Faculty of Engineering

ENGG1000 – 1 Page Project Summaries – S1 2016

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Please read through before Monday

Any questions – please post in Moodle Forum

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School of Chemical Engineering
Chemical Engineering Project:
ENERGY STORAGE FOR SUSTAINABLE TRANSPORT

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The human race appears to be facing a number of converging crises in the 21st century including climate change, damage to natural ecosystems, energy security and resource scarcity – in short, the sustainability of our current way of life. These represent huge social, political and technical challenges for society in general and for engineering graduates in particular.

One of the many issues is our transport system, which is almost entirely dependent on crude oil as a primary energy source. Now that the problems with continued reliance on crude oil are becoming increasingly obvious to all, there is renewed interest in electrically powered transport as an alternative. Once transport is electrified, renewable energy can be used to power it. Batteries, the *sine qa non* of more widespread electric transport, are however not yet up to the task. Existing battery technologies are generally too heavy, too expensive, or both – i.e., they represent a key technical barrier.

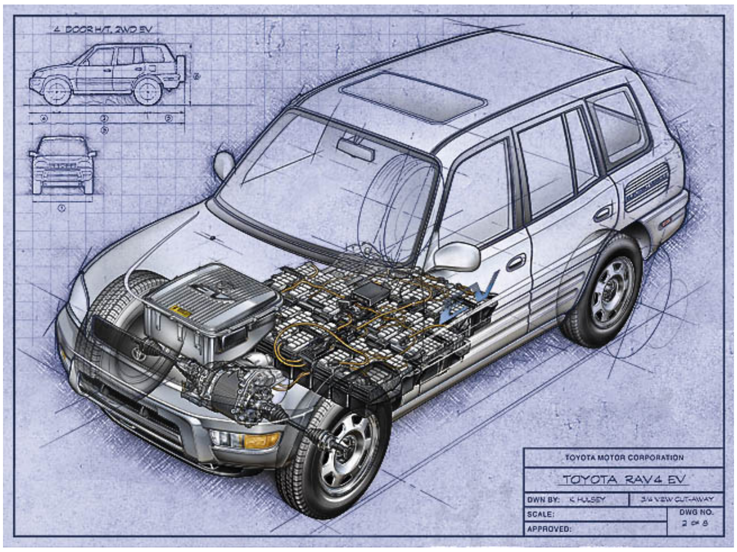

Figure 1 - RAV4EV cutaway view, courtesy of dontcrush.com, via Toyota Motor Corporation.[1]

Battery research and development are some of the many things that chemical engineers and industrial chemists do. Your challenge will be to design, build and test a battery for electric transport. There is no “right” answer to this problem, rather there are many ways this might be achieved. The “best” design in the context of this project is the one that best satisfies the design goals of the testing regime and as are laid out in the design brief.

Design Objectives

Your objective is to design and build, as a team, an electric car and energy storage device to safely transport up to 200g load over a distance of 8 m in less than a minute (you will have 2 chances to achieve this). The load may have any shape. The load and final track will be made available to the teams on the day of the competition (2 hours before the start of the competition).

[1] http://en.wikipedia.org/wiki/Image:Rav4evdrawing.jpg This image is copyrighted. However, the copyright holder has irrevocably released all rights to it, allowing it to be freely reproduced, distributed, transmitted, used, modified, built upon, or otherwise exploited in any way by anyone for any purpose, commercial or non-commercial, with or without attribution of the author, as if in the public domain.

School of Computer Science and Engineering

Project CSE01: Robot Rescue

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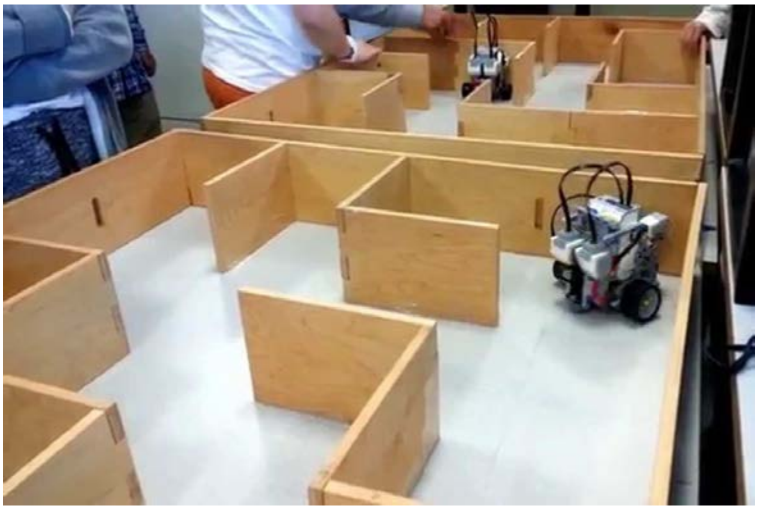
Background

A building is about to collapse after a devastating fire. It's too dangerous to send emergency personnel in, but people trapped inside need to be located and saved. This is a job for robots! Researchers in AI and robotics all around the world are developing just these types of robots. Some were used inside the Fukushima Nuclear Reactor that was severely damaged by the tsunami and earthquake in 2011.

