



Faculty of Engineering
Engineering Design and Innovation

Never Stand Still

Faculty of Engineering

ENGG1000

**ENGINEERING DESIGN
AND INNOVATION**

Course Outline

Semester 1 2013

Dr Chris Daly

Course Co-ordinator

This outline tells you how this course will be run.

If you need more help...

Ask at the School that you are enrolled in
or ask at the Engineering Student Centre

Once you are enrolled, the Moodle Learning Management site has more
specific information for this course

<http://moodle.telt.unsw.edu.au/>

Quick-start To-Do List

When	Action	Location
Monday Week 1 (Mon 4 th March, 2:00pm)	Attend Introductory lecture	As per your class timetable (see my.unsw.edu.au)
Thursday Week 1, 7 th March: 2pm or 3pm as allocated in first lecture – see Location column if lost!	Participate in Impromptu Design activity (this activity is assessable)	Various locations and one of two times as allocated in Intro Lecture, and in Moodle or meet outside Engineering Student Centre before 2pm if lost
Before 5pm Wednesday 13 th March (Week 2)	Finalise your decision on the project you want to select; if you make a mistake contact your project coordinator (Page 4)	Via Moodle
Monday Week 2 (Mon 11 th Mar, 2:00pm)	Attend lecture on Impromptu Design (includes Assessable task)	As per your class timetable (see my.unsw.edu.au)
Thursday Week 2 and onwards 14 th March 2pm	Join the School corresponding to the project you have chosen	See timetable on Moodle website (check for changes)

Course Staff

The course is coordinated by the Faculty of Engineering; most of it will be run by the schools within the Faculty plus Materials Science and Engineering in the Faculty of Science.

Course Convenor for the Faculty

Dr Chris Daly
 Location: Room OMB G36
 Phone: 9385 4514
 Email: c.daly@unsw.edu.au

Contacts for the ten schools that are running projects in this course

School	Coordinator and contact details
Chemical Engineering	Dr Kondo-Francois Aguey-Zinsou f.aguey@unsw.edu.au Room F10-418 ph 9385 7970
Computer Science and Engineering	Professor Claude Sammut claudes@cse.unsw.edu.au Room K17-401J ph 9385 6932
Civil and Environmental Engineering	Associate Professor Ian Turner ian.turner@unsw.edu.au Room CE-411 ph 9381 9829
Electrical Engineering and Telecommunications	Dr Julien Epps j.epps@unsw.edu.au Room EE-337 ph 9385 6579
Graduate School of Biomedical Engineering	Dr Ross Odell r.odell@unsw.edu.au Room F25-507 ph 9385 3920
Materials Science and Engineering	Dr Sean Li sean.li@unsw.edu.au Room E8-217 ph 9385 5986
Mechanical and Manufacturing Engineering	Dr Tim White white@unsw.edu.au Room ME216 ph 9385 5158
Mining Engineering	Dr Chris Daly c.daly@unsw.edu.au Room OMB G36 ph 9385 4514
Petroleum Engineering	Dr Peter Neal peter.neal@unsw.edu.au Room TETB-248 ph 9385 4261
Photovoltaic and Renewable Energy Engineering	Dr Stephen Bremner spbremner@unsw.edu.au Room EE-105 ph 9385 7890

Course Information

Course Size

This course is 6 units of credit.

Units of credit indicate the nominal workload for students. The normal workload expectations at UNSW are 25-30 hours per session for each unit of credit; including class contact hours, preparation and time spent on all assessable work. For a six unit of credit course with no formal examinations, like ENGG1000, this means a typical average total workload of 11 to 13 hours per week.

Course Organisation

This course is coordinated by the Faculty of Engineering which also arranges some common lectures. Most of the course is run in ten project strands by schools of the Faculty of Engineering and the Faculty of Science (Materials Science and Engineering). Learning activities will vary between project strands. Although there are differences in presentations, the course is coordinated to ensure equivalence. All the projects are done in groups.

You may select any of the projects, independently of your preferred field of study. **It is not mandatory to do the project associated with your chosen discipline. This is a common engineering course!**

Project Selection

Project selections are to be finalised by 5pm on Wednesday 7th March. Descriptions of each of the projects are attached to this outline. You will be given more information to help you finalise your project selection during the first Faculty lecture in Week 1 of the course. Full project descriptions and course outlines are available on Moodle. **Make sure you are certain of which project you wish to enrol in before committing yourself to the online selection option.**

How this Course Fits with Others in your Program

This course looks at what it means to be an engineering designer. You will see the big picture and how all your studies, such as mathematics and science, fit together. It will also look at some of the non-technical issues which are just as vital to a successful engineering career as the technical ones.

You will study and experience Engineering Design as a multi-faceted activity, which requires considerable creativity, as well as judgement, decision making and problem solving skills. You will see the need to take context into account and be able to complete design projects on time and within budget. The problem solving and project management skills that you learn in this course will be invaluable for later courses in your degree, in your career and for life in general.

