MATERIALS & PROCESSES ADVANCED (11052)

UNIVERSITY OF CANBERRA
FACULTY OF ARTS AND DESIGN
COURSE IN INDUSTRIAL DESIGN

Design Statement

This unit comprises 3 hours contact per week involving a 1-hour remote lecture and a 2-hour tutorial. Lectures explores material structures, manufacturing processes, advanced composite materials (as they relate to product design for manufacture), material's interaction with the environment, sustainability considerations and social and environmental responsibilities. In the Tutorials examples of materials and processes (covered in the lectures) are inspected and analysed, there are also demonstrations of some of the processes and guidance is provided on working through the assessment projects. All lectures are delivered in a lecture room and a recording is available, immediately after the lecture, on the unit Canvas site. Tutorials are primarily held in the design studio with demonstrations and some of the project work conducted in the workshop.
Knowledge and skills acquired in the lectures and tutorials will be further strengthened and demonstrated through design projects. These projects will require problem solving to generate creative design solutions with the design process as the driving principle. The design projects are aimed to demonstrate knowledge of materials interaction with the environment, material selection, advanced composite design, and advanced composite manufacturing processes. A component of both projects will be to make a physical working model with guidance from your tutor and workshop staff in the workshop.

Workshop induction: Please note that students need to have completed a Workshop induction before they can use the workshop. Please see the workshop staff to book a workshop induction.

Timetable

Week	ACTIVITY	
	Lectures (1hr)	**Studios (2 hr)**
1	**Unit Outline Introduction** **Composites**	**Project 1 launch** (1 HR) + Drawing layout
2	**Composites**	Composites Workshop demo
3	**Composites**	In the Workshop working on project 1
4	**Composite project example**	In the Workshop working on project 1
5	In the Workshop working on project 1	**Project 1 Submission**
6	**Material structures**	**Project 2 launch (1** HR**) +** Material Properties
7	**Corrosion**	In the Workshop- Zinc Plating & Chromating demo
8	**CLASS FREE – NO LECTURE OR TUTORIALS THIS WEEK**	
9	**Sheet metal** **Welding, Brazing & Soldering**	**Project 2- Stage 1 Submission** in the Studio
10	**In the Workshop- Resin infusion Demo.**	Welding Demo & Lathe Demo
11	**Gears & Threads** **Rolling, Forging & Drawing**	Milling Machine Demo. Sheet Metal Bending Demo & Examples
12	In the Workshop working on project 2b	In the Workshop working on project 2 - Stage 2
13	In the Workshop working on project 2b	In the Workshop working on project 2 - Stage 2
14	In the Workshop working on project 2b	**Project 2- Stage 2 Submission** in the Studio

Lists of required texts/readings

Recommended texts/readings

Thompson, R 2007 *Manufacturing Processes for Design Professionals,* Thames and Hudson, London.

Kalpakjian, S. (2014). Manufacturing engineering and technology (7th edition in SI units.). Singapore: Pearson Education South Asia.

Assessment overview

Assessment item (including exams held in the exam period)	Due date of assignments	Weighting (total to equal 100%)
Project 1	Wk 5	30%
Project 2: Stage 1- Report & Concepts	Wk 9	30%
Project 2: Stage 2- Working Model & Report	Wk 13	40%

Materials & Processes Advanced Project Briefs

Project 1

UNIVERSITY OF CANBERRA
COURSE IN INDUSTRIAL DESIGN

Unit : Materials & Processes Advanced
Project 1 : **Propelling Device**
Handout : Wk 1 Tutorial
Submission : Wk 5 Tutorial
Duration : 5 Weeks
Value : **30%**

Aims:

- To acquire, through design, analysis, problem solving and making, practical experience and knowledge of composite manufacturing processes.
- To gain relevant design experience and knowledge for communicating a composite manufacturing design proposal in terms of specifying materials and detail drawings complete with appropriate dimensions and tolerances.

Project:

You are required to design and make a physical working model of a Propelling Device whose task is to propel a Tennis ball a minimum horizontal distance of 2 meters. The **design specifications** for the device are as follows:

- 90%-100% of the Propelling Device must be made from one or more composite material(s).
- 10% of the Propelling Device can be made from any other material that does not have rubber like properties that is able to be stretched by more than 5% and rapidly return to its original length (tensile yield elongation less than 5%)

- Can use any type of rope or string that has a tensile yield elongation less than 5%.
- Each student will be supplied an identical mold to make their propelling device from. Therefore, the inside profile (mold facing) of all the catapult will be the same for every student as seen in Image 1.
- The outside profile can vary in thickness depending on individual layup.
- The front profile (width) of the propelling device can be any shape and size.
- Clamping base must be a minimum of 40mm long as shown in Image 1. The width can be any size and shape.
- Must weigh no more than **15 grams** plus or minus 1 gram.
- Final physical working model of your Propelling Device must be able to perform the specified task.

