Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite

Issue 2

For use with:
- Pearson BTEC Higher Nationals in Construction Management for England
- Pearson BTEC Higher Nationals in Architectural Technology for England
- Pearson BTEC Higher Nationals in Modern Methods of Construction for England
- Pearson BTEC Higher Nationals in Quantity Surveying for England
- Pearson BTEC Higher Nationals in Civil Engineering for England
- Pearson BTEC Higher Nationals in Building Services Engineering for England
- Pearson BTEC Higher Nationals in Construction Management
- Pearson BTEC Higher Nationals in Architectural Technology
- Pearson BTEC Higher Nationals in Modern Methods of Construction
- Pearson BTEC Higher Nationals in Quantity Surveying
- Pearson BTEC Higher Nationals in Civil Engineering
- Pearson BTEC Higher Nationals in Building Services Engineering
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Summary of Construction Suite Unit Booklet Issue 2 changes

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Earlier issue(s) show(s) previous changes.
If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.
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1.0 Introduction

The unit descriptors included in this document are for use with the following qualifications:

- Pearson BTEC Higher Nationals in Construction Management for England
- Pearson BTEC Higher Nationals in Architectural Technology for England
- Pearson BTEC Higher Nationals in Modern Methods of Construction for England
- Pearson BTEC Higher Nationals in Quantity Surveying for England
- Pearson BTEC Higher Nationals in Civil Engineering for England
- Pearson BTEC Higher Nationals in Building Services Engineering for England
- Pearson BTEC Higher Nationals in Construction Management
- Pearson BTEC Higher Nationals in Architectural Technology
- Pearson BTEC Higher Nationals in Modern Methods of Construction
- Pearson BTEC Higher Nationals in Quantity Surveying
- Pearson BTEC Higher Nationals in Civil Engineering
- Pearson BTEC Higher Nationals in Building Services Engineering

1.1 Qualifications indicated ‘for England’

Qualifications that are indicated as ‘for England’ are designed to meet the requirements of specific Occupational Standards. Meeting the requirements of the Occupational Standards relates to:

- qualifications that are ‘quality marked’ as Higher Technical Qualifications (HTQ)
- qualifications that meet the knowledge, skills, and behaviours for identified job roles that are associated with the relevant Occupational Standards.

1.2 Qualifications not indicated "for England"

Qualifications that are not indicated as ‘for England’ can be delivered at any centre, in any country, including those in England. However, in England these qualifications are not ‘quality marked’ as Higher Technical Qualifications by the Institute for Apprenticeships and Technical Education (IfATE).
2.0 Programme structures

Programme structures define the unit combinations required for a given qualification. Unit combinations are defined in section 6 Programme structures in the relevant programme specification for each qualification.
3.0 The unit descriptor

The unit descriptor is how we define the individual units of study that make up a Higher National qualification. Students will complete the units included in the programme you offer at your centre.

We have described each part of the unit as follows.

<table>
<thead>
<tr>
<th>Unit title</th>
<th>A general statement of what the unit will cover.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit code</td>
<td>The Ofqual unit code.</td>
</tr>
<tr>
<td>Unit type</td>
<td>There are three unit types.</td>
</tr>
<tr>
<td></td>
<td>• core (mandatory to all pathways)</td>
</tr>
<tr>
<td></td>
<td>• specialist (mandatory to specific pathways)</td>
</tr>
<tr>
<td></td>
<td>• optional (available to most pathways).</td>
</tr>
<tr>
<td>Unit level</td>
<td>All our Pearson BTEC Higher National units are at Level 4 or 5.</td>
</tr>
<tr>
<td>Credit value</td>
<td>The credit value relates to the total qualification time (TQT) and unit learning hours (ULH). It is easy to calculate:</td>
</tr>
<tr>
<td></td>
<td>• 1 credit = 10 ULH, so</td>
</tr>
<tr>
<td></td>
<td>• 15 credits = 150 ULH.</td>
</tr>
<tr>
<td></td>
<td>To complete a Higher National Certificate or Diploma, students must achieve all of the credits required.</td>
</tr>
<tr>
<td>Introduction</td>
<td>Some general notes on the unit:</td>
</tr>
<tr>
<td></td>
<td>• setting the scene</td>
</tr>
<tr>
<td></td>
<td>• stating the purpose, and</td>
</tr>
<tr>
<td></td>
<td>• outlining the topics and skills gained through the unit.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>These clearly explain what students will be able to do after completing the unit. There are usually four Learning Outcomes for each unit.</td>
</tr>
<tr>
<td>Essential Content</td>
<td>This section covers the content that students can expect to study as they work towards achieving the Learning Outcomes.</td>
</tr>
</tbody>
</table>
Learning Outcomes and Assessment Criteria

Tutors can refer to this table when grading assignments. The table connects the unit’s Learning Outcomes with the student’s work. Assignments can be graded at ‘Pass’ (P), ‘Merit’ (M) and ‘Distinction’ (D), depending on the quality of the student’s work.

Recommended Resources

Lists the resources that students should use to support their study for this unit. It includes books, journals and online material. The programme tutor may also suggest resources, particularly for local information.

Web resources – referencing

Some units have web resources as part of their Recommended Resources list. Hyperlinking to these resources directly can cause problems, as their locations and addresses may change. To avoid this problem, students and tutors should reference web resources as follows.

[1] A link to the main page of the website
[2] The title of the site
[3] The section of the website where the resource can be found
[4] The type of resource it is, for example:
   - research
   - general reference
   - tutorials
   - training
   - e-books
   - report
   - wiki
   - article
   - datasets
   - development tool
   - discussion forum.

Examples

[3] Subjects
[4] (General reference)
4.0 Unit descriptors
Unit 1: Construction Design Project (Pearson-set)

Level: 4
Credits: 15
Ofqual Code: F/618/8080

Introduction

The success of any project relies on the development of a good design and the technical information to allow the project to be built. The aim of this unit is to help students to appreciate and be aware of the design process and the information required to communicate the design itself, specify and quantify materials, provide instructions for the assembly and erection, and facilitate precise costing and project management.

Topics included in this unit are: project phases; construction drawing; detailing; Computer Aided Design (CAD); Building Information Modelling (BIM); schedules; specifications; bills of quantities; information collaboration.

On successful completion of the unit, students will be able to analyse scenarios, make decisions and produce drawings and specifications to achieve appropriate, creative and innovative home design proposals.

Learning Outcomes

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

LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process

LO2 Explain the different types of construction information developed through the course of a project

LO3 Produce design propositions that address project requirements defined through feasibility stages

LO4 Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy.
Essential Content

LO1 Discuss the stages of a design process and the types of information required to communicate, share and manage the project process

Design criteria
Project type (e.g., residential, commercial, industrial, infrastructure)
Client type (e.g., private, institutional, public)
Environment/sustainability
Statutory requirements (e.g., planning permissions, health and safety, building regulations)

Project process
Feasibility
Design
Construction information
Site operations (e.g., variations/architect's instructions, on-site design)
Handover
Post-occupancy

Cost/fee information
Initial budget
Professional fees (e.g., architect/design fees, engineers’ fees, project manager fees)
Construction costs (e.g., material costs, plant costs, labour costs)

Design process
Concept design
Design development
Detail design
Construction information

Construction information
Drawings (e.g., sketches, construction drawings, CAD)
Models (e.g., physical models, digital models, BIM data)
Specifications
Schedules

Information sharing
CAD formats
BIM data
Digital collaboration systems

LO2 Explain the different types of construction information developed through the course of a project

Construction drawings
Site drawings
General arrangement (GA) drawings
Consultant Information (e.g., structural, mechanical, environmental)
Details

Specifications
Preliminaries (‘prelims’)
Specification types (e.g., outline specification, performance specification)
Specification sections

Schedules
Door schedules
Window schedules
Fixtures/fittings schedules
Schedule of Works

Information coordination
Manual information coordination
Digital information coordination (e.g., BIM, single-model data)
Clash detection
Manual clash detection
Digital clash detection
**Health and safety information**

Pre-construction health and safety plan
Health and safety method statements
Risk assessments
Construction phase plans
Health and safety file
Material safety information (e.g., control of substances hazardous to health [COSHH], material handling guidelines)

**LO3** Produce design propositions that address project requirements defined through feasibility stages

**Feasibility**

Client need
Site conditions (e.g., geotechnical, contamination, environmental impact)
Project type
Budget
Legal/statutory requirements

**Design propositions**

Initial/concept propositions
Design development
Design evaluation
Environmental evaluation
Design iteration

**Construction information**

Drawings
Specifications
Schedules
Health and safety information
LO4 **Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy**

*Project roles/stakeholders*
- Client
- User/occupier
- Architects
- Engineers (e.g., structural, mechanical)
- Contractors (e.g., main contractor, sub-contractors)
- Project managers
- Contract managers
- Cost consultants/quantity surveyors
- Suppliers
- Manufacturers