RoboCupRescue is an international competition to foster research into rescue robots in particular and intelligent robots in general. UNSW teams have won the award for best autonomous robot three times! Until now, most of these robots have been very big but a new part of the competition is aimed at developing small robots that can get into confined spaces. Your task is to develop such a robot.

Design Task

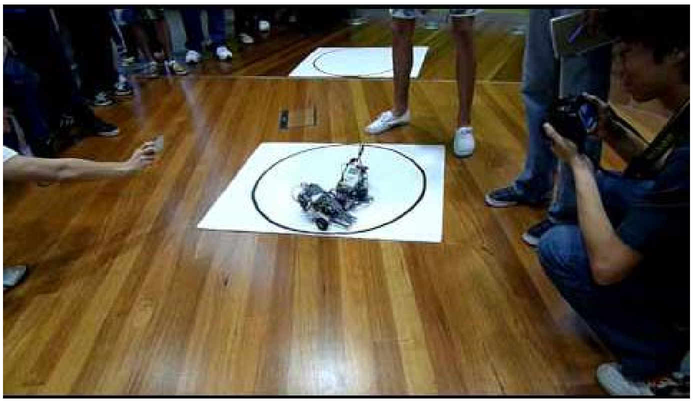


Your team will build a robot to explore a maze, find a small bottle (the victim), pick it up, and then exit the maze.

Your team will:

1. design and construct a robot using the Lego Mindstorms Robot;
2. program, in Python, a Lego EV3 microcontroller, running Linux, to read the robot's sensors and control its motors;
3. test your robot in mazes of varying difficulty.

Preliminary Design Task



As a warm up exercise, before starting on the rescue project, you will design and build a Sumo robot. Your robot will be placed inside a circle with another team's robot with the objective of pushing the other robot out of the circle.

School of Civil and Environmental Engineering

Project CivEnvEng 01:

Civil Infrastructure – Progressive Collapse of Building Structure

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Design Task

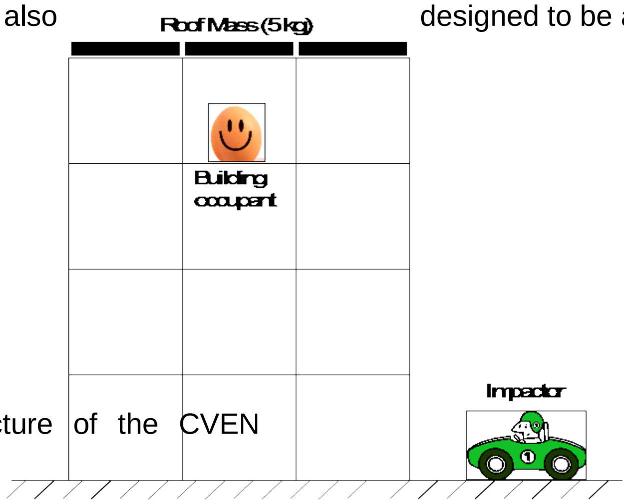
Your task is to work within a small group to design and construct a building to withstand a dynamic load caused by impact or blast load on the structure while protecting building occupants. Also, the building should withstand a static load of 5 kg applied uniformly across the top floor. Allowable materials for the superstructure of your construction are balsa wood, cardboard, paper, sticky tape, glue and string.

Marks will be awarded based on construction and aesthetics as well as performance. The design report will include sections on:

- the design philosophy – why the chosen design?
- a 2D elastic simulation of the structure indicating highly loaded members or regions
- a CAD drawing of the structure showing a plan, elevations and important details
- the performance test results
- an appraisal on the performance of the structure

Design Objectives

The objectives of this project is to introduce you to the profession of Infrastructure Engineering though the studies of engineering design and innovation whilst maintaining context to the profession of Civil Engineering and the role and practices of Engineers in a modern profession. An important aspect in contemporary design is design for a sustainable future and, thus, infrastructure lifecycle design is a key characteristic in the professions modern development. To this end, a series of lectures on developing sustainable infrastructure is integrated into the key project lectures. Whilst taking on serious issues and reviewing the role of Engineers within a societal context, the subject is also designed to be a bit of fun!