Learning and Teaching Philosophy

This course is, first and foremost, an exercise in experiential learning, with emphasis on reflection on the design process. You will work together in teams to design a solution to a specified but open-ended problem. This project will be supported with a variety of additional student experiences to help you acquire individual and group skills in areas needed for communicating the design, including graphical representation, collaboration, report writing and any necessary discipline-specific knowledge.

Aims

1. Introduce you to the principles and methods of engineering design.
2. Involve you in hands-on design and engineering projects.
3. Help you gain skills in written expression.
4. Introduce you to the way a professional engineer works.
5. Provide a team-based environment so you can experience and learn collaborative skills.
6. Help you learn the professional use of information resources.

What you are Expected to Learn

After you have completed this course, you will be expected to have the following capabilities.

- Be familiar with the process of engineering design and the use of design methods for defining an open-ended design problem, generating alternative conceptual solutions, evaluating these solutions and implementing them.
- Understand the basic elements of project management and be able to plan and schedule work activities in accordance with standard practice.
- Understand the dynamics of collaborative teams and how to work effectively within a team to accomplish tasks within given deadlines.
- Be able to organise, conduct and record engineering meetings.
- Be able to effectively convey your thoughts and ideas in an engineering design report.
- Be able to understand the issues of quality, safety, diversity and equal opportunity as they apply to university and professional life.
- Understand some of the roles and responsibilities of a professional engineer.

Teaching Strategies

Teaching in this course is centred on the project. For example, you will develop communication skills by communicating about the project; you will develop teamwork and project management skills in the context of your project team; and you will experience the kinds of technical problems resolved by engineers in your selected project area.

How this will work out in detail will depend upon the particular school presenting a particular project. You will receive a separate handout describing this once you have finalised your choice. If you want to see details earlier, refer to the Moodle site for this course.

Learning Outcomes and Assessment Framework

ENGG1000 has been designed to ensure there is equivalence and alignment between the various School's implementation of the course. Each School operates within an agreed framework of learning outcomes as indicated in the following table.

Learning Outcome	Weight
Development of engineering design skills for creative solutions to open ended problems	30% - 50%
Communication skills in technical report writing, graphical communications and experience in public presentation.	30% - 50%
The development of teamwork and project management skills	10% - 30%
Information gathering and evaluation skills to support the design process.	10% - 30%
School-selected discipline knowledge component	0 - 20%

Full details of each School's specific assessment activities and their weightings are provided in the project outlines available on the Moodle site. You are encouraged to preview these and download them for future reference.

Because of differences between each Schools specific learning and assessment activities it may be necessary to adjust marks (up or down) to ensure fairness. This will be done after all the results are available at the end of the session.

Academic Honesty and Plagiarism

According to the UNSW website www.lc.unsw.edu.au/plagiarism

Plagiarism is taking the ideas or words of others and passing them off as your own. Plagiarism is a type of intellectual theft.

Plagiarism happens for a number of reasons—one is because some students decide consciously to gain credit for the work of others. However, most incidents of plagiarism are the product not of deliberate cheating, but of underdeveloped academic skills.

This course will be an important opportunity for you to develop skills in writing and referencing your sources so that you avoid plagiarism. Look at the website above for help, or see the resources available through The Learning Centre.

A standard UNSW statement on plagiarism is given below.

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.* Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor;
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.

Course Schedule

Shaded items below are Faculty-wide activities

Week	Monday	Thursday
1	Introductions and project descriptions	Impromptu Design (everyone, assessable)
2	Review Impromptu Design including assessable task	School projects begin. Refer to your School Course Outlines for Timetable
3	project activities in Schools	project activities in Schools
4	project activities in Schools	project activities in Schools
5	project activities in Schools	project activities in Schools
6	project activities in Schools	project activities in Schools
7	project activities in Schools	project activities in Schools
8	project activities in Schools	project activities in Schools
	Easter Break	Easter Break
9	project activities in Schools	project activities in Schools
10	project activities in Schools	project activities in Schools
11	project activities in Schools	project activities in Schools
12	project activities in Schools	Celebrate!

Times and Rooms

Dates, times and rooms for common Faculty activities are given below. Dates, times and rooms for the project that you select (Thursday, Week 2 onwards) are available via the Moodle site.

NOTE: Clancy Auditorium/Science Theatre (depending on your timetable) is for Monday weeks 1, and 2 only. All other times you will be somewhere else. Timetables will be available via Moodle so please check them before the end of week 1.

Resources for Students

The eLearning Moodle site for this course is a vital and integrated part of the learning environment. eLearning is the web-based learning environment at UNSW. You can access eLearning via:

<http://moodle.telt.unsw.edu.au> and select Login to Moodle using your zPass.

