MECH401

Product Design Engineering

S1 Day 2016

Dept of Engineering

Contents

General Information

Unit convenor and teaching staff
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Credit points
3

Prerequisites
MECH303 and (MECH304 or COMP350)

Corequisites

Co-badged status

Unit description
Students learn about the entire product design cycle from conceptualization of ideas to design, manufacturing and marketing. Students will be exposed to a range of consumer products and will implement their prior knowledge on how to improve existing designs by applying to state-of-the-art design and manufacturing techniques, advanced composites (including biomaterials) and different approaches that can be used to reduce the cost of final products. These products range from electronic household products, to biomedical implants and specific parts/ components of large machines used in heavy industries.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.

Demonstrate team building abilities and communication skills in the multidisciplinary design of a new product.

Define and critically assess the key features of product design and development in a

mechanical engineering context

Demonstrate an ability to innovate and develop a new product based on identifying market opportunities leading to a final engineering design and cost forecasting analysis

General Assessment Information

The following conditions apply for satisfactorily passing the unit:

1. Must obtain an overall satisfactory mark.
2. Must submit all assessments.
3. Must perform satisfactorily in the "Final Design Report" and "Final Management Report".

For assignments handed in late the following penalties apply: 0-24hrs -25%, 24-48hrs -50%, more than 48hrs -100%.

For each group assessment handed in, students must indicate relative contributions of each team member so that marks are provided accordingly.

There is no invigilated examination for this unit. The capstone project in this unit is all group work, but students receive individual marks on the basis of their individual contributions towards each aspect of the project. Assessment is as follows:

1.Development of a Design Concept (20%)

The students will develop a new engineered product concept. The product will be chosen on the basis of market research, profitability, engineering principles, and manufacturability. Students will assume that their product is to be ultimately pitched to a wide audience and therefore must attempt to develop a concept which would “make-it” in the market-place.

Assessment:

1. A written technical report which shows clear consideration for consumer needs and market requirements, product screening cost and potential profits, target market, and which presents evidence that a realistic strategy has been used for selecting amongst multiple concept ideas. Students can also suggest a plan for viability testing of the concept. The “Concept Report”, to be completed as a group, will be no more than 20 pages including sketches, market analysis/review, concept combinations tables, a mission statement and consumer needs etc. The precise requirements are shown in the rubric.

2. Product Planning (15%)

The students must perform a full product development management analysis. This will include demonstrating planning in the progression of key steps in their product development and design process. The students will imagine that they will ultimately pitch their product to a wide audience,

and therefore it is expected that the management plan is done over realistic timescales (from weeks, months or even years depending on how long it would take for the product to be launched). This management plan, in addition to including accurate time planning must include an accurate analysis of cash flow forecasts. The cash flow forecast must include accurate budgeting and costing, and there should be signs which show that students have optimized the design or manufacturing techniques to ultimately reduce cost and time to product launch.

The students should make use of professional engineering management tools such as Gantt charts, critical paths, and design structure matrices and consider NPV, IRR and other relevant financial markers.

Assessment:

1. A management report including cost calculations, figures and tables, clearly outlining the management of the development of the product over its lifetime utilizing professional engineering management and product development tools where necessary. The report will not exceed 15 pages. The precise requirements are shown in the rubric.

3. Design and Analysis (40%)

Students will design their product using CAD software, and this will include models, detailed part drawings and assembly drawings, with a full choice of materials. Students must support their chosen designs with technical calculations.

Assessment

1. The submitted CAD drawings (their technical accuracy, adherence to standards, accurately dimensioned, sufficient cross-sectional views, sufficient part drawings, well annotated drawings, etc.) The precise requirements are shown in the rubric.
2. The supplementary report, max 15 pages excluding any Appendices. This report will outline any details on the design which are not included in the drawings such as *technical calculations*, a DFM or DFA analysis of the product, justification of the manufacturing techniques chosen, and an assessment of product quality and risks of failure (such as FMEA). The key technical design features must be discussed and must include features which avoid over-engineering (with technical calculations), features which minimize the number of parts, and features which are conducive to automated and mass manufacturing where possible. The precise requirements are shown in the rubric.

4. The final pitch and prototype (15%),

Students will create a 2 pg summary of the key features of their product which is targeted towards a wide audience that may know nothing about engineering (the report can include anything the students think is important, from the design itself, potential profits etc., it can be thought of as a brochure). The student team will stand up in-front of a panel of 3-5 academics which has read their 2pg report, and the students will “pitch” their product, trying to convince at least one academic to “invest” in their idea. The students must present a prototype. If this can be

easily manufactured, then the students can use a 3D printer, otherwise a good 3D model of the product with key features is expected.

Assessment:

1. The attractiveness and perceived need of the product as shown by the 2 page report
2. The final presentation and the amount of “points” the students accrue by the academics on the “selection panel”. A team must ask for a particular sum of fake money for investment to take place. Based on the amount of “money” the panel decides to give, marks will be awarded. The precise requirements are shown in the rubric.
3. The clarity and usefulness of the prototype. The precise requirements are shown in the rubric.

5. Project Progress (10%)

Attendance will be taken at all tutorial and mentoring sessions and it is expected that a continuous development of the product is shown throughout the unit. Marks will be allocated as per the rubric.

Assessment

1. Students must attend all tutorials and mentoring sessions and be engaged showing project progress.
2. Students (as a group) must keep a logbook of all activities (the log can be hand-written or it can be electronic and sent in through iLearn as a single pdf).