Further Information

Further details on the structure of the CVEN projects, the objectives and the assessable tasks at:

http://www.engineering.unsw.edu.au/civil-engineering/resources/engg1000-school-site

School of Civil and Environmental Engineering

Project CivEnvEng 02: Civil Infrastructure – Resistance of Building Structure to Earthquake Loading

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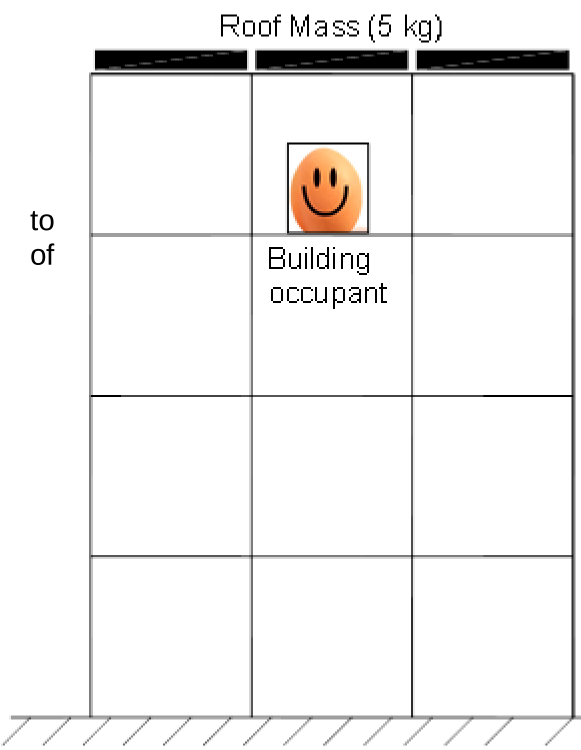
Design Task

Your task is to work within a small group to design and construct a building to withstand a dynamic load caused by **earthquake load** on the structure while protecting building occupants. Also, the building should withstand a static load of 5 kg applied uniformly across the top floor. Allowable materials for the superstructure of your construction are balsa wood, cardboard, paper, sticky tape, glue and string.

Marks will be awarded based on construction and aesthetics as well as performance. The design report will include sections on:

- the design philosophy – why the chosen design?
- an elastic simulation of the structure indicating highly loaded members or regions
- a CAD drawing of the structure showing a plan, elevations and important details
- the performance test results
- an appraisal on the performance of the structure



Design Objectives

The objectives of this project is to introduce you to the profession of Infrastructure Engineering though the studies of engineering design and innovation whilst maintaining context to the profession of Civil Engineering and the role and practices of Engineers in a modern profession. An important aspect in contemporary design is design for a sustainable future and, thus, infrastructure lifecycle design is a key characteristic in the professions modern development. To this end, a series of lectures on developing sustainable infrastructure is integrated into the key project lectures. Whilst taking on serious issues and reviewing the role of Engineers within a societal context, the subject is also designed to be a bit of fun!

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School of Civil and Environmental Engineering

Civil/Environmental Engineering Project CivEnvEng 03:

Civil-Environmental Infrastructure – Wave Energy from Oceans

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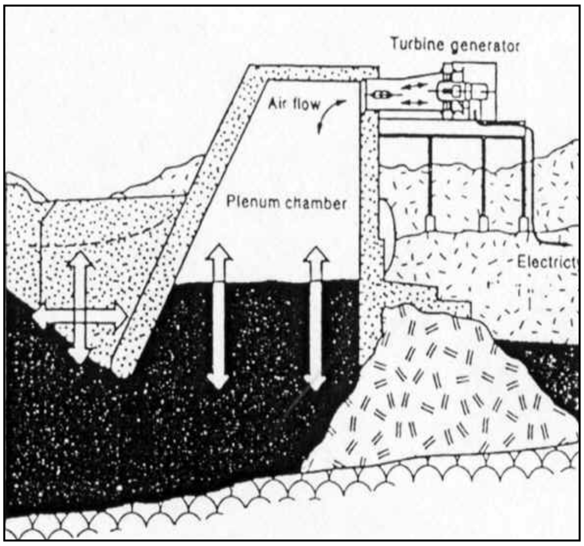
Civil-Environmental Infrastructure – Wave Energy from Oceans

Design Task

Your task is to work within a small team to design a device to extract wave energy from the ocean. You will test your model in a wave flume under controlled laboratory conditions. Both civil and environmental design aspects will be central to the design process. The natural variability of environmental conditions will be a key consideration in the design and testing of your wave power device.

Design Objectives

Design, construct and test a scaled physical model of a wave energy device. Working in groups, you will design, construct and test the performance of a wave energy device. Powered by waves, the device is to be designed to harness the power of sea waves to generate power. Limitations on the construction materials will be in place and designs will be tested in a wave basin in the Hydraulics Laboratory in the Civil and Environmental Engineering Building.