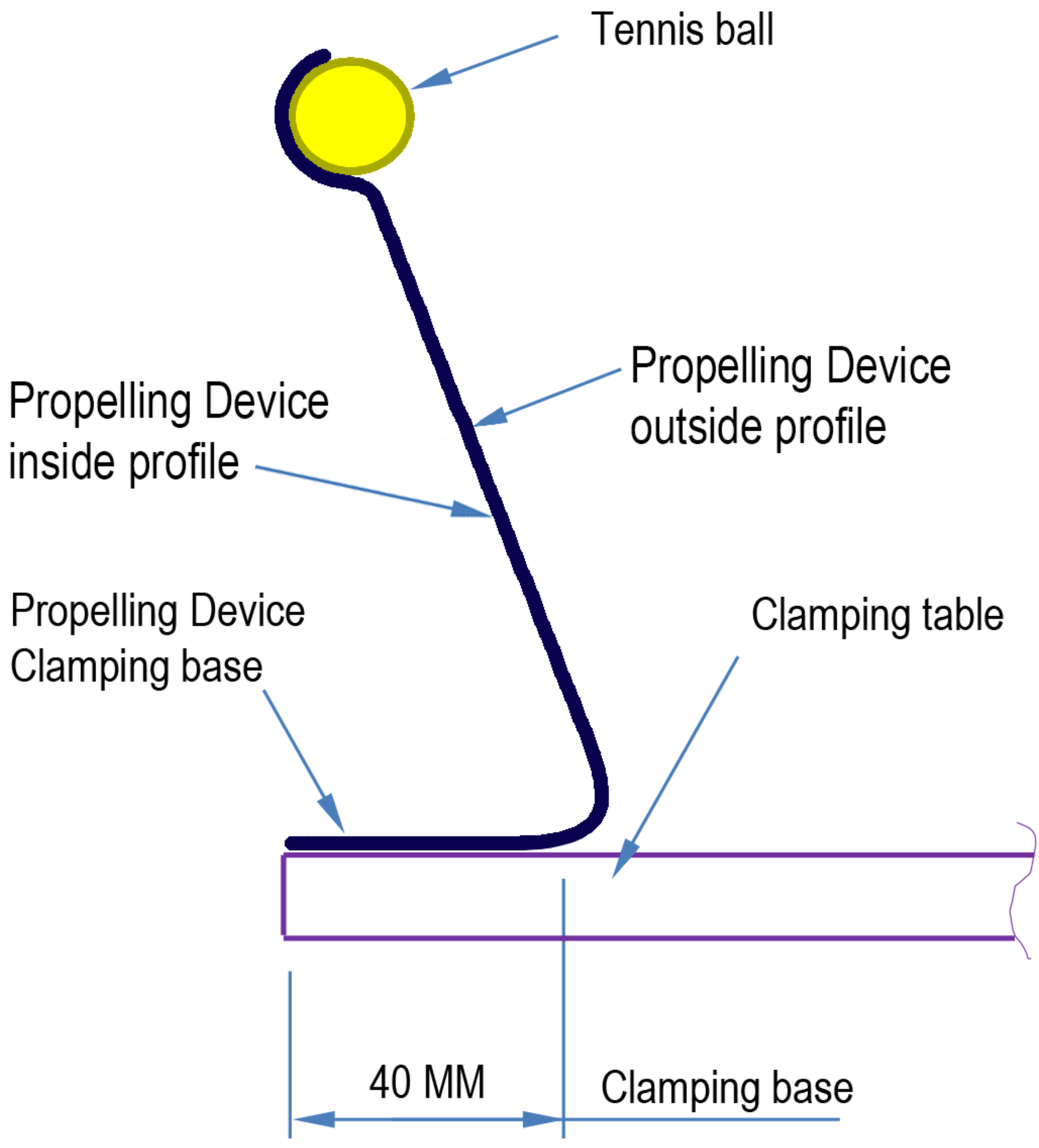

Image 1. Catapult side view

Submission Requirements:

1a. Composite Propelling Device Report- Week 5: 10%.