*Project relationships*
- Contractual relationships
- Professional collaboration (e.g., information sharing, information management)
<table>
<thead>
<tr>
<th>Learning Outcomes and Assessment Criteria</th>
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</thead>
<tbody>
<tr>
<td><strong>Pass</strong></td>
</tr>
<tr>
<td><strong>LO1</strong> Discuss the stages of a design process and the types of information required to communicate, share and manage the project process</td>
</tr>
<tr>
<td><strong>P1</strong> Describe the stages and activities of a construction design process.</td>
</tr>
<tr>
<td><strong>P2</strong> Explain the types of information required throughout the different stages of a project process.</td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the different types of construction information developed through the course of a project</td>
</tr>
<tr>
<td><strong>P3</strong> Examine a brief to ascertain the requirements of a building project</td>
</tr>
<tr>
<td><strong>P4</strong> Outline the relationships between drawings, schedules and specifications.</td>
</tr>
<tr>
<td>Pass</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td><strong>LO3</strong> Produce design propositions that address project requirements defined through feasibility stages</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a construction information package, highlighting the coordination of information between different project stakeholders to ensure accuracy</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
BELBIN, R. (2010), *Team Roles at Work*, Routledge

Web resources
(Professional Body)

https://bit.ly/3Id8PaW  Project plans for building design and construction
(Wiki)

https://bit.ly/3rKsWpc  Chartered Association of Building Engineers
(Professional Body)

(General Reference)

www.thenbs.com  The NBS Knowledge
(General Reference)
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 39: Personal Professional Development
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction
- Unit 54: Advanced Quantity Surveying Practice.
Introduction

The basic principles of construction technology have not changed for hundreds of years. However, the materials and techniques used to achieve these basic principles are constantly evolving to enable the construction industry to deliver better quality buildings. Scarcity of resources and the continuing demand of more sophisticated clients, end users and other stakeholder interests, are driving the construction industry to provide buildings that facilitate enhanced environmental and energy performance, and greater flexibility. This is in response to ever-increasing financial, environmental, legal and economic constraints.

This unit introduces the different technological concepts used to enable the construction of building elements, from substructure to completion, by understanding the different functional characteristics and design considerations that need to be borne in mind when selecting the most suitable technological solution.

Learning Outcomes

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

LO1 Explain the terminology used in construction technology

LO2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria

LO3 Discuss different methods of dealing with site conditions to support building and infrastructure construction

LO4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building.
Essential Content

LO1 Explain the terminology used in construction technology

Types of structures in the built environment
Building scale (e.g., low, medium, high-rise)
Domestic buildings (houses, flats, multi-occupancy)
Commercial buildings (e.g., offices, shops)
Industrial buildings (e.g., light industrial, warehouses factories).
Civil engineering structures (e.g., roads, highways, bridges, tunnels)

Structures
Loadbearing and non-loadbearing
Structural stability
Movement and thermal expansion

Construction methods
Timber frame
Steel frame
Masonry
Modern Methods of Construction (MMC) (e.g., offsite manufacture, panellised systems, volumetric/modular)

Materials
Types (e.g., timber, concrete, brick, steel)
Properties (e.g., durability, weather and moisture resistance, acoustics, thermal performance, fire resistance)

Environment
Insulation (e.g., fibreglass, solid panel, expanded foam, wool)
Heat loss and heat gain
Thermal transmission
Heating and cooling (e.g., passive, active)
Health and safety
Fire (e.g., fire resistance, flame spread, smoke, combustion)
Building regulations
Health and safety during construction

Construction information
Types of information (e.g., drawings, details, specification, schedules)
Information production (e.g., CAD, Building Information Modelling [BIM])

Sustainability
Scarcity and renewability
Supply chain
Lifecycle (e.g., ‘Cradle-to-grave’, ‘Cradle-to-cradle’, circular economies)

Professional bodies
Codes of practice
Codes of conduct
Professional ethics

LO2 Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria

Pre-design studies
Desk-top research
Site reconnaissance
Soil investigation

Substructure design considerations
Soil type and content (e.g., water and chemical content, bearing capacity)
Position of trees
Economic considerations (e.g., cost of foundation type, labour, materials)
Legal considerations (e.g., health and safety, building regulations)
Plant requirements
Types of substructure
Shallow and deep foundations
Strip and deep strip foundations
Pad foundations
Raft foundations
Piled foundations (including replacement and displacement piles)

Superstructure design considerations
Form (e.g., building form, infrastructure form)
Building/infrastructure use
Aesthetics
Substructure type
Site access
Legal considerations (e.g., health and safety, building regulations)

Types of superstructure
Masonry (e.g., brick, block)
Framed construction (e.g., timber, steel, composite)
Reinforced concrete
Infrastructure types (e.g., roads, bridges, tunnels)

Walls
External walls (e.g., cavity wall, timber frame, lightweight steel)
Wall cladding (e.g., panel systems, infill systems, composite panel systems)
Internal partition walls (e.g., timber framed, steel framed, manufactured panels)

Roofs
Roof types (e.g., pitched, flat roof systems)
Roof construction (e.g., beams, rafters, fascia, battens)
Roof coverings

Floors
Floor type (e.g., ground floors, intermediate floors)
Floor construction (e.g., decking, subfloor, screed)
Floor finishes (e.g., timber, stone, sheet, poured)
Staircases
Staircase types (e.g., straight, dog-leg, circular, helical)
Stair construction (e.g., timber, concrete, metal)
Means of escape
Stair elements (e.g., tread, rise, stringer, nosing)

Finishes
Ceiling, wall, and floor finishes.

LO3 Discuss different methods of dealing with site conditions to support building and infrastructure construction

Site remediation
Contamination management (e.g., cut-off techniques, encapsulation)
Soil remediation (e.g., stone piling, vibro-compaction, phytoremediation)

De-watering
Piling (e.g., sheet piling, secant piling)
Concrete methods (e.g., diaphragm walls, coffer dams, caissons, culverts)
Grout injection
Freezing
Temporary techniques (e.g., pumping, wells, electro-osmosis)

LO4 Illustrate the supply and distribution of a range of building services and how they are accommodated within the building

Primary service supply
Cold water
Gas
Electricity

Heating
Heat generators (e.g., boilers, solid fuel burners, combined heat and power plant)
Heating distribution (e.g., hot water, forced air, steam)
Heat delivery (e.g., radiators, fan coil units, air handling)
**Ventilation**
Mechanical (e.g., fans, pressure systems, vacuum systems, exhaust systems)
Natural (e.g., wind driven, stack ventilation, cross ventilation)

**Air conditioning**
Central air vs split system
Components (e.g., compressor, evaporator, cassette)

**Services distribution**
Hot and cold water
Single-phase and 3-phase electricity
Ventilation and air conditioning ductwork.

**Services accommodation**
Raised access flooring
Suspended ceilings
Partitioning
Rising ducts
# Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Explain the terminology used in construction technology</td>
<td><strong>M1</strong> Analyse the way that construction projects address risk and health and safety.</td>
<td><strong>D1</strong> Compare the construction terminology used in different types of construction project.</td>
</tr>
<tr>
<td><strong>P1</strong> Describe the differences between residential, commercial, industrial buildings and infrastructure projects.</td>
<td><strong>P2</strong> Discuss the ways in which sustainability can be promoted in construction projects.</td>
<td><strong>M2</strong> Analyse how site conditions impact on the design of foundations.</td>
</tr>
<tr>
<td><strong>LO2</strong> Describe the different techniques used to construct a range of substructures and superstructures, including their function and design selection criteria</td>
<td><strong>P3</strong> Describe the pre-design studies carried out and types of information collected for a given construction site.</td>
<td><strong>D2</strong> Evaluate a given construction project with regard to the ways that superstructure, substructure and civil engineering structures are used to support the structure.</td>
</tr>
<tr>
<td><strong>P4</strong> Explain the functional characteristics and design criteria for primary and secondary elements of a substructure and superstructure.</td>
<td><strong>P5</strong> Describe techniques used for remediating the site prior to construction commencing.</td>
<td><strong>M3</strong> Compare different types of structural frame used to carry the primary and secondary elements of the superstructure.</td>
</tr>
<tr>
<td><strong>P6</strong> Describe the types of substructure works carried out by civil engineers.</td>
<td><strong>P7</strong></td>
<td></td>
</tr>
<tr>
<td>Pass</td>
<td>Merit</td>
<td>Distinction</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td><strong>LO4</strong> Illustrate the supply and distribution of a range of building services and how they are accommodated within the building</td>
<td><strong>P7</strong> Describe the supply arrangements for primary services.</td>
<td><strong>D3</strong> Analyse the ways in which the distribution of the primary services impact on the overall design of the building.</td>
</tr>
<tr>
<td><strong>P8</strong> Explain the distribution arrangements for primary services.</td>
<td><strong>M4</strong> Demonstrate the elements of the superstructure used to facilitate the primary services.</td>
<td></td>
</tr>
</tbody>
</table>

- **Pass**
- **Merit**
- **Distinction**
Recommended Resources

Print resources


FLEMING, E. (2009), *Construction Technology*, John Wiley & Sons

MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 22: Scientific Principles for Building Services
- Unit 24: Principles of Off-site Construction
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 35: Sustainable Methods of Construction
- Unit 41: Highway Engineering
- Unit 44: Maintenance & Operations
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.
Unit 3: Science & Materials

Level: 4
Credits: 15
Ofqual Code: L/618/8082

Introduction

Science and material performance are intrinsically linked through the need to create structures and spaces that perform in both mechanical operation and in providing human comfort.

This unit aims to support students in making material choices to achieve the desired outcomes of a brief. This is approached from the perspective of materials being fit for purpose; as defined by testing standards and properties but also by consideration of the environmental impact and sustainability. Students will consider health and safety alongside the need to meet legislative requirements.