The recommended textbook for this course is:

Dym, Clive L., Engineering Design A Project Based Introduction, 3rd Edition

It is available as a text and as an accompanying eBook from the Bookshop.

You should have some access to a copy as it provides useful reading on a number of relevant topics. There are copies available for purchase from the University Book Store and available in the University Library Reserved Collection. The coordinator of your selected project will tell you if alternative or additional textbooks are recommended. References specific to a particular project are given in the School outlines that will be supplied after you have finalised your decision and may be previewed on the eLearning site for this course.

Continual Course Improvement

Engineering Design is a team effort and we are particularly interested in your feedback. We want your suggestions of what is good and should be retained, and what is not so good and should be improved (with

ideas on how to do it). In addition to the standard UNSW Course and Teaching Evaluation and Improvement (CATEI) surveys we will be asking for your feedback in other ways during your studies. Do make attempts to communicate constructive feedback to your lecturers.

Administrative Matters

For most of you this will be your first session at UNSW. We are a large, complex organisation and you will have much to become familiar with. Take time to review the documentation on processes and procedures that you will have received at enrolment and from your School. Additional Administrative Matters documentation for this course will be posted on the Moodle site.

Expectations of Students

UNSW expects regular attendance at lectures and tutorials/laboratory classes/seminars. Although exceptions may be made for special circumstances, we do expect University commitments to take precedence over regular work activities, holidays etc.

UNSW has rules for computer use, for example, for email and online discussion forums. You will have to agree to them when you first access the UNSW network.

We expect everyone – staff and students – to treat each other with respect.

Procedures for Submission of Assignments

Instructions will be supplied by the School concerned during lectures and within the respective course outlines.

Occupational Health and Safety

Like the wider community, UNSW has strict policies and expectations on Occupational Health and Safety and you should read these. They may be accessed on:

<http://www.gs.unsw.edu.au/policy/ohspolicy.html>

Your School will also have policies that you must get to know and follow.

Examination Procedures and Advice Concerning Illness or Misadventure

There are no formal examinations in this course. However, if you find that your performance in an assessable component has been significantly affected by illness or other unexpected circumstance, then you should make an application for special consideration as soon as possible after the event by visiting UNSW Student Central. Talk to your course convenor too. Note that considerations are not granted automatically.

Equity and Diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or www.studentequity.unsw.edu.au/). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

My eLearning Enrolment Information for ENGG1000

Once you have read this booklet and decided upon a project that is of interest to you, you can then visit Moodle's ENGG1000 course module to commence the project selection process.

It's recommended that you have a look at the **Course Videos** first to get an idea of how the course runs. Other videos are available via <http://www.youtube.com/> Search on ENGG1000 for a number of short videos on completed projects. The next step is to go into the **Project Description and Selection Page** and research the different projects that are available. When there is no doubt in your mind which project you want to do, click on the signup tool icon. You may select any of the projects, independently of your preferred field of study. It is not mandatory to do the project associated with your chosen discipline. **If you make a mistake please contact the Faculty Course Coordinator via the email address given at the beginning of this outline.**

Introduction to the Projects

Why Projects?

We want you to experience the engineering design process as well as hear about it and reflect upon it. So, in this course you will learn by doing; by working on tasks connected with a project.

Performance of your design will be one important part of the assessment, the other marks will be awarded for process (what you do) and your reflection (thinking about and showing that you have understood what you do).

Range of Projects and Project Selection

Projects fall within the topic areas listed below. Some areas have more than one project. You may choose a topic in any area, irrespective of the program you are enrolled in. All selections are subject to quotas.

Selections may be changed on-line up to the end of week 2. Changing after that is not recommended because project activities will have begun. For exceptional circumstances please contact the relevant School coordinator.

Topic area	Project title(s)	Page
Chemical Engineering	Batteries for Electric Cars	11
Computer Science and Engineering	Robo Rescue	12
Civil and Environmental Engineering	Project 01: Model Bridge Structure	13
	Project 02: Water for a Cambodian Village	14
	Project 03: Wave Energy from the Oceans	15
Electrical Engineering and Telecommunications	Autonomous Delivery System	16
Graduate School of Biomedical Engineering	Bionic Hand	17
Materials Science and Engineering	Advanced Application of Shape Memory Effects	18
Mechanical and Manufacturing Engineering	Project "TaRFU"	19
Mining Engineering	Design a Dragline	21
Petroleum Engineering	Geological storage of greenhouse gases	23
Photovoltaic and Renewable Energy Engineering	Space Elevator	24

Commonality of Teaching/Learning Schemes

Each topic area is run by a different school. Because schools have differing requirements there are variations in approach and in details of assessment. However, as described above, we will coordinate results for fairness and consistency.