The design report will include sections on:

- the design philosophy – why did you choose this design?
- difficulties encountered and if and how you overcame them,
- test conditions and their selection,
- measurements undertaken on the model
- some calculations on the power generated in the model
- a CAD drawing of the structure, and
- an appraisal of the performance of the device, including a calculation of the power available from the waves.

(Source: http://www.irishscientist.ie/p186a.htm)

Further Information

Further details on the structure of the CVEN projects, the objectives and the assessable tasks are given at: http://www.civeng.unsw.edu.au/information-for/current-students/current-undergraduates/engg1000

School of Civil and Environmental Engineering

Civil/Environmental Engineering Project CivEnvEng 04: Surveying and Geospatial – DIY Aerial Mapping

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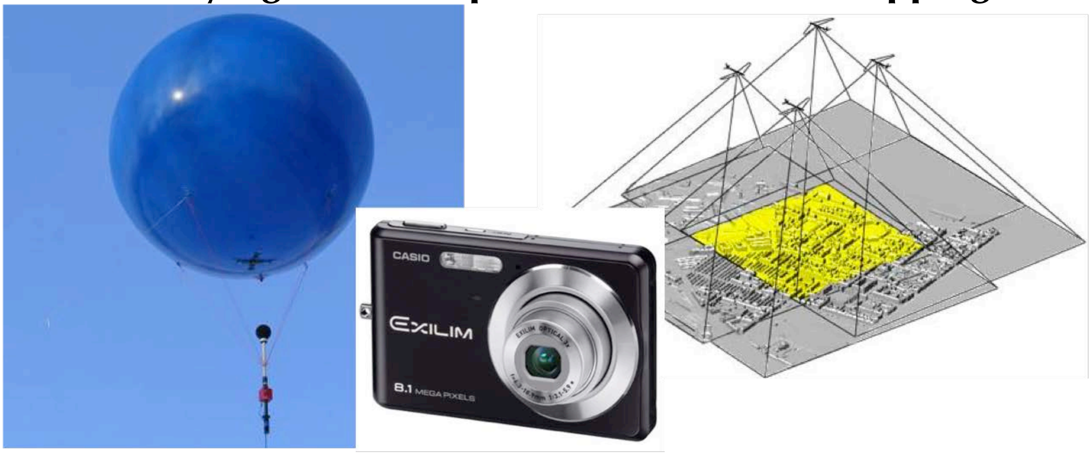
Surveying and Geospatial – DIY Aerial Mapping



Maps are nowadays created using photographic images taken from platforms above the Earth's surface. These may be satellites, aircraft, UAVs ("drones") or balloons. The advent of comparatively low-cost digital cameras and sophisticated image processing software has made small area mapping viable for surveyors and engineers. Furthermore, the very nature of the "map" has changed, and is today typically pixel-based images, or vector data, or 3D "point clouds", which can be manipulated via software to create 3D models, to analyse their geometric properties, and to visualize the map in many ways, such as rotating, tilting and even "fly-throughs" that are reminiscent of computer games.

Design Task

Your task is to work within a small team to design and construct an aerial platform comprising a helium balloon, to which a digital camera can be attached. This platform is then manoeuvred across a patch of the campus of a few hundred square metres. Multiple digital photographs are taken and input into image processing software to produce an aerial map of a patch of the UNSW campus.

Design Objectives

Design, execute and report on the various steps in the construction and operation of a low-cost balloon-borne digital camera system. The photographic images are combined using image processing software to create a digital map. The digital map can be input into CAD software for further analysis. The design report will include sections on:

- Building the camera-carrying helium balloon system
- Attaching (and stabilising) the digital camera to the helium balloon
- Operating the helium balloon mapping system so as to take as many photographic images as necessary the patch of campus being mapped
- The means by which scale (and coordinate system) is incorporated
- The results of processing the photographic images
- Use of CAD software to combine different sources of map information into one model
- An appraisal of the quality of the cartographic results

The quality of the map results will be the basis of a comparative test between the different groups.

Further Information

Further details on the structure of the CVEN projects, the objectives and the assessable tasks are given at:

http://www.engineering.unsw.edu.au/civil-engineering/resources/engg1000-school-site

School of Electrical Engineering and Telecommunications
Electrical Engineering Project:
Smarter Homes

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An exciting emerging area in electronics is the ‘Internet of Things’ (IoT). Almost every device in the future could contain electronics and be connected to the internet, allowing them to communicate and improve our quality of life. Just imagine: say you enter in your calendar that you have a 9am meeting, the alarm clock has determined what time it needs to wake you up, and the coffee maker automatically gets a brew ready for you – an easy start to the day. When it is time to walk out the door the umbrella reminds you to take it with as showers are expected in the afternoon.