The topics covered in this unit include: health and safety; storage and use of materials; handling and problems associated with misuse and unprotected use; environmental and sustainable consideration in material choices; human comfort performance parameters. Material choice is developed through the understanding of testing procedures to establish conformity to standards and define performance properties. The performance of materials to satisfy regulations and provide appropriate comfort levels is addressed through design and calculations.

On successful completion of this unit, students will be able to make informed decisions regarding material choices, based on understanding the structural behaviour of materials established through recognised testing methods, sustainability, context of build and health and safety. Students will be able to perform the calculations necessary to establish anticipated performance of the materials in use and therefore determine their compliance with regulations and suitability.
Learning Outcomes

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

LO1 Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site

LO2 Discuss the environmental and sustainability factors that inform the material choices for a given construction project

LO3 Present material choices for a given project using performance properties, experimental data, sustainability and environmental consideration

LO4 Evaluate the performance of a given project in respect of its human comfort requirements.
Essential Content

LO1 Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site

Regulations and guidance
Health and safety management regulations
Construction design management regulations
Provision and use of equipment regulations
Control and management of hazardous materials through storage, movement and use

Materials handling and installation
Risk assessments and method statements (qualitative and quantitative)
Materials storage (e.g., moving materials safely, working in confined spaces, working at height)
Occupational health risks associated with materials (e.g., asbestos-related and respiratory disease, dermatitis and skin problems, musculoskeletal disorders, hand arm vibration)
Personal Protective Equipment (PPE)

LO2 Discuss the environmental and sustainability factors that inform the material choices for a given construction project

Environmental considerations
Lifecycle assessment
Environmental profile methodology
Environmental product declaration and certification
Embodied energy
Waste management: the economics and technologies of construction waste disposal

Sustainability
Resource availability and depletion: renewable and non-renewable materials
Reuse and recycling of construction and demolition waste
Waste and Resources Action Programme (WRAP)


Environmental assessment methods

Building Research Establishment Environmental Assessment Method (BREEAM)
Leadership in Energy and Environmental Design (LEED)
Green Star
Estidama, or other forms of environmental assessment
Construction Industry Research Information Association (CIRIA)

LO3 Present material choices for a given project using performance properties, experimental data, sustainability and environmental consideration

Material testing
Testing methods
Interpreting results of tested material data.
Codes and standards

Structural behaviours
Performance properties (e.g., strength, elasticity, toughness, hardness, creep, fatigue, porosity, brittleness, density, thermal conductivity, durability)
Inherent material properties.
Relationship between material properties, behaviour and use

LO4 Evaluate the performance of a given project in respect of its human comfort requirements

Thermal
Heat loss
Heat gain
Thermal control (e.g., passive, active)

Illumination
Natural light
Artificial light
Heat gain through sunlight/exposure

Acoustics and vibration
Equipment noise/vibration (e.g., ventilation fans, air conditioning systems)
Road noise/vibration
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site</td>
<td><strong>M1</strong> Analyse how risk assessments are used to address hazards posed by selected materials or activities.</td>
<td><strong>D1</strong> Evaluate how multiple regulations and legislation may apply to a given site activity, highlighting how to plan and manage for safe handling and use of materials and processes.</td>
</tr>
</tbody>
</table>

**P1** Discuss the regulations associated with the storage, handling and use of materials.  
**P2** Describe strategies to safely manage the storage, handling and use of a selection of vocationally typical construction materials.

**LO2** Discuss the environmental and sustainability factors that inform the material choices for a given construction project

**P3** Explain material environmental profiling and lifecycle assessment, based on a material choice.  
**P4** Discuss the benefits of product declaration and environmental certification.

**LO3** Present material choices for a given project using performance properties, experimental data, sustainability and environmental consideration

**P5** Select construction materials for a given project based on testing results and their performance properties in use.  
**P6** Present the results of relevant testing procedures to identify performance characteristics of selected construction materials.

**M2** Produce a waste management plan for a given project, considering a typical range of relevant waste materials.  
**M3** Assess the selection of structural materials, based on comparison of loading and performance and behaviour in alternative material choices.  
**D2** Illustrate how the use of sustainable practices and considerations for material choice can improve the environmental rating of the completed project.
<table>
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</table>
| **LO4** Evaluate the performance of a given project in respect of its human comfort requirements | **P7** Define a material selection strategy with regard to human comfort requirements.  
**P8** Identify materials for a selected area within a project and explain how these contribute to human comfort. | **M4** Perform calculations (e.g., lux levels, u-values, acoustic performance, air changes) to support the provision of human comfort for a given project.  
**D3** Evaluate how the use of passive or active strategies can minimise energy, materials, water and land use. |
Recommended Resources

Print resources
BLANC, A. (1994), Internal Components, Longman Publishing Group
CASINI, M. (2016), Smart Buildings, Woodhead Publishing
KHATIB, J. (2016), Sustainability of Construction Materials, Woodhead Publishing
LYONS, A. (2014), Materials for Architects and Builders, Routledge
MCDONOUGH, W., BRAUNGART, M. (2010), Cradle to Cradle: Remaking the Way We Make Things, North Point Press
SOMAYAJI, S. (2001), Civil Engineering Materials, Pearson College Division
THOMAS, R. (2006), Environmental Design, Taylor & Francis

Links
This unit links to the following related units:
• Unit 2: Construction Technology
• Unit 9: Principles of Heating, Ventilation and Air Conditioning
• Unit 14: Principles of Refurbishment
• Unit 15: Principles of Alternative Energy
• Unit 28: Group Project (Pearson-set)
• Unit 33: Construction Technology for Complex Buildings Projects
• Unit 35: Sustainable Methods of Construction
• Unit 36: Value Engineering & Cost Control
• Unit 45: Advanced Materials.
Unit 4: The Construction Environment

Level: 4
Credits: 15
Ofqual Code: R/618/8083

Introduction

Construction is a complex and dynamic sector of the local, regional, national and international economy. In many countries it is a driving force in the growth of finance, property and employment. This also means that it has considerable impact on many factors beyond its direct influence on the buildings and infrastructure that are created and maintained.

The construction industry is one of the major contributors to CO2 emissions. Also, the way that buildings are designed, constructed and maintained means they have an ongoing impact on the environment. Similarly, as a major employer, the industry has an ongoing impact on the working conditions of those in the sector and the way that people are educated, trained and supported through their careers.

In this unit, students will explore the make-up and the impact of the construction industry on the environment and society. By exploring the roles and relationships of individuals and organisations in the construction sector, students will gain an overview of the organisational and the personal ways in which the sector works to continue to improve the built environment and limit its impact on the environment, while maintaining economic sustainability and growth.

Learning Outcomes

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

LO1 Explore the development of the construction industry through the roles and relationships of the professionals involved

LO2 Assess the impact of the construction industry

LO3 Discuss the ways in which the construction industry ensures quality, timely completion and safety

LO4 Examine the routes to employment and progression within the construction industry.
**Essential Content**

**LO1** Explore the development of the construction industry through the roles and relationships of the professionals involved

*History of the industry*

*Roles*
- Architect
- General contractor
- Sub-contractor
- Engineer (e.g., structural, civil, building services, traffic, fire)
- Project manager
- Quantity surveyor
- Others

*Collaboration*
- Relationships between organisations/roles
- Individuals and collaboration
- Collaboration through technology (e.g., project sharing, BIM, email)
- Avoiding conflict in collaboration

*Professional bodies*
- The purpose of professional bodies
- Chartered Institute of Building (CIOB)
- Chartered Institution of Building Engineers (CIBSE)
- Chartered Association of Building Engineers (CABE)
- Chartered Institute of Architectural Technologists (CIAT)
- Institution of Civil Engineers (ICE)
- Royal Institute of British Architects (RIBA)
- Royal Institution of Chartered Surveyors (RICS)

*Others*
- Codes of conduct
- Professional ethics
LO2 **Assess the impact of the construction industry**

*Construction and economy*

*Employment*
- Direct
- Supply chain
- Skills gaps

*Construction and sustainability*
- Definitions of sustainability (e.g., environmental, social, economic, cultural)
- Connections between forms of sustainability

*Environmental sustainability*
- Carbon emissions
- Carbon footprint
- Embodied energy
- Carbon reduction
- Targets (government/global)

*Environmental Strategies in Construction*
- Material selection
- Local supply
- Renewables
- Energy
- ‘Retrofit First’

*Diversity and inclusion*
- The current state of the industry (e.g., gender representation, minority representation, ‘an aging industry’)
- Promoting diversity and inclusion (e.g., benefits, challenges)
- Equality and diversity legislation
- Organisation for equality and diversity (e.g., professional bodies, Women into Construction, GoConstruct)
LO3  Discuss the ways in which the construction industry ensures quality, timely completion and safety

*History of safety in construction*
Pre-regulations
Post-regulations

*Ensuring safety*
Safety pre-construction (e.g., design and planning, building regulations)
Site safety (e.g., legislation, regulations)
Safety in use

*Cost control and cost monitoring*
Material costs
Plant costs (e.g., purchase, lease)
Labour costs (e.g., direct labour, subcontractors)
Cost overrun (e.g., caused by defects, caused by changes, caused by weather)