More Details

You can get more details on projects by:

1. Attending the first Faculty lecture on Monday of week 1
2. Reviewing the project information pages on Moodle for ENGG1000
3. Attending the relevant School project information session on Thursday of week 2



School of Chemical Engineering

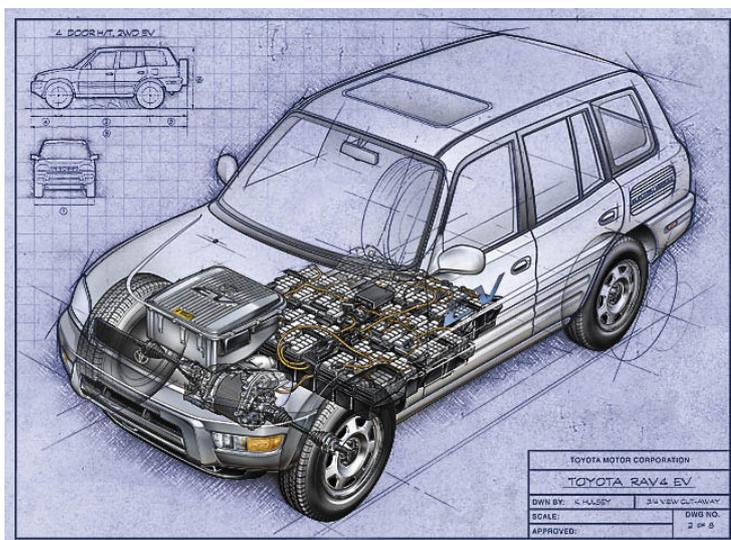
Chemical Engineering Project: Batteries for Electric Cars

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Faculty of Engineering

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 qua 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.



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.

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

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.



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School of Computer Science and Engineering

CompSci: Robo Rescue

Design Task

Your team will build a robot to navigate through a maze, find a small bottle, pick it up, and then exit the maze.

Your team will:

1. design and construct a robot using the Lego Mindstorms Robotic Invention Set
2. program a Lego RCX microcontroller brick to read the robot's touch and light sensors and control its motors
3. create a maze to test your robot and those of other groups

You are limited to one RCX brick, three motors, three light sensors and two touch sensors and the brick itself only has 32k of memory, so you must make efficient use of the hardware and memory.

Design Objectives

The robot must:

- Complete the task within a 3 minute time limit
- Be less than the size and weight limits
- The program that controls the robot must be well organized and well documented.
- The maze you create must be challenging and look good.



For more information see <http://www.cse.unsw.edu.au/~en1000>



School of Civil and Environmental Engineering

Civil/Environmental Engineering Project 01: Civil Infrastructure – Model Bridge Structure

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Faculty of Engineering

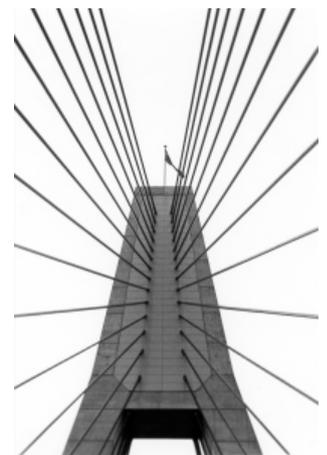
Project CivEnvEng01: Civil Infrastructure – Model Bridge Structure

Design Task

Your task is to work within a small group to design and construct a bridge to withstand a load generated by a truck loaded to 5 kg rolling from a height of 0.5 metres above the structure. Allowable materials for the superstructure of your construction are cardboard, paper, sticky tape, glue and string and the total mass of the structure is not to exceed 350 grams.

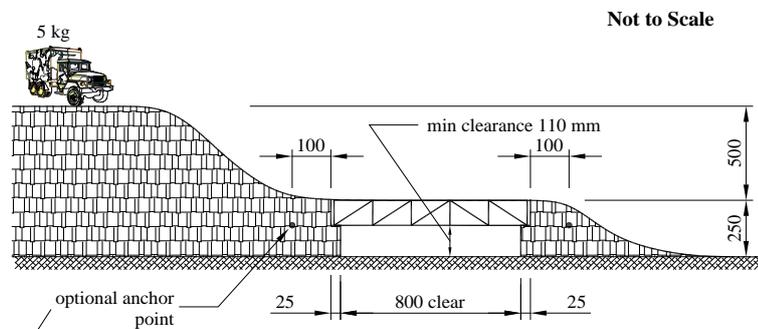
Marks will be awarded based on construction and aesthetics as well as performance. The design report will include sections on:

- 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 through 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 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 02: Engineering in Development - Water for a Cambodian Village

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More than ever, engineers are turning their attention to areas in the world where the need is greatest. This project will allow you to learn from those who have taken their engineering skills to developing regions, and to try your hand at designing for a Cambodian context.

Design Task

Your task will be to work as a member of a small team to design a new community that is to be established in the Kampong Speu region of Cambodia – about 2 hours drive from Phnom Penh. Its purpose will be to provide a new life for approximately 100 families who are living in Phnom Penh under impoverished conditions, and provide them with the basics needed to start a new and better life back in rural Cambodia. An emphasis will be placed on ensuring this a sustainable village.