Does this sound like science fiction? According to the electronic industry, this will be the near future.

Design Task: Your challenge will be to design a (miniature) smart internet-connected household system, which can monitor and report the status of the occupants and the conditions over the internet – important for remote health care monitoring applications. Further, the system should be able to take in input from the internet to make smart decisions – determine when to turn the heating and cooling system on/off, and to signal an emergency if the occupant has a heart attack. The focus of this project is on the electronics – you will *design nearly everything in the electronics from scratch,* giving heaps of flexibility in how you go about it. The project aims to expose you to the areas of electronics, sensors, control, and communications, all of which are central disciplines within Electrical Engineering.

Design Objectives: On testing day, your team will demonstrate the functionality of your system. Via smart phone, tablet, website, or other, you’ll show the state of our miniature test household – temperature, state of lighting, and status of occupants (heart-rate, blood pressure). You’ll then be asked to demonstrate how the system can take input to adjust the temperature, and signal an alert if it detects that an occupant has a problem. For bonus points, you can demonstrate to us any other novel and innovative application of the IoT in the home environment.

How will the project work? Your team will be assigned a mentor from the academic staff, with whom you will meet for one hour each week. In addition to academic staff mentors, the weekly laboratory sessions will be attended by enthusiastic, highly capable demonstrators, most of whom are students who excelled in EE&T design courses. We’ll also give you some hardware and support to assist you in the internet connectively aspect of the project.

What if I don’t know anything about Electrical Engineering? The project assumes no prior knowledge of electronics or electrical engineering. To make your learning experience as fruitful and focused as possible, the School of EE&T will provide a series of targeted lectures covering basic electronic circuit design principles, with many relevant examples. The material in these lectures is valuable also to students taking other degree programs, since an elementary understanding of electrical circuits is required in many disciplines.

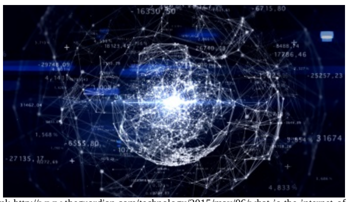

Photo sources: http://www.3g.co.uk/PR/Feb2015/internet-of-things-everything-you-need-to-know.html; http://www.theguardian.com/technology/2015/may/06/what-is-the-internet-of-things-google; http://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#770cc4846828; http://www.forbes.com/sites/sap/2014/11/20/internet-of-things-how-will-it-work/#3de4f996816f

Graduate School of Biomedical Engineering

Project: Bionic Hand

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Background

Hands are pretty, well, *handy*. They can lift heavy weights, repair watches, play a guitar, applaud the lecturer. It can be argued that hands were the major driving force behind the evolution of the human brain. Our upright posture freed our hands so that they could start *manipulating* things. Our brain then evolved in new directions because of the greater scope for doing. No dispute. Hands are useful. Loss of the use of a hand is a serious disability.

You are to design and build a mechanical hand prosthesis, a device that will replace the function of one hand. The client might be an amputee or a quadriplegic (with some upper limb function).

Design criteria

The prosthesis is to be fixed to a forearm. The hand must be held as a fist with no strap across the palm. It is assumed that the opposite hand is missing. The prosthesis will comprise a gripper of some sort and a means of activating it. The activation method is open. Some possibilities are:

Direct muscle activation

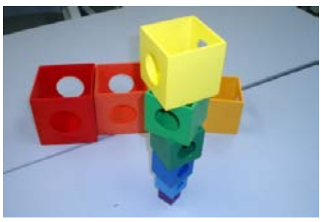
- Any muscle can be used directly to activate the hand as long as the muscles are not associated with the hand whose function is being replaced. (Note that this <u>does not</u> include direct use of the opposite hand to activate a switch or pull a wire, for example.)

Indirect muscle activation

- Muscle movement can be converted to an electrical signal which in turn is converted to a mechanical force that activates the hand.
- Muscle electrical (myoelectric) activity might be converted to a mechanical force.

It may be built from materials bought in a supermarket, hardware, hobby or toy shop for less than $120 total. Junk is free. Any electrical components must be battery (not mains) powered.

Tasks



1. Pour water into a soft plastic cup and drink the contents without spilling. The elapsed time will be measured and judges will assess the degree of spillage.
2. Stack a set of plywood boxes as high and as fast as you can. The number of boxes and the elapsed time will be recorded.
3. An unrehearsed pick-up. Ten or more objects of different sizes and shapes will be placed on a table. You will pick them up in any order and place them in a basket. The number of objects transferred and the elapsed time will be recorded.