*Contracts, safety and quality, safety and quality*
Types of contract relationship (e.g., services contracts, works contracts)
Contract requirements (e.g., time, cost, quality)
Contracts and statutory requirements

*Timely completion and quality*
Quality and value (e.g., defining value, increasing value, increasing safety)
Project ‘sign-off’ and quality (e.g., documenting completion of work, certifying safe work, hand-over of relevant information)
Professional standards and professional bodies

LO4  Examine the routes to employment and progression within the construction industry

*Technical skills*

*Employability skills*
Communication
Collaboration
Resilience
Adaptability
Independence

Stages of employment
Professional bodies
Technician
Chartered
Fellow

Progressing in employment
Education and training
Continuing Professional Development
Personal development plans
Lifelong learning

Leadership and management
Developing as a manager
Leadership skills
Supporting the development of others
### Learning Outcomes and Assessment Criteria

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<tr>
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<tr>
<td><strong>LO1</strong> Explore the development of the construction industry through the roles and relationships of the professionals involved</td>
<td><strong>P1</strong> Discuss the development of the construction industry using historic and contemporary examples.</td>
<td><strong>M1</strong> Analyse the purpose of professional bodies in supporting the industry and protecting the public.</td>
</tr>
<tr>
<td><strong>P2</strong> Explain the roles and responsibilities of those that work in the construction industry.</td>
<td><strong>D1</strong> Evaluate the ways in which professionalism, diversity and inclusion are important to the growth of the construction sector.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Assess the impact of the construction industry</td>
<td><strong>P3</strong> Explain the different types of sustainability and how the construction industry is reflected in these.</td>
<td><strong>M2</strong> Illustrate the challenges of the construction industry in regard to diversity and inclusion.</td>
</tr>
<tr>
<td><strong>P4</strong> Define potential strategies to promote equality, diversity and inclusion and ensure fairness at work.</td>
<td><strong>LO3</strong> Discuss the ways in which the construction industry ensures quality, timely completion and safety</td>
<td><strong>M3</strong> Analyse the ways in which legislation and regulation work to ensure safety during construction and occupation.</td>
</tr>
<tr>
<td><strong>P5</strong> Discuss the processes and requirements for project handover, ensuring the safety and quality of work.</td>
<td><strong>D2</strong> Critically analyse the role of professional bodies in supporting quality and safety in construction.</td>
<td><strong>P6</strong> Explain the importance of monitoring costs in construction projects.</td>
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<tr>
<td><strong>P6</strong> Explain the importance of monitoring costs in construction projects.</td>
<td><strong>M3</strong> Analyse the ways in which legislation and regulation work to ensure safety during construction and occupation.</td>
<td><strong>D2</strong> Critically analyse the role of professional bodies in supporting quality and safety in construction.</td>
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<tr>
<td><strong>LO4</strong> Examine the routes to employment and progression within the construction industry</td>
<td><strong>M4</strong> Assess the ways in which CPD and lifelong learning support employment progression.</td>
<td><strong>D3</strong> Evaluate the ways in which education, training and CPD are used to build leadership and management capacity in construction organisations.</td>
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<td><strong>P7</strong> Prepare a personal development plan, highlighting routes to achieve subject relevant technical and employability skills.</td>
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<tr>
<td><strong>P8</strong> Examine the role of professional bodies and routes into employment.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
GRUNEBERG, S., FRANCIS, N. (2019), *The Economics of Construction, Economics of Big Business*
MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Web resources
https://bit.ly/3rKsWPc  
Chartered Association of Building Engineers  
(Professional Body)
Chartered Institute of Architectural Technologists  
(Professional Body)
Chartered Institution of Building Services Engineers  
(Professional Body)
https://bit.ly/3fsrTP1  
Institution of Civil Engineers  
(Professional Body)
Royal Institute of British Architects  
(Professional Body)
Royal Institution of Chartered Surveyors  
(Professional Body)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 25: Quantity Surveying Practice
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 39: Personal Professional Development
- Unit 54: Advanced Quantity Surveying Practice.
Unit 5: Legal and Statutory Requirements in Construction

Level: 4
Credits: 15
Ofqual Code: Y/618/8084

Introduction

The construction industry is perceived to be a dangerous, noisy and disruptive area of work that impacts on the use of land and buildings. It is, however, governed by a range of areas of law to ensure that professionals, such as architects, quantity surveyors and contractors, comply with legal and statutory requirements to design, construct and deliver buildings and alterations using safe working practices and utilising land appropriately.

This unit introduces the different areas of law that are relevant to the construction industry throughout the development process. This includes applying for planning approval to undertake construction activities and using building control regulations to evaluate building design and alterations at the preconstruction stage. Students will explore the laws of occupiers’ liability, trespass and nuisance to manage construction activities on-site, and the legal aspects of the sale and leasing process involved in the disposal of buildings, using the law of contract and land law.

On successful completion of this unit, students will be able to apply legal and statutory requirements and processes common to the construction sector.

Learning Outcomes

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

LO1 Explain the process used to obtain planning permission for the construction and alteration of buildings

LO2 Discuss the processes and regulations used to control design and to ensure safe buildings

LO3 Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users

LO4 Analyse how the law of contract and land law are used to sell and lease land and buildings.
Essential Content

LO1  Explain the process used to obtain planning permission for the construction and alteration of buildings

Purpose of planning regulations
Development control
Environmental protection
Land use

Gaining planning permission
The legal framework (e.g., legislation, regulatory)
Types of development
Permitted development
Application process (e.g., application forms, statutory and public notification)
Approval process and conditions.

Appealing planning decisions
The right of appeal (e.g., applicants, general public, timeframes)
Appeal processes (e.g., forms, procedures, notification periods)

Planning enforcement
Notification processes and procedures
Right of appeal and timeframes

LO2  Discuss the processes and regulations used to control design and to ensure safe buildings

Building control/building regulation systems
History and development
Legislation
Regulatory agencies

Requirements of building control and regulations
Building regulation standards and areas of jurisdiction
Obtaining approval and right of appeal processes
Approvals, inspection and compliance
Enforcement and dangerous buildings

Building regulations and health and safety

Safety in construction

Safety in operation and occupation

**LO3 Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users**

*Administration of the law*

Courts, personnel, sources of law, including legislation and case law, speciality courts and alternative dispute resolution methods

*Health and safety*

Legislation

Documentation

Enforcement

*Liability*

Occupiers' liability (e.g., duty of care, breach of duty, damage, defences, dangerous premises, visitors, children, independent contractors, trespassers and non-visitors, case law and legislation)

Vicarious liability (e.g., definitions of employer and employee, application of the course of employment rule, independent contractors, general principles, non-delegable duties)

*Trespass to land*

Forms of trespass (e.g., intrusion, possession)

Defence and remedy (including damages, injunction and ejectment)

The operation of the construction industry and trespass

Mitigating measures (e.g., Considerate Contractors Scheme)

*Nuisance*

Private nuisance (e.g., encroachment, interference, unlawfulness, impact of continuity, sensitivity and locality, liability, damage, defences and remedies)

Public nuisance (e.g., obstruction, pollution, criminal offence, mitigation)
Insurance
Types of insurance, including public liability insurance
Employers’ liability insurance
Contractors’ All Risks insurance
Latent defects insurance
Machinery insurance
Personal accident insurance and contract bonds

LO4 Analyse how the law of contract and land law are used to sell and lease land and buildings

History and development of land ownership
Types of land ownership and registration of ownership (e.g., freehold, leasehold)
Tenure restrictions on ownership (e.g., restrictive covenants, easements)

Law of contract and property conveyancing
Key stages in the law of contract (e.g., offer, intention, capacity, consideration)
The stages and requirements of the property conveyancing process

Landlord and tenant law
Legislation
Types of lease (e.g., residential, commercial)
Lease terms and conditions
Rent and repair responsibilities
Management of other agreed terms
Terminating and ending a lease
Lease disputes and mediation processes

Construction activity and party and boundary walls
Types of wall (e.g., party walls, party structures, boundary conditions, retaining walls)
Key legislation, regulations and case law
Trespass and nuisance considerations
Procedures and obligations on neighbour notification and agreement
Learning Outcomes and Assessment Criteria

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<tbody>
<tr>
<td><strong>LO1</strong> Explain the process used to obtain planning permission for the construction and alteration of buildings</td>
<td><strong>M1</strong> Analyse the role of planning systems and agencies in managing the development of land, buildings and structures.</td>
<td><strong>D1</strong> Evaluate the impact of planning systems and building regulations agencies on managing the development of land, buildings and structures.</td>
</tr>
<tr>
<td><strong>P1</strong> Describe the key legislation and agencies involved in the planning process.</td>
<td><strong>P2</strong> Discuss how planning decisions are made and processes available to appeal and monitor.</td>
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</tr>
<tr>
<td><strong>LO2</strong> Discuss the processes and regulations used to control design and to ensure safe buildings</td>
<td><strong>P3</strong> Explain the key legislation and agencies involved in the building control process.</td>
<td><strong>M2</strong> Analyse the differences in building regulations, related to safety, applicable low- and medium-rise buildings.</td>
</tr>
<tr>
<td><strong>P4</strong> Explore the processes for monitoring and appealing building control decisions.</td>
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<tr>
<td><strong>LO3</strong> Assess the laws used to ensure that construction sites operate safely and consider adjoining land-users</td>
<td><strong>P5</strong> Explain how the law of trespass and nuisance relate to the construction industry.</td>
<td><strong>M3</strong> Analyse legislation related to safe operation of construction sites.</td>
</tr>
<tr>
<td><strong>P6</strong> Discuss how liability law applies to the construction industry.</td>
<td></td>
<td><strong>D2</strong> Produce a detailed plan for a contractor to reduce the legal impacts of a large urban construction project.</td>
</tr>
<tr>
<td><strong>LO4</strong> Analyse how the law of contract and land law are used to sell and lease land and buildings</td>
<td><strong>P7</strong> Analyse how land law has evolved to shape modern land ownership and the role of contract law in buying and selling property.</td>
<td><strong>M4</strong> Assess the application of land law and landlord and tenant law control the disposal and use of a given property.</td>
</tr>
<tr>
<td><strong>P8</strong> Discuss how landlord and tenant law is used to manage a given property.</td>
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<td><strong>D3</strong> Evaluate the impact of land law and property law on the development, sale and tenanting of a large urban construction project.</td>
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Recommended Resources