Design Objectives

You will design a complete system for the community that will provide:

- Clean and reliable supplies of water throughout the year.
- Appropriate methods of dealing with the wastewater from the community.
- Adequate sanitation (toilet facilities) for the new village.

Designing such a project for Cambodia is very different from designing it for Australia. The Cambodian village must be able to sustain and maintain its own water system. Other local villages should be able to replicate and rebuild each design. Effort should be made to use locally available materials. Low dependence on village electricity and water supply systems is desirable.



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 03: Civil-Environmental Infrastructure – Wave Energy from Oceans

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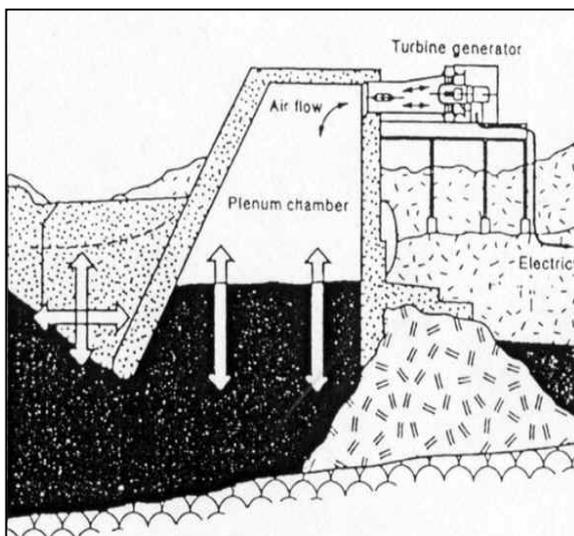
Faculty of Engineering

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.civenq.unsw.edu.au/information-for/current-students/current-undergraduates/engg1000>



School of Electrical Engineering and Telecommunications Electrical Engineering Project: Autonomous Delivery System

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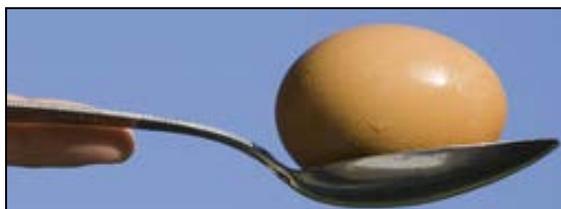
Ever wondered how robots can efficiently move delicate objects to precise locations ? or how information can be invisibly communicated through the air, without wires ? or how the human ear can tell different sounds apart ?

Design Task: Autonomously move fragile cargo (an egg) from a pre-determined start position to one of two or more fixed, high locations, as quickly as possible without damaging the cargo. The destination location will be wirelessly communicated (infrared and audio) to the delivery system by a control module after the system has started moving. This is not a robotics programming project – you will design nearly everything from scratch, giving you heaps of flexibility in how you go about it.

Design Objectives: On testing day, your team will compete to see who can move the egg from the start position to the correct finish position as quickly as possible with minimal damage, but marks will also be given for innovation, robustness in the presence of background noise and possibly for extra functionality.

How will the project work ? Your team, of at most 8, will be assigned a mentor from the academic staff, with whom you will meet for 1 hour each week. The team will be initially divided into two sub-groups, based on your initial conceptual design. Each sub-group is assigned its own initial set of design objectives which will be the subject of “acceptance testing” in Week 9. The sub-groups then integrate their work, fix problems and optimize their design, leading up to the final race. 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. To sign up, please visit the course’s Moodle page and follow the EE&T project instructions.

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. To ensure that all team members make the effort to empower themselves with the necessary skills for this challenging design project, there will be a lab skills test and a circuit design principles test, worth a total of 20% of the final mark. Both are geared to help you develop the skills for success in your project, and students found them helpful in previous years.**





Graduate School of Biomedical Engineering

Biomedical Engineering Project: Bionic Hand

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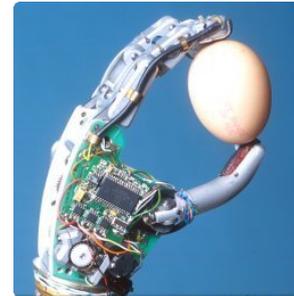
Faculty of Engineering

Graduate School of Biomedical Engineering

Project: Bionic Hand

Hands are pretty, well, *handy*. They can

- Lift heavy weights;
- Repair watches;
- Play a guitar;
- Salute the idiot driver who cut you off this morning;
- 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.

You can lose the use of your hands in several ways. You can lose the hands themselves (amputation). You can lose the ability to control them (spinal injury).