You are required to submit a PDF report that documents the design, materials and manufacturing processes for your Propelling Device that includes:

- Your name, sheet title and date on each sheet.
- A project description (brief introduction), body of the report (design, materials, & manufacturing processes), and reflections (conclusion)
- Sketches of your design in either elevation and or perspective views with one sectional view showing the composite layup (fibre direction, fabric type/weave style and fabric weight) of your Propelling Device. Sketch must include at least overall dimensions. You are not required to show colour.
- Identify all materials, joining means, finishes and parts.
- List the manufacturing process(s), in their correct sequence, required to manufacture your Propelling Device. You can use images and or sketches to show this.
- Identify what is innovative about your design including function, sustainability, environmental issues, etc
- Provide references to verify your work.
- Show all the above on 4 A4 pages (title page and references are additional). Must be in PDF format.

Note: You must upload your PDF report to the Canvas site.

1b. Composite Propelling Device Working Model - Week 5 tutorial: 20%.

You are required to submit the following:

A 3D physical working model of your Propelling Device to be presented and tested in class. Model must comply with the listed design specifications and can perform the required task.
Any Propelling Device that does not comply with the design specifications will receive a 0% mark for 2.1

Mark allocation for submission requirement **1b:**

- 10% if your Propelling Device can propel a Tennis ball a minimum horizontal distance of 2 meters.
- 10% to the person whose Propelling Device has the best distance to weight ratio. 0% to the person whose Propelling Device has the worst distance to weight ratio. All other marks will fall between 10% and 0% based on their distance to weight ratios.

Assessment criteria

1. Report- Must include your name and project title.
2. Report- Must include a project description (brief introduction), report body, and reflections (conclusion).
3. Report Body- The quality of sketches to clearly communicate the design intent of the Composite Propelling Device? This includes elevation and or perspective views, and one section or exploded view, overall dimensions, and the composite layup of your Propelling Device. Has the fibre direction, fabric type/weave and fabric weight for each layer been clearly communicated?
4. Report body- Accuracy, depth of information and level of supporting evidence (references to substantiate your work). Have all the materials, manufacturing processes and manufacturing steps been identified? Does the report demonstrate an understanding, application and appropriateness of chosen materials and manufacturing process to allow the device to perform its intended task including the level of design innovation? Are the manufacturing steps listed in their correct sequence? Have only allowable materials been used and within the acceptable percentages?
5. Working Model - Can it propel a tennis ball 2 meters.
6. Working model - Power to weight ratio.

Project 2

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Unit	: Materials & Processes Advanced
Project 2	: **Resistant to the Elements**
Handout	: Wk 6 Tutorial
Submission	: Stage 1 in WK 9 Tutorial - Stage 2 in WK14 Tutorial
Duration	: 9 Weeks
Value	: **70%**

Aims

- To acquire, through design, analysis and problem solving, practical experience and knowledge of materials, manufacturing processes and corrosion prevention.
- To gain relevant design experience and knowledge for communicating and presenting a manufacturing design proposal in terms of drawings with appropriate dimensions and information.
- To gain experience and knowledge on investigating and applying guidelines on sustainability and environmental responsibility.

Project Brief

This project will involve 2 stages as follows:

- In **stage 1**, you will be assigned three materials that you will conduct corrosion testing on to determine the best method to protect the materials against corrosion.
- In **stage 2**, you will use the knowledge from stage 1 to design a new domestic LED Light from your assigned materials that is resistant to corrosion. You will need to decide what *type of domestic LED light* you will design- for example- a table mounted reading light, a table mounted bed side light, a wall mounted entrance light, a hanging ceiling light, etc.

The project requirements for the two stages are as follows:

Stage 1- Corrosion Testing and Concepts.

Process and requirements:

1. **Corrosion Testing-** In the week 6 tutorial you will be randomly assigned one anodic and one cathodic metal. Everyone will also be assigned Carbon Fibre reinforced composite (CFRC).
2. **Corrosion Testing-** You then need to apply a saltwater immersion test as shown on page 245 of the corrosion lecture notes (that are on your canvas site) and record how long it takes for signs of galvanic corrosion to occur between your three materials. Before testing the CFRC, sand the surface on one side only (under running water) to expose the carbon fibres. Leave the surface on the other side un-sanded. Test both sides to see if there are any differences in their corrosion potential.
3. **Corrosion Testing-** Observe what happens to your materials during the corrosion tests and record the results with photos and written notes. This includes the rate of corrosion over time and describe what the corrosion looks like.
4. **Corrosion Testing-** You next need to do something to your materials so that when you apply the same saltwater immersion test there is no galvanic corrosion over double the time applied in the first test(s). Try

different methods to prevent corrosion between your materials in the immersion test. To prevent corrosion, the only things you cannot do is to paint, powder coat, or oil your materials.