Print resources

Links
This unit links to the following related units:
- Unit 4: The Construction Environment
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 35: Sustainable Methods of Construction
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.
Unit 6: Digital Applications for Construction Information

Level: 4
Credits: 15
Ofqual Code: D/618/8085

Introduction

Achieving successful projects in the built environment requires a range of different types of information to describe the project, quantify the materials, provide clear instructions for assembly and erection, and allow for accurate costing and management. Throughout the process of design, construction and post-occupancy management, information is critical.

Central to construction information is the production of construction drawings. These provide the geometric definition of a project through the use of graphic conventions. Most other forms of construction information will rely, to a greater or lesser degree, on reference to construction drawings. Therefore, the production of accurate and clearly defined construction drawings is a critical part of the overall construction information package.

Digital applications play a key role in the production of construction drawings. They provide a way to manage drawing information and make changes with greater efficiency and can be shared readily through a variety of digital communication systems.

In this unit students will develop the skills to needed produce accurate and consistent construction information using industry-standard software. On completion of the unit, students will be able to produce a construction information package. Successful achievement of the unit, may also lead to vendor certification.
Learning Outcomes

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

LO1 Discuss the key types of construction information that may be produced in support of construction projects

LO2 Demonstrate the use of project standards and their setup in digital applications

LO3 Generate construction information for a given project using industry-standard digital applications

LO4 Present a package of construction information, including drawings, schedules and specifications for a given construction project.
**Essential Content**

**LO1** Discuss the key types of construction information that may be produced in support of construction projects

*Pre-design information*
Survey information (e.g., site survey, building survey)
Surveying existing buildings
Client requirements (e.g., client brief, existing documents)

*Construction drawings*
Plans (e.g., floor plans, ceiling plans, site plans, roof plans, electrical plans, HVAC plans)
Sections (e.g., building sections, wall sections)
Elevations (e.g., interior elevations, exterior elevations)
Details (e.g., construction details, assembly details)

*Schedules*
Door schedules
Window schedules
Finish schedules
Other

*Specifications*
Performance specification
Outline specification
Full specification
Specification templates/standards

*Relationship with other forms of construction information*
Contracts and associated costing
3D models
Building Information Modelling (BIM)
Project and site management (e.g., programmes of work, schedule of work, reporting of progress)
Information collaboration

Working with other professionals
Individual production vs team production
Integrating information from others

LO2 Demonstrate the use of project standards and their setup in digital applications

Project standards
Managing consistency in information
Ensuring quality in construction

Graphic standards
Line types (e.g., solid lines, dotted lines, centre lines)
Line weights
Line colours
Hatching types
Industry-defined graphic standards
Layer settings

Information standards
Sheet templates (e.g., title blocks, sheet layout)
Drawing symbols (e.g., drawing titles, section markers, elevation markers)

Reusable objects
Graphic objects (e.g., furniture, fittings, symbols)
Standard details

LO3 Generate construction information for a given project using industry-standard digital applications

Drawing objects
Lines and polylines
Rectangles and polygons
Circles and arcs
Drawing accuracy
Grid snapping
Object snapping
Coordinate systems

Drawing modification
Move and copy objects
Rotate and scale objects
Duplication and arrays (e.g., linear arrays, polar arrays)
Trimming
Extending (e.g., extend to object, extend to boundary extend to intersection)
Mirroring objects
Object editing (e.g., using ‘handles’ to modify lines, rectangles, polygons, polylines)
Fillets and chamfering

Fills and hatching
Solid fills
Pattern fills
Hatching (e.g., material hatching, pattern hatching)

Drawing layers
Using layers to relate to separate construction elements
Layer-specific settings (e.g., line weights, colours)
Layer visibility
Moving objects between layers

Annotation and dimensions
Dimensions (e.g., positioning, terminators, font size and style)
Annotations (e.g., notes, leader lines, arrows, font size and style, position, section markers, detail bubbles)
LO4 Present a package of construction information, including drawings, schedules and specifications for a given construction project

Standard sheets
DIN formats (e.g., A4, A3, A2, A1)
Imperial formats (e.g., 18 × 24, 24 × 36, 36 × 48)

Sheet templates
Title blocks
Sheet numbering
Project information

Creating sheet views
Sheet view and scale
Placing sheet views

Coordinating layer visibility with output
Printing and non-printing layers
Layer-defined properties

Schedules
Including schedules in drawings
Schedules as separate documents

Specifications
Document format
Specification standards (e.g., NBS, MasterSpec)
References (e.g., to drawings/schedules, from drawings/schedules)

Output standards
Printing setup
Plotting setup
# Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Discuss the key types of construction information that may be produced in support of construction projects</td>
<td><strong>P1</strong> Explain the different types of construction information that are required for a given project. <strong>P2</strong> Describe the relationship between construction drawings and other forms of construction information, and their potential impact on project costs.</td>
<td><strong>M1</strong> Compare the use of digital applications with other forms of construction drawing production in terms of efficiency and accuracy. <strong>D1</strong> Evaluate the use of project standards in the development of consistent construction drawings for different projects.</td>
</tr>
<tr>
<td><strong>LO2</strong> Demonstrate the use of project standards and their setup in digital applications</td>
<td><strong>P3</strong> Setup project standards in an industry-standard digital application for a given construction project. <strong>P4</strong> Define drawing symbols and reusable objects for a given construction project.</td>
<td><strong>M2</strong> Use layer settings to define consistent line styles, colours and weights for construction drawings.</td>
</tr>
<tr>
<td>Pass</td>
<td>Merit</td>
<td>Distinction</td>
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<tr>
<td><strong>LO3</strong> Generate construction information for a given project using industry-standard digital applications</td>
<td><strong>P5</strong> Create plans, sections, elevations and details for given a construction project, using industry-standard digital software.</td>
<td><strong>D2</strong> Justify the approach to producing construction information for a given project, highlighting examples of good practice in the use of industry-standard digital applications.</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a package of construction information, including drawings, schedules and specifications for a given construction project</td>
<td><strong>M3</strong> Demonstrate the use of modification tools to assist in the development of accurate construction drawings.</td>
<td><strong>M4</strong> Manage the use of printing and non-printing layers to develop coherent construction information output.</td>
</tr>
<tr>
<td><strong>P7</strong> Output construction drawings, to scale, on industry-standard sheet sizes for a given project.</td>
<td><strong>P8</strong> Coordinate information; both paper-based and digital, presented in schedules and specifications with construction drawings.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
(General Reference)

www.thenbs.com The NBS Knowledge
(General Reference)

https://bit.ly/3ye1BY2 Autodesk University
(Training)

https://bit.ly/3BMiFq6 CSI
(General Reference)
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 47: Advanced Building Information Modelling.
Unit 7: Surveying, Measuring & Setting-out

Level: 4
Credits: 15
Ofqual Code: H/618/8086

Introduction

Surveying is an essential function in the construction industry, providing services throughout a project’s lifecycle. It begins with collections of initial data on which to base design, then moves on to positional control of the construction process and finally records the ‘as built’ position for comparison with design. There is also a need for monitoring of adverse effects to the surrounding environment. The aspect that binds all of these functions is the control network, which forms the basis for all measurements, and this is a continuous thread throughout the unit.

In practice, surveying functions are divided between the ‘Land Surveyor’ to establish the positional reference and provide topographic data, and the ‘Civil Engineer’ to provide control of construction (setting out) and monitoring. Since there is dependence and commonality between them, this unit covers both contexts equally.

In this unit, students will explore the techniques used to set up controls and conduct initial surveys, including communication of results and methods of setting out the built environment. Students will be able to identify and analyse the sources of error and mitigation techniques used in common aspects of surveying.