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 the forearm. It will comprise a gripper of some sort and a means of activating it. The activation method is open. Some possibilities are:

Direct muscle activation

- ❖ A muscle or muscles 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 does not 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 \$100 total. Junk is free. The device must be built by students enrolled in ENGG1000, only. With permission, special items might be fabricated by university technical staff. Special electronic components that might be useful may be made available by the Graduate School of Biomedical Engineering (a virtual fee may be charged).

Any electrical components must be battery (not mains) powered. Teams may consult with "experts" on specific fabrication or design problems. There may be a (virtual) charge for these services.

The Bionic Hand should be designed to carry out the following tasks:

1. Pour water into a soft plastic cup and drink the contents without spilling.
2. The test begins with a bottle of water and an empty cup on a table. When the signal is given, the contestant picks up the bottle, fills the cup 1/2 way and then drinks the contents and returns the empty cup to the table. The elapsed time will be measured and judges will assess the degree of spillage.
3. Stack a set of plywood boxes as high and as fast as you can.
4. An unrehearsed pick-up and move. Ten or more objects of different sizes and shapes will be placed on a table. You will pick them up and place them in a basket. The number of objects transferred and the elapsed time will be recorded.
5. Hands will also be assessed by judges for innovation, imagination and degree of difficulty. This is partly to compensate teams with clever and/or ambitious designs that are difficult to implement.



Judging

Teams will be ranked in order of performance on each task/criterion. An overall rank will be calculated as the mean rank.

Assessment

<i>Assessment Task</i>	<i>weight</i>
Faculty-wide design exercise (individual)	5
Learning portfolio (individual)	20
Design notebook (individual)	10
Design proposal (group)	10
Clinical trial protocol and consent form (group)	5
Design performance (group)	15
Poster (group)	10
Design report (group)	20
Teamwork appraisal (individual)	5
Total	100

View Claudia Mitchell

<http://www.youtube.com/watch?v=X1OBzc9QfIs>

View Jesse Sullivan

<http://www.youtube.com/watch?v=ddInW6sm7JE>



School of Materials Science and Engineering

Material Science and Engineering Project: Advanced Application of Shape Memory Effects

Never Stand Still

Faculty of Engineering

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

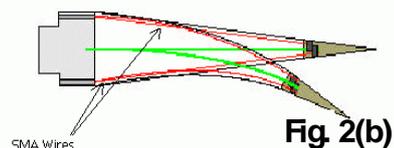


Fig 2(b)

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.

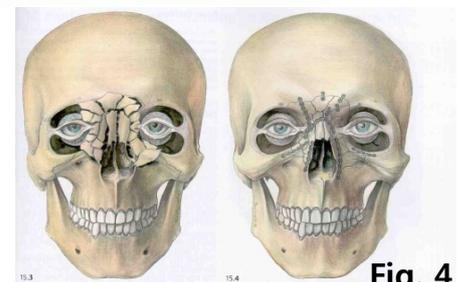


Fig. 4

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.



School of Mechanical and Manufacturing Engineering

Mechanical Engineering Project: Project “TaRFU”

Never Stand Still

Faculty of Engineering

Background

For more than 20 years, students from universities across Australia have been participating in the annual Weir-Warman Student Design-and-Build Competition. Students in the MMAN stream will compete in the Competition as part of MMAN 2100 in their second year. As well as being a vehicle by which you will achieve the learning objectives of ENGG1000, our project this Session will give you a taste of what to expect and prime you for a competitive run in second year. For more information about “The Warman” (including the perpetual trophy and cash prize!) start here: <http://www.ncedaust.org/index.php?select=151>.

Design Task

The project is set on the mythical planet Gondwana which has only recently been civilised. For support during the early stages of the development of their planet's infrastructure, the Gondwanans are heavily dependent on visitors from Earth. Power for the planet's industry is supplied by fission reactors fuelled by enriched Unobtanium, a mineral abundant in Gondwana's crust.

Mining is thus a critical enterprise on Gondwana. Alas, the OH&S culture has not matured in-line with the industrial enterprise and the cavalier attitude of a worker has resulted in the spillage of radioactive material in a transport tunnel, thus halting production. Fortuitously, the accident has co-incided with the annual visit to Gondwana of work experience students from UNSW – a group whom the Gondwanans have come to rely upon over the years to solve many tricky problems.

“We won't be able to get close to the dangerous pellets, so need an autonomous machine”, noted one student.

“It'll have to be small enough to pass through the duct as well as its access opening”, commented another.

“It'll have to be as light as possible to avoid distorting the duct and thus spilling the pellets” said a third.

The Gondwanans doubted that the earthlings could help them this time – but indeed they did – and solved the problem with their Project TaRFU – **T**ransit and **R**etrieve **F**allen **U**nobtainium.

The Challenge

The challenge is to design a prototype system to meet the needs of the Gondwanan industry. You will work in groups of five or six to design a system which retrieves the spilled radioactive material. Resources on Gondwana are limited, so the machine presented as part of the winning tender 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 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.



