

# Unit 1: Engineering Design

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| <b>Unit code</b>    | <b>K/615/1475</b> |
| <b>Unit type</b>    | <b>Core</b>       |
| <b>Unit level</b>   | <b>4</b>          |
| <b>Credit value</b> | <b>15</b>         |

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## Introduction

The tremendous possibilities of the techniques and processes developed by engineers can only be realised by great design. Design turns an idea into a useful artefact, the problem into a solution, or something ugly and inefficient into an elegant, desirable and cost effective everyday object. Without a sound understanding of the design process the engineer works in isolation without the links between theory and the needs of the end user.

The aim of this unit is to introduce students to the methodical steps that engineers use in creating functional products and processes; from a design brief to the work, and the stages involved in identifying and justifying a solution to a given engineering need.

Among the topics included in this unit are: Gantt charts and critical path analysis, stakeholder requirements, market analysis, design process management, modelling and prototyping, manufacturability, reliability life cycle, safety and risk, management, calculations, drawings and concepts and ergonomics.

On successful completion of this unit students will be able to prepare an engineering design specification that satisfies stakeholders' requirements, implement best practice when analysing and evaluating possible design solutions, prepare a written technical design report, and present their finalised design to a customer or audience.

## **Learning Outcomes**

By the end of this unit students will be able to:

1. Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements.
2. Formulate possible technical solutions to address the student-prepared design specification.
3. Prepare an industry-standard engineering technical design report.
4. Present to an audience a design solution based on the design report and evaluate the solution/presentation.

## Essential Content

### LO1 Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements

#### *Planning techniques used to prepare a design specification:*

Definition of client's/users objectives, needs and constraints

Definition of design constraints, function, specification, milestones

Planning the design task: Flow charts, Gantt charts, network and critical path analysis necessary in the design process

Use of relevant technical/engineering/industry standards within the design process

#### *Design process:*

Process development, steps to consider from start to finish

The cycle from design to manufacture

Three- and five-stage design process

Vocabulary used in engineering design

#### *Stage of the design process which includes:*

Analysing the situation, problem statement, define tasks and outputs, create the design concept, research the problem and write a specification

Suggest possible solutions, select a preferred solution, prepare working drawings, construct a prototype, test and evaluate the design against objectives, design communication (write a report)

#### *Customer/stakeholder requirements:*

Converting customer request to a list of objectives and constraints

Interpretation of design requirements

Market analysis of existing products and competitors

Aspects of innovation and performance management in decision-making

**LO2 Formulate possible technical solutions to address the student-prepared design specification**

*Conceptual design and evaluating possible solutions:*

Modelling, prototyping and simulation using industry standard software, (e.g. AutoCAD, Catia, SolidWorks, Creo) on high specification computers

Use of evaluation and analytical tools, e.g. cause and effect diagrams, CAD, knowledge-based engineering

**LO3 Prepare an industry-standard engineering technical design report**

*Managing the design process:*

Recognising limitations including cost, physical processes, availability of material/components and skills, timing and scheduling

*Working to specifications and standards, including:*

The role of compliance checking, feasibility assessment and commercial viability of product design through testing and validation

*Design for testing, including:*

Material selection to suit selected processes and technologies

Consideration of manufacturability, reliability, life cycle and environmental issues

The importance of safety, risk management and ergonomics

*Conceptual design and effective tools:*

Technologies and manufacturing processes used in order to transfer engineering designs into finished products

**LO4 Present to an audience a design solution based on the design report and evaluate the solution/presentation**

*Communication and post-presentation review:*

Selection of presentation tools

Analysis of presentation feedback

Strategies for improvement based on feedback

## Learning Outcomes and Assessment Criteria

| Pass  | Merit   | Distinction  |
|---|---|--|
| <b>LO1</b> Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements  |   | <b>D1</b> Compare and contrast the completed design specification against the relevant industry standard specification |
| <p><b>P1</b> Produce a design specification from a given design brief</p> <p><b>P2</b> Explain the influence of the stakeholder's design brief and requirements in the preparation of the design specification</p> <p><b>P3</b> Produce a design project schedule with a graphical illustration of the planned activities</p> | <p><b>M1</b> Evaluate potential planning techniques, presenting a case for the method chosen</p> <p><b>M2</b> Demonstrate critical path analysis techniques in design project scheduling/planning and explain its use</p> |  |
| <b>LO2</b> Formulate possible technical solutions to address the student-prepared design specification  |   | <b>D2</b> Evaluate potential technical solutions, presenting a case for the final choice of solution                   |
| <p><b>P4</b> Explore industry standard evaluation and analytical tools in formulating possible technical solutions</p> <p><b>P5</b> Use appropriate design techniques to produce a possible design solution</p>   | <b>M3</b> Apply the principles of modelling, simulation and/or prototyping, using appropriate software, to develop an appropriate design solution   |  |

| Pass   | Merit   | Distinction  |
|--|---|--|
| <b>L03</b> Prepare an industry-standard engineering technical design report  |   | <b>D3</b> Evaluate the effectiveness of the industry standard engineering technical design report for producing a fully compliant finished product |
| <b>P6</b> Prepare an industry-standard engineering technical design report<br><br><b>P7</b> Explain the role of design specifications and standards in the technical design report   | <b>M4</b> Assess any compliance, safety and risk management issues specific to the technical design report    |  |
| <b>L04</b> Present to an audience a design solution based on the design report and evaluate the solution/presentation  |   | <b>D4</b> Justify potential improvements to the design solution and/or presentation based on reflection and/or feedback                            |
| <b>P8</b> Present the recommended design solution to the identified audience<br><br><b>P9</b> Explain possible communication strategies and presentation methods that could be used to inform the stakeholders of the recommended solution | <b>M5</b> Reflect on the effectiveness of the chosen communication strategy in presenting the design solution |  |

## Recommended Resources

### Textbooks

DUL, J. and WEERDMEESTER, B. (2008) *Ergonomics for beginners*. 3rd Ed. Boca Raton: CRC Press.

DYM, C.L., LITTLE, P. and ORWIN, E. (2014) *Engineering Design: a Project Based Introduction*. 4th Ed. Wiley.

GRIFFITHS, B. (2003) *Engineering Drawing for Manufacture*. Kogan Page Science.

REDDY, K.V. (2008) *Textbook of Engineering Drawing*. 2nd Ed. Hyderabad: BS Publications.

### Websites

[www.epsrc.ac.uk](http://www.epsrc.ac.uk) Engineering and Physical Sciences Research Council  
(General Reference)

[www.imeche.org](http://www.imeche.org) Institution of Mechanical Engineers  
(General Reference)

### Links

This unit links to the following related units:

*Unit 23: Computer Aided Design and Manufacture (CAD/CAM)*

*Unit 34: Research Project*