School of Materials Science and Engineering

Material Science and Engineering Project:

Advanced Application of Shape Memory Effects

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Design Task

Shape memory effect is a process of restoring the original shape of a plastically deformed sample by heating it. Some alloys called Shape Memory Alloys (SMA), such as NiTi, CuZnAl, and CuAlNi etc. possess this effect. The extraordinary properties of SMA are being applied to a wide variety of applications in a number of different fields and have become the bases of advanced technologies. For example, biomedical and mechanical engineers can't make an advanced "robot hand" without the artificial muscles made with SMA (Fig. 1). SMA is also the unique material used to fabricate a huge antenna with hemispherical shape in satellites. SMA has been widely used in aerospace (Fig. 2) and robot industries.

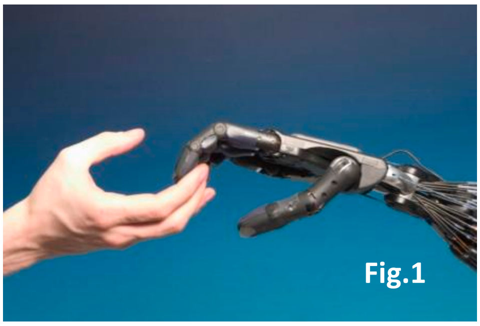

Fig.1

Fig. 2(a)

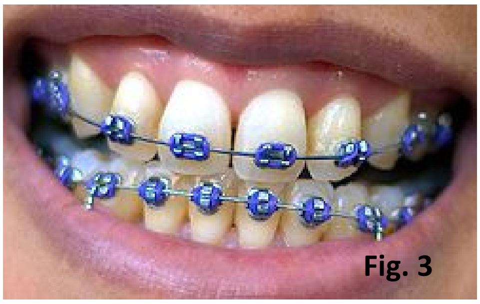

Fig. 3

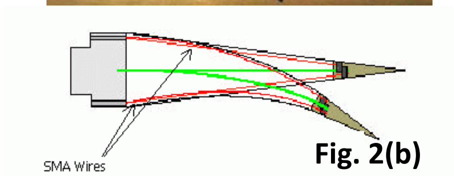

Fig. 2(b)

SMA exhibits a number of remarkable properties, which open new possibilities in engineering and more specifically in biomedical engineering. For example, the dental braces were developed to exert a constant pressure on the teeth with SMA (Fig. 3). The excellent biocompatibility of SMA makes it an ideal biological engineering material, especially in orthopaedic surgery (Fig. 4) and cardiovascular stents.

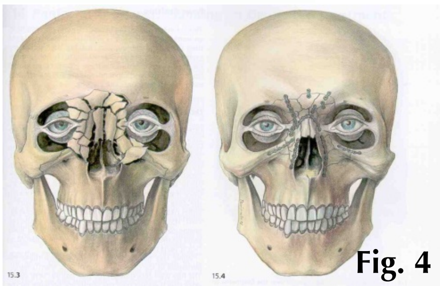

Fig. 4

Design Objectives

There are many possible applications for SMAs. Future applications are envisioned to include engines in cars and airplanes and electrical generators utilizing the mechanical energy resulting from the shape transformations. In this project, we will use the shape memory alloys to build an engine which can be driven by the wasted heat. How to design a high performance heat engine with SMA is a great challenge. In this project, the students are required to:

(1) Understand the principle of shape memory effects associated with the materials.
(2) Design a high performance heat engine.
(3) Build a prototype of the engine.
The performance of engine will be evaluated by determining the rotating speed of the engine.

Background

Engineers need to develop new designs and concepts then bring their designs to reality. Our project this session gives you a taste of what it is like to design and build a machine for competition and in the process you will achieve the learning objectives of ENGG1000.

Design Task

A multinational engineering company has won a contract to develop a low cost all terrain mobile emergency transport system. The purpose of the system is to transport a newly developed unstable medical drug called “OMEGA-1”, which has the capability to neutralize the spread of infections in undeveloped communities. The drug can only be transported in an upright position as its stratified components remain stable. If the drug is tilted significantly during transport the stratified layers can recombine and the drug becomes unstable and hazardous. During transport the vehicle must be capable of travelling over unknown terrain while keeping the load upright, as road infrastructure may be non-existent in locations where the vehicle may operate.

The company is having difficulty in developing or finding a suitable design. It has heard of the impressive work done previously by UNSW ENGG1000 students and has requested design input for the development of a prototype system.

The project is to be known as: **Project METS – Mobile Emergency Transport System**

The Challenge

The challenge is to design a prototype system to meet the needs of the client. You will work in groups of five or six to design a system which is capable of transporting “OMEGA-1” in an upright position whilst travelling over rough terrain. Additionally, the company has allowed design flexibility so you are free to be as creative and innovative as possible. The vehicle is to be capable of being constructed locally by undeveloped communities, so in order for the prototype device to meet the challenge it will be constructed from commonly-available materials using simple processes which may be performed by unskilled workers.