Impressing the Judges – 2010



Warman Competition National Final - 1994



School of Mining Engineering

Mining Engineering Project: Design a Dragline

Never Stand Still

Faculty of Engineering

Background

Draglines are commonly used in open-cut coal mining operations to remove overburden material, uncovering and providing access to the coal seam beneath. These are high-capital-cost/low-operating-cost systems typically costing between \$50 and \$100 million AUD. They are very large, heavy and highly productive pieces of machinery comprised of a bucket that is suspended from a boom (typically 45-100m) by two cables known as the 'hoist rope' and 'drag rope'. These 'ropes' are generally powered by electric motors and are used to manoeuvre and control the bucket for various operations. A typical dragline cycle involves dragging the bucket into the muck-pile and then swinging it to a location where the material is dumped, often at a higher elevation. They are usually connected to the grid, rather than using diesel power, due to their large energy usage (up to 6 MW during normal digging operations). As the main equipment on-site, production is generally scheduled around the operation and productivity of the dragline.



Figure 1: Dragline at the Curragh Coal Mine

Source: <http://en.academic.ru/dic.nsf/enwiki/310235>

Project Description

A dragline is going to be used in Hunter Valley operations (**Figure 2**) that are located 24km north west of Singleton in New South Wales. These operations supply international markets up to 11 million tonnes of thermal and semi-soft coking coal per annum. Private rural residences surround the proposed dragline site. Consequently, there is community sensitivity to dust, noise, vibration and lighting. The impact to the community needs to be considered in the design of the dragline operations.

Design Objectives

Your team is charged to design, construct a working model of a dragline and optimise the cycle time for a stationary dragline system (no walking) capable of removing material from a muck-pile and dumping into a dumping bin (**Figure 1**).

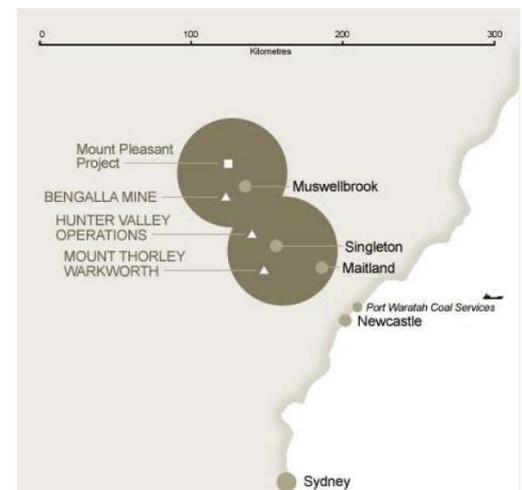


Figure 2: Map of mine locations at Singleton

Due to the high power requirements of draglines, it is essential to ensure an efficient operating cycle. This consists of three main actions: 1. Hoist; 2. Drag; 3. Swing. Each action will be controlled by a separate motor and gearbox (these will be supplied to each group at the beginning of the project). Spoil placement and characteristics of the bucket control should be carefully considered for optimising the patterns of machine position, dig location, digging sequence, and dump locations.

Dragline Cycle

Your dragline should be able to operate in one complete cycle including: Positioning the bucket to load; filling the bucket by dragging; hoisting the bucket; swinging the load bucket; dumping the load; swinging back and repositioning; **repeat the cycle**.

Dragline constraints and parameters:

- The dragline's base frame sits on a workbench 400mm x 400mm.
- Muck pile: includes a type of grain (e.g. corn) – samples will be provided to groups.
- 3 x 6V DC motors and gearboxes are supplied for 1-Hoist, 2-Drag, 3-Swing
- Batteries must have a voltage rating of 9V or less. Battery life must be sufficient for at least 5 minutes
- It is envisaged that the model will be built from materials bought in a supermarket, hardware, hobby or toy shop for less than \$50 total. Junk is free.
- The device must be built by students enrolled in ENGG1000, only.
- Limited access to basic hand tools will be provided in the Mining Laboratory.