5. **Corrosion Testing-** Select your most successful method(s) at preventing corrosion between your materials. Concisely explain your chosen method(s) and explain what lead you to decide that this is the most successful method(s) at preventing corrosion.

6. **Concepts-** You first need to choose what *type of domestic LED light* you want to design. for example- a table mounted reading light, a table mounted bed side light, a wall mounted entrance light, a hanging celling light, etc.
7. **Concepts-** You need to generate 2 different concept designs for a new domestic LED light that uses all three of your assigned materials. You can select the same *type of domestic LED light* for both concepts or a different *type of domestic LED light* for each concept.
8. **Concepts-** Your new domestic LED Light must be resistant to corrosion by employing your most successful corrosion prevention method(s) from stage 1 but must not be painted, oiled, or powder coated.
9. **Concepts**- Design your domestic LED Light so that between 80% - 100% (by surface area) of it is made from your assigned anodic, cathodic, and CFRC materials. For the remaining % you can use any other material (metal, plastic, timber, etc) in any form (rod, tube, solid, screws, bolts, nuts, rivets, etc). Each of your assigned metals must account for approximately no less than 20% of the total material used (by surface area). The assigned materials must be in sheet form no thicker than 3mm.
10. **Concepts**- Your new Light must be able to perform its intended function, have an aesthetic and creative quality, and be environmentally sustainable.
11. **Concepts**- Your new Light must be no bigger than 300mm x 300mm x 300mm.
12. **Concepts**- The LED light must run from a standard power outlet (not battery powered) and all components must be readily available on the market from for example- Bunnings, Jcar, online, etc.

Two of the following Metal samples will be randomly assigned in the week 1 tutorial-
Anodic Metals - Aluminium, Mild Steel
Cathodic Metals- Copper, Brass.

Material sample assigned to everyone- CFRC

Stage 1 Submission & requirements

Week 9 tutorial: 30%- The submission must include a report and presentation of 2 concept designs for your new domestic LED Light as follows:

Report requirements- Corrosion Testing:

1. 4 A4 pages starting with your name, project name and number each sheet. Start the report with a 100-word maximum introduction of your LED Light project aims for stage 1.
2. Report on your saltwater immersion tests showing images of galvanic corrosion between your materials, what you observed, and the time taken for the corrosion to occur.
3. Identify the method(s) you used to prevent galvanic corrosion in the saltwater immersion tests. Identify and describe your best method(s) for preventing corrosion and explain why these were the two most successful methods, include images from your tests.

The report must be in PDF format.
Submit your report by uploading it to the canvas site by 11:59 pm on the day of your week 9 tutorial.

Concept requirements:

You are required to submit 2 x A3 sheet per concept (total 4 A3 sheets minimum) that contain the follows:

1. Quality sketches (orthographic views with overall dimensions, section view and one perspective view) of your LED Light design that clearly communicate the design intent, *type of domestic LED light*, all materials, joining methods (ensuring they inhibit corrosion), and manufacturing processes in their correct order.
2. Identify what is novel about your design.
3. The LED light must run for a standard domestic power point (not battery powered) and all components must be readily available on the market from suppliers such as- Bunnings, Jcar, online, etc.
4. Identify what is sustainable and environmentally responsible about each concept.

You must pin-up and present your 4 x A3 concept sheets in the week 9 tutorial.

You are also required to submit your presentation sheets by uploading them to the canvas site by 11:59 pm on the day of your week 9 tutorial (presentation day).

This project is designed to not only test and apply your knowledge but also demonstrate how well you impart this knowledge to the others in the class. For your presentation think of effective ways to sell your design and to get the message across. A Good idea is to practice what you will say and do not read word for word from a script.

Stage 1- Assessment criteria

1. REPORT- Does the report include your name, project title, brief project introduction with aims and references?
2. REPORT- Does the report identify your three materials? Using words and images, how clearly have you documented your saltwater immersion tests, what you observed and the time it took for galvanic corrosion to occur between your materials?
3. REPORT- Using words and images, does the report identify and clearly document all the saltwater immersion corrosion prevention methods and tests you conducted? How clearly have you identified and described the best method(s) you found for preventing corrosion between your materials and explained why it was the most successful method(s)?
4. CONCEPTS- Do the sketches (orthographic views with overall dimensions, section view and one perspective view) of your LED Light concepts clearly communicate the design intent, technical package, ability to perform their intended function and aesthetics?
5. CONCEPTS- Do the concepts clearly identify the *type(s) of LED light*, the materials, joining methods, and manufacturing processes? Are the manufacturing processes in their correct sequence?
6. CONCEPTS- Do your concepts clearly show that the allowable percentage of materials by surface area is used?
7. CONCEPTS- How well has your most successful method(s) of preventing corrosion been applied to your LED Light concepts?
8. CONCEPTS- Do the concepts clearly identify what is sustainable and environmentally responsible about your LED Light design?
9. CONCEPTS- Have you clearly identified what is novel about your LED Light design?