Assessment Tasks

Name	Weighting	Due
Concept Report	20%	Week 9
Group Final Pitch Report	5%	Week 12
Group Final Pitch Presentation	5%	Week 13
Prototype	5%	Week 13
Logbook and Project Progress	10%	Throughout S1
Final Design Report	40%	S1 exam period (19th June)
Final Management Report	15%	S1 exam period (19th June)

Concept Report

Due: **Week 9**
Weighting: **20%**

Group Concept Design Report

On successful completion you will be able to:

- Demonstrate an ability to innovate and develop a new product based on identifying market opportunities leading to a final engineering design and cost forecasting analysis

Group Final Pitch Report

Due: **Week 12**
Weighting: **5%**

Group Prototype Report

On successful completion you will be able to:

- Demonstrate team building abilities and communication skills in the multidisciplinary design of a new product.

Group Final Pitch Presentation

Due: **Week 13**
Weighting: **5%**

Group Presentation

On successful completion you will be able to:

- Demonstrate team building abilities and communication skills in the multidisciplinary design of a new product.

Prototype

Due: **Week 13**
Weighting: **5%**

Prototype

On successful completion you will be able to:

- Demonstrate an ability to innovate and develop a new product based on identifying market opportunities leading to a final engineering design and cost forecasting analysis

Logbook and Project Progress

Due: **Throughout S1**
Weighting: **10%**

Group logbook indicating development of project throughout S1 and attendance and engagement at tutorial and mentoring sessions

On successful completion you will be able to:

- Define and critically assess the key features of product design and development in a mechanical engineering context

Final Design Report

Due: **S1 exam period (19th June)**
Weighting: **40%**

Group Report Including CAD drawings and technical calculations

On successful completion you will be able to:

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.

Final Management Report

Due: **S1 exam period (19th June)**
Weighting: **15%**

Group Management Report

On successful completion you will be able to:

- Define and critically assess the key features of product design and development in a mechanical engineering context

Delivery and Resources

There is no mandatory core text for this unit. However, the following texts are recommended:

"Product Design and Development" by Ulrich and Eppinger

"Product Design for Engineers" by Shetty

Unit Schedule

Week 1

- Review engineering design courses from previous years
- Introduction to the unit, method of assessment and description of the project

Week 2: The Basics of Product Design and Development

- The Stages of Product Design and Development
- Types of Products and measures of successful products
- Opportunity Identification, Customer Needs, Target Market
- Case Studies of successful/unsuccessful products

Week 3: Concept Choice and Development

- Generating, Developing and Choosing a Concept
- Concept Ranking
- Product Concept Case Studies
- Concept Viability Testing

Week 4: Product Specifications and Design for Manufacture (DFM)

- Generating target and final specifications for a new product
- Design for Manufacture Strategies (DFM)
- Tips on easing manufacture
- Maximization of manufacturability (simple mathematical approach)
- Case Studies

Week 5: Design for Assembly (DFA), Industrial Design (ID) and Prototyping

- Design for Assembly (DFA) techniques (DFA index, Boothroyd-Dewhurst Method)
- What is industrial design? Who invests in ID?
- Types of prototypes, how to choose?

Week 6: Product Development Management and Quality

- Management tools for product development, review of the basics (Gantt chart, PERT chart, critical path)
- Design Structure Matrices (DSM) with Case Studies
- Risks and quality in Product Development (Risk Maps, Pareto Analysis, FMEA)
- Quality in Products: Six Sigma, DMAIC, The Toyota Wastes

Week 7: Product Development Economics

- Re-cap: Fixed Costs vs Variable Costs and breaking even
- Re-cap: Product Screening
- The Net Present Value, Cash Flow Forecasting and Cash Flow Sensitivities applied to

product development

- The Internal Rate of Return and the Cost of Equity

Weeks 8-13: Lectures become mentoring sessions (Kourmatzis, Cheng, Diasinos, Huda, Lee, and Lang)

- Lecture Hall will consist of multiple teams (6 teams) with one mentor assigned to each, mentoring sessions will take place in the lecture theatre or another suitable location.
- Attendance will be taken at the tutorials and mentoring sessions. Tutorials will take place in the CAD lab for students to work on their products during these time slots.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.
- Define and critically assess the key features of product design and development in a mechanical engineering context

- Demonstrate an ability to innovate and develop a new product based on identifying market opportunities leading to a final engineering design and cost forecasting analysis

Assessment task

- Concept Report

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Demonstrate team building abilities and communication skills in the multidisciplinary design of a new product.
- Define and critically assess the key features of product design and development in a mechanical engineering context

Assessment task

- Final Management Report

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcome

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.

Assessment task

- Logbook and Project Progress

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge,

scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcome

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.

Assessment tasks

- Group Final Pitch Report
- Group Final Pitch Presentation
- Prototype
- Final Design Report

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.
- Define and critically assess the key features of product design and development in a mechanical engineering context

Assessment tasks

- Prototype
- Final Design Report
- Final Management Report

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Demonstrate an ability to apply the analytical, design, and theoretical techniques learned throughout the first 3 years of the degree to the design and development of a new innovative product.
- Define and critically assess the key features of product design and development in a mechanical engineering context
- Demonstrate an ability to innovate and develop a new product based on identifying market opportunities leading to a final engineering design and cost forecasting analysis

Assessment tasks

- Prototype
- Final Design Report

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcome

- Demonstrate team building abilities and communication skills in the multidisciplinary design of a new product.

Assessment tasks

- Concept Report
- Group Final Pitch Report
- Group Final Pitch Presentation
- Logbook and Project Progress

Changes since First Published

Date	Description
26/02/2016	The following is now in the beginning of "General Assessment Information" section: For each group assessment handed in, students must indicate relative contributions of each team member so that marks are provided accordingly. There is no invigilated examination for this unit. The capstone project in this unit is all group work, but students receive individual marks on the basis of their individual contributions towards each aspect of the project.