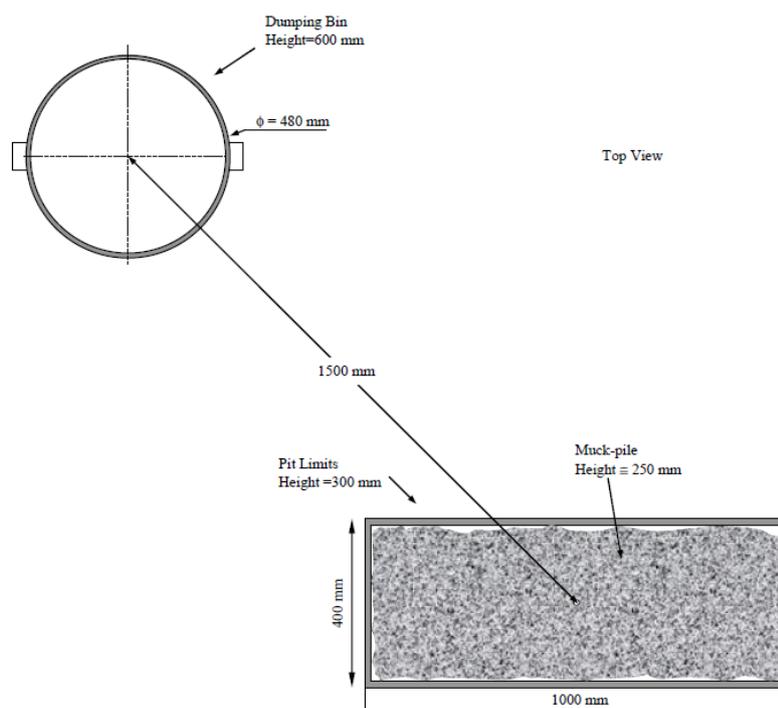


Figure 3: Dragline working space layout



School of Petroleum Engineering

Petroleum Project: Geological storage of greenhouse gases

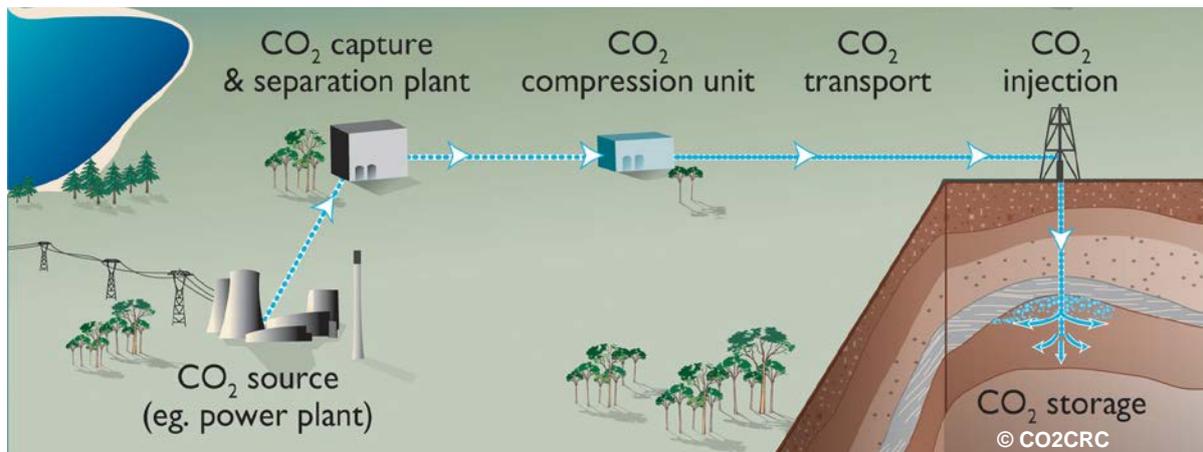
Never Stand Still

Faculty of Engineering

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 3.9 tonnes per annum, which is slightly above the estimated sustainable limit (3.5 tonnes 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.



Design Task

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.

Design Objectives

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 an amount specified by the School in Week 2.



School of Photovoltaic and Renewable Energy Engineering

Photovoltaic and Renewable Energy Project: Space Elevator

Never Stand Still

Faculty of Engineering

Design task

Find a cheaper and safer way into space, powered with renewable energy! Using solar-electric panels and motor provided, plus any other materials of “no commercial value”, design a “Space Elevator” that can climb to the top of a 7-metre “Space Tether” and return back down, safely. Your group will design, construct and test an elevator, and then compete in a contest to determine the best performing design in several categories.

Your elevator must climb on the 2.5-cm-wide nylon strap (the Space Tether) that will be suspended from ~7 meters to the ground. Gears, bands, belts, pulleys, balsa, plastic, glue, spit, tape – basically any materials of no commercial value – can be used in the construction. The more recycled materials, the better! However, the only allowed source of energy is the solar panels provided – no batteries, wind up devices or other extraneous forms of energy are allowed. Your elevator must also be completely self contained and have some way that allows it to make a controlled return to the ground safely (falling doesn’t count). The elevator must also carry a “Space Tourist” to the top and back again safely.



Check this out if you want to see people serious about space elevators: <http://www.isec.info/>

* The Space Tourist is a small figurine provided by the group.

Design Objectives

Your team’s objective is to design, test and build a Space Elevator that will (1) meet the design constraints (to be provided), (2) be constructed from no commercially valuable materials and (3) climb to the top of the Space Tether and return in a controlled manner back to the ground in minimum time. A final elimination competition will be held to determine the winning design with a prize also going to the fastest time of the day!

Space Elevator designs will also be recognised for:

- Coolest looking design (usually very competitive)
- Most innovative feature
- Best construction
- Best use of recycled materials
- And more...