Learning Outcomes

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

LO1 Explain the methods and technologies used in surveying for construction
LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control
LO3 Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements
LO4 Explore the causes of errors and techniques to improve accuracy in surveying and setting out.
Essential Content

**LO1 Explain the methods and technologies used in surveying for construction**

*Applications of surveying in construction*
- Topographic (e.g., green field, brown field, green belt)
- Cut and fill survey
- Control of construction
- Monitoring construction
- As-built

*Current and emerging technologies*
- Total station
- GPS (Global Positioning System) and GNSS (Global Navigation Satellite System)
- LiDAR (Light Detection and Ranging)
- Drones/UAV (Unmanned Aerial Vehicles)
- Laser scanning
- Mobile 3D mapping
- Photogrammetry

*Survey outputs*
- 2D drawings
- 3D data
- Point cloud
- Coding conventions
- Graphic symbols
- Vector outputs
- File formats
LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control

Types of control points and control networks
First order
Second order
Local and national grid coordinate systems

Types of traverse
Open traverse
Closed traverse

Methods of traverse
Standard methods of horizontal angle and electronic distance measurement
Physical positioning of instruments and targets
Plane table traversing (2D)
Levelling for height
Calculating accuracy of levelling and traverse observations
Calculations to obtain coordinates
Control station accuracy and national/industry standards

Health and safety in surveying and setting out
Assessing site conditions
Existing structures and safety
Working at height
Personal positioning
Working near machinery and mobile plant
LO3 **Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements**

*Holistic view of topographic surveying and setting out*

Terminology

Referencing control in data collection and setting out

*Topographic and construction elements*

Buildings and walls, outlines – footprint

Centre lines of structural elements

Boundary locations from national co-ordinates

Road centre lines – kerbs and street furniture

Drainage – utility covers

Hard and soft landscape features

Ground levels, bank tops and bottoms

*Positioning and orientating a total station*

Free station

Known back sight

Resection

Set orientation

Redundancy and checking

*Setting-out and data collection techniques*

Obtaining and transferring topographic and setting-out data

Recording topographic detail

Setting-out structures and offsetting lines of structural elements

Horizontal and vertical control of construction

Determining accuracy in setting out

Comparing setting out accuracy with national/industry standards
LO4 Explore the causes of errors and techniques to improve accuracy in surveying and setting out

Errors in surveying and setting out

Collimation error in the horizontal plane

Instrumentation error (e.g., prism constants, reflector heights, atmospheric influences, calibration certification, setup errors, discrete setting out)

Observation error (e.g., two-face observation, pointing and focus, horizontal and vertical collimation)

Human errors (e.g., alignment of levelling staffs and hand- or tripod-mounted prisms, physical setting-out constraints)

Improvement of accuracy

Use of technology to provide checking methods

Testing procedures for instrumentation to be used in setting out and surveying

Using national/industry standards to determine accuracy
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Learning Outcome (LO)</th>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1 Explain the methods and technologies used in surveying for construction</strong></td>
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</tr>
<tr>
<td><strong>P1 Describe the different types of surveying and their uses for construction.</strong></td>
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<tr>
<td><strong>P2 Explain the technologies used in surveying for construction.</strong></td>
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<tr>
<td><strong>M1 Analyse the potential benefits of using different technologies in surveying.</strong></td>
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<tr>
<td><strong>D1 Evaluate the accuracy that may be achieved in a closed traverse survey using different methods and technologies.</strong></td>
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</tr>
<tr>
<td><strong>LO2 Undertake a closed levelling and stages of a closed 2D traverse survey to establish station coordinates for horizontal and vertical control</strong></td>
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<tr>
<td><strong>P3 Conduct a closed levelling to establish height control.</strong></td>
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<tr>
<td><strong>P4 Carry out stages of a closed 2D traverse to establish horizontal control.</strong></td>
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<tr>
<td><strong>M2 Calculate coordinates and heights of control stations from field observations.</strong></td>
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<tr>
<td><strong>LO3 Apply industry-standard techniques in the collection of survey data and setting out the coordinates of construction elements</strong></td>
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<tr>
<td><strong>P5 Collect topographic detail using point and line codes.</strong></td>
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<tr>
<td><strong>P6 Undertake setting-out operations for construction elements.</strong></td>
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<tr>
<td><strong>M3 Analyse the accuracy achieved in setting-out and data collection activities.</strong></td>
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<tr>
<td><strong>D2 Use industry-standard techniques, including software/technology, to improve the accuracy of survey and setting-out data.</strong></td>
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<tr>
<td><strong>LO4 Explore the causes of errors and techniques to improve accuracy in surveying and setting out</strong></td>
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<tr>
<td><strong>P7 Explain the common causes of errors in setting out and surveying.</strong></td>
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<tr>
<td><strong>P8 Compare the accuracy of setting out data to national/industry standards.</strong></td>
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<tr>
<td><strong>M4 Assess the impact of surveying and setting-out errors for construction projects.</strong></td>
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</tr>
</tbody>
</table>


Recommended Resources

Print resources


Web resources

https://bit.ly/3soI0J0  Chartered Association of Civil Engineering Surveyors
(Professional Body)

https://bit.ly/3fsrTP1  Institution of Civil Engineers
(Professional Body)

(Professional Body)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 17: Civil Engineering Technology
- Unit 23: Construction Economics & Sustainability
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling,
Unit 8: Mathematics for Construction

Level: 4
Credits: 15
Ofqual Code: K/618/8087

Introduction
The aim of this unit is to develop students’ knowledge and understanding of the mathematical principles and theories that underpin many aspects of construction technology, structures and materials. Students will be introduced to mathematical methods and statistical techniques so that they can analyse and solve problems in a construction engineering context.

Topics included in this unit are: trigonometry and algebraic mathematical techniques; matrices; statistical techniques; differential and integral calculus; binomial and normal distribution; dimensional analysis; arithmetic progressions; vector analysis.

On successful completion of this unit, students will be able to employ mathematical methods in a variety of contextualised examples; use analytical and computational methods to evaluate and solve engineering construction problems; interpret data using statistical techniques and apply calculus techniques. Students will gain crucial employability skills such as critical thinking, problem solving, analysis, reasoning and data interpretation.

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

LO1 Use analytical and computational methods to solve construction-related problems

LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages

LO3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus

LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems.
EJential Content

LO1 Use analytical and computational methods to solve construction-related problems

Analytical methods
Trigonometry
Irregular areas and volumes
Sine rule
Cosine rule
Area of triangles applications

Trigonometry
Coordinate systems
Basic trigonometric ratios and their inverses
Trigonometric ratios for the four quadrants
Solution of triangles
Areas and volumes of regular solids

Algebra
Linear
Simultaneous and quadratic equations (graphical or algebraic solving)

Matrices
Multiplication
Transposition
Inversion (up to 2 x 2)

Application to construction problems
Analysis and design issues
Processes and operations
Resource issues e.g., labour, finance
Project planning
Levelling, contouring
Triangulation, traversing, cut and fill, setting out
LO2 **Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages**

*Statistical methods*
Presentation of data (histograms, frequency graphs, cumulative frequency graphs)

*Central tendency and dispersion*
Dispersion (standard deviation, variance, interquartile range)
Distribution theory: normal distribution
Measures of dispersion (range, variance, standard deviation, quartiles, deciles and percentiles)
Grouped and ungrouped data
Probability theory, binomial and normal distribution

*Applications*
Presentation of data
Estimation
Prediction
Quality control

LO3 **Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus**

*Differential calculus*
Basic differentiation techniques applied to algebraic, trigonometric and logarithmic functions
Products and quotients
Function of a function
Second order derivatives
The location of stationary values

*Integral calculus*
Indefinite and definite integration techniques applied to algebraic, trigonometric and exponential functions
Practical construction problems
Solution of problems involving maxima and minima
Growth and decay
Centroids
Moments of inertia
Areas under curves and volumes of revolution
Use in electrical theory, structural mechanics, fluid mechanics as appropriate

LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems

Trigonometrical techniques
Vector analysis (e.g., static forces, relative motion, frameworks)

Arithmetic progressions
Dimensional analysis
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Use analytical and computational methods to solve construction-related problems</td>
<td><strong>P1</strong> Solve construction problems using trigonometry techniques. <strong>P2</strong> Solve construction problems using algebraic techniques. <strong>M1</strong> Apply the use of matrices to solve problems. <strong>D1</strong> Evaluate analytical and statistical findings from construction problems completed and justify the techniques adopted to solve such problems.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages</td>
<td><strong>P3</strong> Apply statistical methods, including the calculation of the mean and standard deviation, to produce accurate and appropriate solutions to construction engineering problems. <strong>P4</strong> Calculate probabilities within both binomially distributed and normally distributed random variables. <strong>M2</strong> Interpret the results of a statistical hypothesis test conducted from a given scenario.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus</td>
<td><strong>P5</strong> Use differential calculus techniques to solve functions which incorporate: axn, sine ax, cosine ax, loge x, eax and methods including function of a function. <strong>P6</strong> Use integral calculus techniques to determine indefinite and definite integrals of functions involving axn, sine ax, cosine ax, 1/x and eax. <strong>M3</strong> Apply the rules of integral calculus to determine solutions for complex construction-related problems. <strong>D2</strong> Analyse differential calculus techniques in the determination of maxima and minima in construction-related problems.</td>
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<tr>
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<tr>
<td><strong>LO4</strong> Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems</td>
<td><strong>P7</strong> Apply dimensional analysis to solve problems. <strong>P8</strong> Generalise answers from a contextualised arithmetic progression problems.</td>
<td><strong>M4</strong> Solve construction problems using vector analysis. <strong>D3</strong> Evaluate the effectiveness and relevance, to the solving of complex construction problems, of the mathematical technique of vector analysis.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

Links
This unit links to the following related units:
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 16: Principles of Public Health Engineering
- Unit 17: Civil Engineering Technology
- Unit 18: Principles of Electrical Design & Installation
- Unit 19: Principles of Structural Design
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics
- Unit 49: Advanced Electrical Design & Installation.
Unit 9: Principles of Heating, Ventilation and Air Conditioning

Level: 4
Credits: 15
Ofqual Code: M/618/8088

Introduction

The buildings we use in everyday life – to work, study, socialise and live in – can be increasingly complex in their design, as well as being subject to more stringent environmental targets for emissions. The heating, ventilation and air conditioning systems in buildings play a major role in maintaining the comfort of the occupants and managing environmental impact.