Your team’s objective will be to optimise the overall performance within the criteria listed below:

- Use one vehicle to carry out safe, reliable delivery of the load.
- The vehicle must comply with the rules regarding size, movement and position during transfer.
- It must work within time constraints to complete the transfer and delivery of the load.
- Your vehicle must demonstrate innovation, styling and simplicity.

Figure 1: Tackles a real problem affecting many parts of the world.

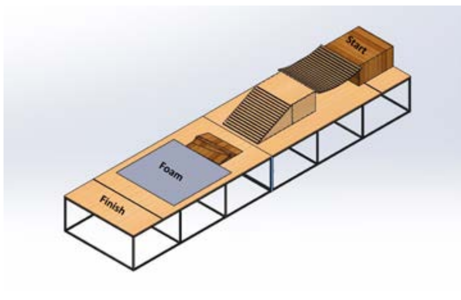

Figure 2: Indicative competition track your design needs to negotiate (track length 5m).

School of Mining Engineering
Project: Mars Regolith Collection

UNSW THE UNIVERSITY OF NEW SOUTH WALES

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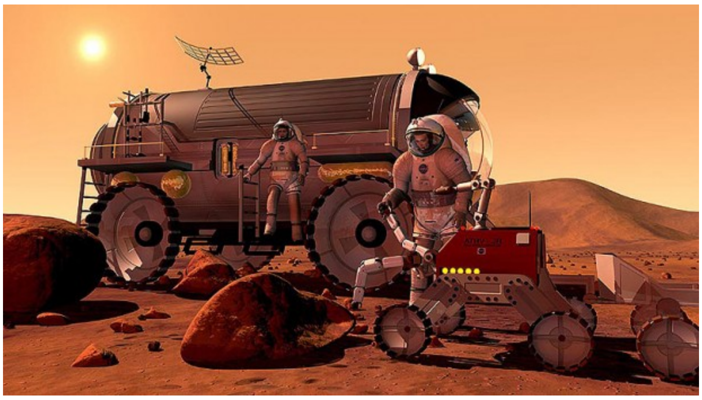
Background

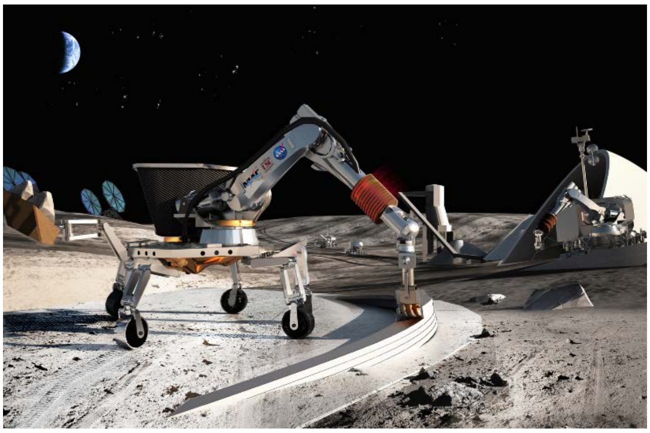
As history has repeatedly shown, where there are valuable minerals to be unearthed, adventurous humans will arrive in droves - even if it means battling extreme conditions and risking life and limb. So what will happen when the next great "gold rush" in our history is quite literally out of this world? And what kind of technology would be needed for the mining?



People were looking up in the sky since the beginning of times, though modern technologies allow us seriously to think about mining and building settlements on other planets. Mars has always been a planet of a special interest. A bunch of probes, satellites and several rovers were sent to the so-known Red Planet for geological investigations, habitability potential, surface exploration, life existence and natural resources research. As a terrestrial planet, Mars consists of minerals containing silicon and oxygen, metals, and other elements that typically make up rock. So, why to bring constructor materials from Earth if we have all we need for building right on Mars? It sounds simple enough, mining raw materials from a rocky, sandy planet. We do it here on Earth, why not on Mars, too? But it's not as simple as it sounds.

Your task:

This project examines a later stage of Mars colonisation: building a radiation protection shelter or resource storage for a settlement on Mars. The project requires the design, construction and testing of an item of equipment that can drive on a «Mars-like surface», collect regolith and transport it to the feeder of a 3D printer. It will be used to print a shelter/radiation protection infrastructure. We will provide you with a map of the Martian surface your rover is going to work on, so you can plan your regolith collection strategy.



There is considerable amount of information on this topic and there will be guest lectures from specialists in this field. Full specifications will be provided by week 3. All power must come from 9Volt dry batteries. Workshop facilities and basic hand tools will be available during the semester.

