in Australia’s Collins Class submarines. Due to their large size, the electrolyte can form a varying density gradient under charging and discharge cycling, which is known as acid stratification. The current system involves supplying compressed air to each cell in order to agitate the electrolyte. This project investigated redesigning the system to comprise of a single cell powered pump in order to remove the external compressors as well as 2000m of air hosing. The common problems of cluttered cell tops and air hose blockages are eliminated by this redesign. Additionally, by isolating each cell’s agitation system, failures don’t propagate throughout the cell network. This presentation demonstrates the work that was undertaken in order to find a feasible pumping solution. The testing procedures, concept designs and results will also be presented along with a demonstration of the final system in operation.
Project Sponsors

![Australian Plant Phenomics Facility](image1)

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