This unit introduces students to the principles of the design and installation of heating, ventilation and air conditioning systems for non-domestic buildings.

In this unit, students will develop an understanding of the components and systems that may be integrated into a building services installation, including key calculations, sizing and specification of non-domestic heating, ventilation and air conditioning systems and components.

Learning Outcomes

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

LO1 Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation

LO2 Analyse the heating and cooling loads for a non-domestic building

LO3 Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type

LO4 Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation.
**Essential Content**

**LO1** Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation

*The design process*
- Design stages and tasks
- Legislation and regulation (e.g., building regulations, professional bodies, codes of practice)

*Health and safety*
- Design constraints
- Risk assessment

*Pre-design/design brief*
- Building form
- Building orientation
- Air tightness
- Fabric insulation
- Glazing
- Thermal mass
- Occupancy, usage details
- Potential internal loads
- Budget
- Cost plan
- Health and safety risk assessment

*Design data*
- External design data
- Internal design condition
- Design standards and statutory requirements
- Publications and guides
Contracts
Consultancy
Sub-contract
Management
Installation
Maintenance

Sustainability
Existing energy use
Potential of passive systems (e.g., solar gain, passive ventilation)
Building fabric modifications (e.g., improved glazing systems, insulation)

LO2 Analyse the heating and cooling loads for a non-domestic building

U-values
Calculation of U-values for composite structures

Heat loss
Calculation of heat losses
Ventilation heat losses

Total heating loads and heating plant capacity
Plant diversity
Plant configuration
Single and multiple boiler options
Minimising heat loads

Cooling loads due to solar radiation
Solar geometry and terminology
Direct and diffuse solar radiation
Calculation of solar irradiance on vertical, horizontal and pitched surfaces
Transmission of solar radiation on building structures
Total cooling load and cooling plant capacity
Factors contributing to cooling plant capacity
Assessment of total heat gains to the interior
Effect of building construction and orientation
Use of tables
Reference data and software to determine cooling loads for rooms, zones and buildings

Strategies to prevent building overheating
Effect of shadows and shading
Passive and active cooling measures

Peak summertime temperatures
Calculation and assessment of peak summertime temperatures in rooms
Use of tables
Reference data and computer software

LO3 Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type

Heating media and distribution systems
Requirements of the heating system
Radiant and convective output
Distribution
Zoning options
Integration with domestic hot water (DHW) requirements, integration with low-carbon technology options.

Heating media options
Radiant
Air
Water (e.g., low pressure hot water (lphw), medium pressure hot water (mphw), high pressure hot water (hphw), steam)
System layouts
Centralised or de-centralised
Distribution system layout options
Two-pipe
Reverse return
Constant flow and variable flow systems

Heat emitters
Radiators
Natural convectors
Underfloor heating
Fan convectors
Radiant panels

Heat sources
Direct and indirect options
Conventional boilers or other heat sources such as heat pumps or combined heat and power (CHP)
Fuel options and possible storage requirements
Boiler and burner types
Plant room design requirements
Flue and chimney design

Heating system components
Pipework
Pumps
Pressurisation units
Expansion vessels
Air and dirt separators
Pipework expansion devices
Regulating valves
Fire collars
Ventilation systems
Natural ventilation systems
Mechanical ventilation systems
Mixed mode and displacement ventilation systems
Process, fume and dust extraction systems
Free cooling and night purging
Mechanical ventilation heat recovery (MVHR) systems

Air conditioning systems
Properties and characteristics of comfort cooling and close control application
Humidity control
Cooling coils (e.g., direct expansion (DX), chilled water)
Centralised and local plant selection
Air conditioning systems (e.g., constant volume (CV), variable air volume (VAV), fan coils units, chilled beams, chilled ceilings, room-based heat pumps (versatemp systems), split systems, heat pumps, variable refrigerant flow (VRF) systems)

LO4 Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation

Sizing and specification of heating system components
Pipes
Pumps
Pressurisation units
Expansion vessels
Low loss header
Air and dirt separators
Pipework expansion devices
Regulating valves
Fire collars
Commissioning, testing and handover procedures
Sizing and specification of ventilation system components

Duct sizing
Fan sizing
Fan selection and fan laws
Damper sizing and selection
Air handling unit (AHU) sizing and selection
Grille and diffuser sizing and selection

Sizing and specification of air conditioning system components

Psychrometric principles
Use of psychrometric charts to size cooling and heating coils and humidification requirements
Refrigeration principles
Plotting refrigeration cycles and calculation of coefficient of performance (COP)
Sizing and specification of heat pumps and VRF systems

Commissioning, testing and handover procedures

Current standards and procedures for commissioning ventilation and air conditioning systems
Commissioning procedures for ventilation and air conditioning system components
Commissioning schedules and handover documentation

Sustainability

Energy use
Use of passive systems
Overall strategy (e.g., building fabric, insulation, HVAC solution)
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation</td>
<td><strong>P1</strong> Explain the design process stages and tasks for a non-domestic heating, ventilation and air conditioning installation. <strong>M1</strong> Analyse human comfort requirements to support a proposed non-domestic heating, ventilation and air conditioning installation. <strong>D1</strong> Evaluate the health and safety and environmental legislation relevant to the design and operation of a non-domestic heating, ventilation and air conditioning installation.</td>
<td></td>
</tr>
<tr>
<td><strong>P2</strong> Produce design data for a heating, ventilation and air conditioning installation for a given non-domestic building.</td>
<td><strong>P3</strong> Prepare a health and safety risk assessment for a non-domestic heating, ventilation and air conditioning installation.</td>
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</tr>
<tr>
<td><strong>LO2</strong> Analyse the heating and cooling loads for a non-domestic building</td>
<td><strong>P4</strong> Undertake calculations to establish u-values, heat loss and total heat/cooling loads for a given non-domestic building. <strong>M2</strong> Assess the current requirements for minimum u-values in domestic and non-domestic buildings.</td>
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<tr>
<td><strong>P5</strong> Compare the impact of changes to materials on calculation of u-values, heat loss and heating/cooling loads for a given non-domestic building.</td>
<td><strong>P5</strong> Compare the impact of changes to materials on calculation of u-values, heat loss and heating/cooling loads for a given non-domestic building.</td>
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<tr>
<td><strong>LO3</strong></td>
<td>Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type</td>
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<tr>
<td><strong>P6</strong></td>
<td>Discuss suitable alternative heating, ventilation and air conditioning strategies for a given non-domestic building type</td>
<td>M3 Analyse the performance of selected components of a heating, ventilation, and air conditioning installation.</td>
</tr>
<tr>
<td><strong>P7</strong></td>
<td>Present a design proposal for a non-domestic heating, ventilation and air conditioning installation.</td>
<td>D2 Evaluate options for a non-domestic heating, ventilation and air conditioning installation to improve sustainability in a given project.</td>
</tr>
<tr>
<td><strong>LO4</strong></td>
<td>Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation</td>
<td></td>
</tr>
<tr>
<td><strong>P8</strong></td>
<td>Calculate sizes of pipework and ducting for a proposed heating, ventilation and air conditioning installation.</td>
<td>M4 Discuss how the selection of different components impacts on an installation strategy.</td>
</tr>
<tr>
<td><strong>P9</strong></td>
<td>Discuss how selected heating, ventilation and air conditioning components meet the requirements of the given building.</td>
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</tr>
</tbody>
</table>

Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite
Issue 2 – December 2022 © Pearson Education Limited 2022
Recommended Resources

Print resources
AL-SHEMMERI, T., PACKER, N. (2021), Building Services Engineering, John Wiley & Sons
BUTCHER, K. (2005), Heating, Ventilating, Air Conditioning and Refrigeration, Chartered Institution of Building Services Engineers.
CHADDERTON, D. (2014), Air Conditioning, Routledge
CHADDERTON, D. (2004), Building Services Engineering, Routledge
CIBSE (2006), Environmental Design, CIBSE
PORTMAN, J. (2016), Building Services Engineering, John Wiley & Sons

Links
This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics
- Unit 48: Thermofluids & Acoustics
- Unit 49: Advanced Electrical Design & Installation.
Introduction

The techniques explored in this unit are essential skills in maintaining the competitive position of a construction firm in obtaining work through the procurement routes of construction. Mastering the skills of measurement and estimating is essential for the quantity surveyor and estimator.

The overall aim of this unit is to give students an understanding of the quantity surveying techniques of measurement and the estimation of rates for the compilation of tender information. This is a vital activity in achieving a successful outcome for a contracting company in tendering and winning work.

Topics included in this unit are: estimating techniques; standard methods of measurement; taking-off dimensions; preparation of bills of quantities; estimating data collection; the assembly of an estimate for a work package.