Please visit: **http://www.acser.unsw.edu.au/**

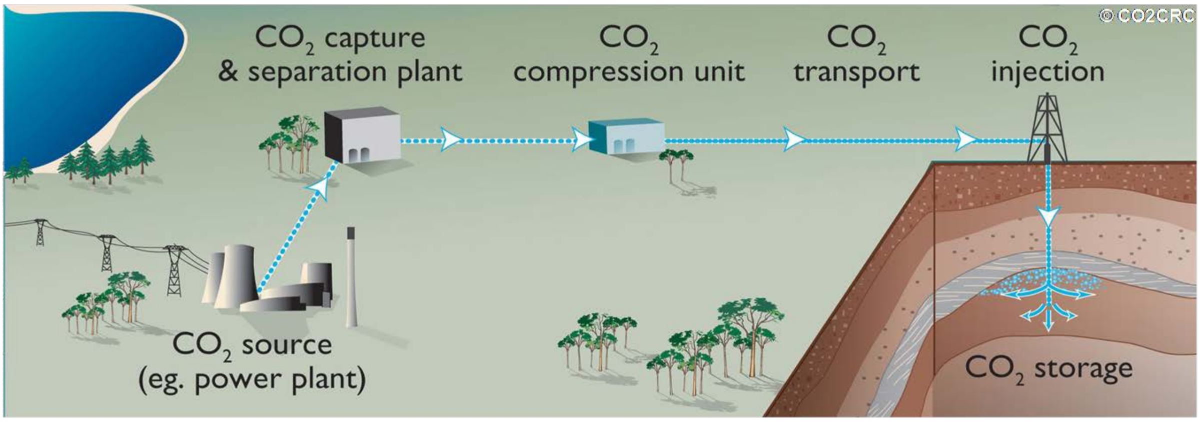
And on Youtube: Colonising Mars.

Students will be able to access the School's AVIE (3-D Virtual Reality Cinema to assist with visualising your designs)

Putting carbon back where it came from

One of the main greenhouse gases causing climate change is carbon dioxide (CO_2). It is estimated that 7 billion tonnes a year of CO_2 emissions come from human activity. According to International Energy Agency, the current estimation of greenhouse gases per capita is about 3.9tonnes per annum, which is slightly above the estimated sustainable limit (3.5tonnes per annum).

The Petroleum Engineering project examines an important technology called carbon capture and storage (CCS). CCS is one of a suite of methods proposed to reduce carbon emissions into the atmosphere. CCS can be applied to stationary sources of CO_2 like oil and gas fields, power stations and industrial plants making things like steel, aluminium, petrochemicals and cement. In a CCS process CO_2 is captured from the source, transported to a storage site and injected into deep, secure geological structures. These structures include oil and gas reservoirs and deep saline rock formations.



This project models the CCS process at the bench scale. Your task in this project is to design and build a device that will take air (representing the CO_2) and inject it into a model storage reservoir supplied by the school. This reservoir is packed with glass beads and filled with water.

Your objective is to maximize the amount of 'CO_2' stored in one minute while also minimising the cost of 'CO_2' storage. How well you meet this objective depends on you and your team's device design, construction, mechanism and cost.

The device must be operated manually and made from simple materials (available from any hardware store) and constructed using simple techniques. The device can't cost any more than \$30.

School of Photovoltaic and Renewable Energy Engineering
Project: Sun Ray

UNSW THE UNIVERSITY OF NEW SOUTH WALES

Never Stand Still Faculty of Engineering

Background

Engineers require a large range of skills to work in project teams. Designing and developing solutions while working in a team can present many challenges so the project this semester in ENGG1000 introduces you to some of those skills you will need.

Design task:
In this new world where petrol is expensive and there is plenty of free time we need a vehicle to transport our petrol guzzling ski boat to the ocean. Your team will need to design a prototype solar vehicle to tow your speedboat to the local ski zone. This vehicle and boat will be a scaled version, which will need to be tested, raced and presented over a series of days to some very important buyers.

The Vehicle and boat will need to be constructed on a low cost budget as funding for this project is limited. The racing will be performed on an oval pursuit style track. The vehicle must be powered by solar panels and tow the boat. Some components will be made available and can be used if appropriate to your design. The vehicle must be design to carry four people.

The Challenge
Your team's objective is to design, build and test the vehicle. The vehicle must tow the boat which is only a mock up and the specifications of the boat will be provided. Your teams final prototype will (1) meet the design constraints (to be provided), (2) be constructed from a low budget and (3) be able to race in a knock out competition. Race winners will be awarded positive marks but the overall mark is not just about the fastest Vehicle.

Your team will be also be recognized for:

- Coolest looking design
- Most innovative features
- Best construction
- Able to navigate the track in the fastest possible time
- Plus many more

Come and join us for an exciting project and semester!