Stage 2- Working Model.

Process and requirements:

1. Based on the feedback from your tutor in stage 1a, refine your concepts down to one final design to suit the *type of domestic LED light* you selected.
2. Make a working model (prototype) of your new domestic LED Light so that between 80% - 100% (by surface area) of it is made from your assigned anodic, cathodic, and CFRC materials. For the remaining % you can use any other material (metal, plastic, timber, etc) in any form (rod, tube, solid, screws, bolts, nuts, rivets, etc).

Each of your assigned metals must account for approximately no less than 20% of the total material used (by surface area). The assigned materials must be in sheet form no thicker than 3mm.

3. The LED light must run for a standard power out (not battery powered) and all components must be readily available on the market from for example- Bunnings, Jcar, online, etc.
4. Your new LED Light must be resistant to corrosion by employing the most successful method(s) you selected in stage 1. Please note that if you decide to use additional materials, to your assigned metals, you need to consider their potential for corrosion and apply measures to prevent corrosion.
5. Must be resistant to corrosion but must not be painted or powder coated.
6. Your new Light must be able to perform its intended function, have an aesthetic and creative quality, and be environmentally sustainable.
7. Your new Light must no bigger than **300mm x 300mm x 300mm**.

8. **The materials for this project can be purchased from WORKSHOP 7.**

Stage 2 Submission & requirements

Week 14 tutorial: 40%- The submission must include a report and presentation of your new domestic LED Light working model (prototype) as follows:

Report requirements:

You are required to produce a concise 2-page pdf report (2 A4 sides MAXIMUM) of your new domestic LED Light that contains the following required components:

1. Project title
2. Your name
3. What *type of domestic LED Light* is this?
4. What is its intended function(s)?
5. What are the materials you used?
6. What method(s) did you use to prevent corrosion?
7. What manufacturing processes did you use to make your new LED Light? The processes must be listed in their correct sequence that you used to make your LED light. You can use images and or sketches to show this.
8. What is innovative about your new LED Light?
9. What is environmentally sustainable about your new LED Light?

Can use images to document your manufacturing processes

Model requirements:

1. Make a full-size working model of your domestic LED Light made as per the requirements of the project brief listed in stage 2.
2. You are required to present your working model in the week 14 tutorial where you will be given **4 minutes** to sell your design after which your tutor will provide feedback.

You are required to upload 5 quality images of your new domestic LED Light working model and the Report to the canvas site at 11:59 PM on the day of the presentation.

This project is designed to not only test and apply your knowledge but also demonstrate how well you impart this knowledge to the others in the class. For your presentation think of effective ways to sell your design and to get the message across. A Good idea is to practice what you will say and do not read word for word from a script.

Stage 2- Assessment criteria

1. REPORT- Does the report contain all the required components?
2. REPORT- Is the report information clearly communicated?
3. MODEL- Does your new domestic LED Light model use the required percentage of materials by surface area?
4. MODEL- How well have your two most successful methods of preventing corrosion been applied to your new domestic LED Light model?
5. MODEL- What is the build quality of your new domestic LED Light model?
6. MODEL- What is the aesthetic quality of your new domestic LED Light model?
7. MODEL- How successful is your new domestic LED Light model at performing its intended function?

List of recommended texts and web sites:

- Kalpakjian, S. (2014). Manufacturing engineering and technology (7th edition in SI units.). Singapore: Pearson Education South Asia.
- Kalpakjian, S. (2010). Manufacturing Engineering and Technology, 6nd edn, Pearson Prentice Hall, USA.
- Oswald, P. F. & Munoz, J. (1997). Manufacturing Processes and Systems, 9th edn, John Wiley & Sons, Inc. USA.
- Bralla, J. G. (2007). Handbook of Manufacturing Processes How Products, Components and Materials are Made. Industry Press, New York, USA.
- Groover, M. P. (2002). Fundamentals of Modern Manufacturing Materials, Processes, and Systems. 2nd edn, ohn Wiley & Sons, Inc. USA.
- Thompson, R. (2007). Manufacturing Processes for Design Professionals. Thames & Hudson Inc. New York, USA.
- Ashby, M & Johnson, k. (2002). Materials and Design - the art and science of material selection, Butterworth Heinrmann,.
- Engineering Drawing Handbook, Standards Australia
- https://ez-pdh.com/corrosion-help/