On successful completion of this unit, students will be in a position to take-off quantities from drawn information and to prepare estimates for work packages. Students will have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Define standard measurement techniques used for taking-off quantities for estimating purposes

LO2 Perform taking-off techniques in the production of a range of quantities for a structure

LO3 Interpret the principles and techniques of estimating in compiling a final price

LO4 Prepare an estimate for a work activity.
Essential Content

LO1 **Define standard measurement techniques used for taking-off quantities for estimating purposes**

*Techniques for quantifying budgets*
- Preliminary, intermediate and final estimates for clients’ budgets
- Project Comparison Estimating using historical project cost data
- Use of Building Cost Information Service (BCIS)
- Square metre and cubic metre estimates
- Elemental estimating
- Approximate quantities techniques
- Measurement using dimension paper
- Measurement using software packages

*Standard methods of measurement for taking-off quantities*
- Construction and Building Services (e.g., New Rules of Measurement (NRM), NRM 1 – quantification of building works for the purpose of preparing cost estimates and cost plans, NRM 2 – preparation of bills of quantities and quantified schedules of works, NRM 3 – quantification and description of maintenance works)
- Civil Engineering (e.g., Civil Engineering Standard Method of Measurement 4 (CESMM4) – procedure for the preparation of a bill of quantities)
- International Construction Measurement Standards (ICMS)
- International Property Measurement Standards (IPMS)
- Standard Method of Measurement (e.g., (Legacy) SMM7 – detailed information, classification tables and rules for measuring building works)
- Coding schemes
- Measurement rules
- Dimension sheets

*Project stages*
- Client’s budget setting
- Preliminary stages
- Project comparison stages
- Final design stage
Preparation of bills of quantities for the tendering for work (e.g., sub-contract and supply chain packages)

Final account

Maintenance and refurbishment works

**LO2** Perform taking-off techniques in the production of a range of quantities for a structure

*Measurement techniques and processes*

Traditional (using dimension paper)

Abstraction of quantities

Associated working up processes

Preparation of bill of quantities pages

Computer aided systems

Use of digitisers

Building Information Modelling (BIM)

*Taking-off*

Facilitating works (e.g., toxic/hazardous/contaminated material removal, major demolition works, temporary support to adjacent structures, specialist groundworks, temporary diversion works, extraordinary site investigation works)

Substructure (e.g., excavation works, standard foundations, specialist foundations, lowest floor construction, basement excavation and retaining walls)

Superstructure (e.g., frame, upper floors, roof, stairs and ramps, external walls, windows and external doors, internal walls and partitions, internal doors)

Internal finishes (e.g., wall finishes, floor finishes, ceiling finishes)

Fittings, furnishings, equipment

Services (e.g., sanitary installations, mechanical and electrical installations)

External works (e.g., site preparation works, roads, paths, pavings and surfacings, bridges, culverts, soft landscaping, planting and irrigation systems, fencing, railings and walls, external fixtures, external drainage)
LO3 Interpret the principles and techniques of estimating in compiling a final price

Collection of data
Characteristics
Labour and labour costs
Plant rates data
Company data (on output levels)
Material costs (e.g., terms of supply, delivery, handling, wastage)

Processes and procedures for estimate
Factors affecting prime costs
Method statements (effect on estimating)
Use of standard reference documents
Coverage rules for units of work (e.g., SMM, NRM, CESMM etc.)

Calculation of unit rates in building up an estimate
Labour rates (e.g., direct, sub-contractors, labour-only sub-contractors [LOSC])
Materials (e.g., purchase price, delivery costs, wastage rate)
Plant (e.g., purchase or hire options, output and capacity)
Overheads and margin
Outputs (e.g., recorded historically, use of price books)

Adjustments to unit rates in building up an estimate
Historical rates adjusted for time
Inflation
Risk
Technology
Alternatives (plant, material, process)
Location (labour costs, material costs)
LO4 Prepare an estimate for a work activity

Estimating techniques for budgeting purposes
Preparation of approximate quantities for cost budgets
Elemental cost estimating from given historical cost data
Use of preliminary design drawings
Preparation of estimate using comparative cost data
Other forms of local cost data
Adjustments for time, size and quality, inflation and overheads

Estimating techniques
Application of all in rates to quantities
Total net value
Overheads and profit
Preliminary items
VAT
Calculating cost of risk (e.g., factors affecting risk)
Inclusion of sub-contracted elements
Effect of location
Contract period
Inclusion of provisional items
Use of standard templates and forms
Use of ISO 9000 company devised systems

Preparing a bill of quantities
Types of BOQ (e.g., approximate, elemental, work package, work section, ‘unpriced’ (Tender Pricing Document))
Standard forms of BOQ (e.g., New Rules of Measurement (NRM), Civil Engineering Standard Method of Measurement (CESMM4), International Construction Measurement Standards (ICMS), International Property Measurement Standards (IPMS), Standard Method of Measurement (SMM7) – legacy)
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Define standard measurement techniques used for taking-off quantities for estimating purposes</td>
<td><strong>P1</strong> Explain the techniques used in the production of accurate quantities.</td>
<td><strong>M1</strong> Compare techniques used for production of quantities against the lifecycle of a project.</td>
</tr>
<tr>
<td><strong>P2</strong> Explain how a rule of measurement supports accurate quantities.</td>
<td><strong>M2</strong> Accurately apply a standard method of measurement to the production of quantities.</td>
<td><strong>D1</strong> Critically evaluate an estimating technique to its accuracy in the production of quantities.</td>
</tr>
<tr>
<td><strong>LO2</strong> Perform taking-off techniques in the production of a range of quantities for a structure</td>
<td><strong>P3</strong> Take-off quantities for a range of construction activities.</td>
<td><strong>M2</strong> Accurately apply a standard method of measurement to the production of quantities.</td>
</tr>
<tr>
<td><strong>P4</strong> Abstract a range of quantities for construction or civil engineering activities.</td>
<td><strong>M3</strong> Accurately apply a standard method of measurement to the production of quantities.</td>
<td><strong>D2</strong> Produce an accurate bill of quantities work section from final design drawings for a construction of infrastructure project.</td>
</tr>
<tr>
<td><strong>LO3</strong> Interpret the principles and techniques of estimating in compiling a final price</td>
<td><strong>P5</strong> Calculate labour unit rates for an estimate by compiling and processing rate build-up data.</td>
<td><strong>M3</strong> Analyse the factors that have an effect on the compilation of unit rates for an estimate.</td>
</tr>
<tr>
<td><strong>P6</strong> Calculate ‘all in’ rates for a range of construction or civil engineering activities.</td>
<td><strong>M4</strong> Compare the techniques used for the formulation of budgets with estimating final design costs.</td>
<td><strong>D3</strong> Evaluate estimating techniques used for the different stages of a project’s lifecycle.</td>
</tr>
<tr>
<td><strong>LO4</strong> Prepare an estimate for a work activity</td>
<td><strong>P7</strong> Produce a comprehensive estimate for a work section or activity.</td>
<td><strong>M4</strong> Compare the techniques used for the formulation of budgets with estimating final design costs.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


Links

This unit links to the following related units:

- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 12: Tender & Procurement
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.
Unit 11: Financial Management & Business Practices in Construction

Level: 4
Credits: 15
Ofqual Code: K/618/8090

Introduction

The contemporary construction company operates in a very competitive sector of the economy. The size of company ranges from small to large. The types of company includes sole traders, partnerships, limited companies and public limited companies, working in local, regional and multinational contexts. Construction companies have evolved their business practices to ensure economic survival and growth. However, they continue to be impacted by the construction market and external factors such as interest rates, government legislation and political and economic conditions.

This unit introduces students to the concepts of business management and financial control. They will examine a range of factors that influence the ways in which companies grow, raise finance and control their costs and resources.

Topics included in this unit are: the legal status of building companies and how it impacts on raising finance; the different sources of finance and how a company manages them; contemporary management strategies; how the day-to-day management of the different resources used by a construction company have an impact on their success.

On successful completion of this unit, students will be able to analyse the legal status of different types of construction companies, their business strategies and how they raise and manage their finances, and the management of the resources available to them.
Learning Outcomes

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

LO1 Explain the legal status of different types of construction companies

LO2 Explore different sources of finance available to a construction company and strategies used to manage finance

LO3 Evaluate different forms of company organisation in the contemporary construction industry

LO4 Illustrate the different strategies used by construction companies to manage resources.
Essential Content

LO1 Explain the legal status of different types of construction companies

Company types
Sole trader
Partnership and limited liability partnership (LLP)
Private company (e.g., limited by shares (Ltd), limited by guarantee, unlimited)
Public company (e.g., public limited (PLC))
Holding and subsidiary companies

Legal statutes surrounding companies
Company law
Responsibility to shareholders
Bankruptcy and insolvency

Key legal characteristics of registered companies
Company registration
Memorandum of Association
Articles of Association
Statement of capital and initial shareholdings
Choosing a company name

Company closure
Winding-up/dissolution or liquidation
Members’ voluntary winding-up/dissolution
Creditors’ winding-up/dissolution
Compulsory ‘strike-off’
Insolvency
Bankruptcy
Administration
Secured and unsecured creditors
Distribution of assets
LO2  Explore different sources of finance available to a construction company and strategies used to manage finance

Types of capital
Short-term, medium-term, long-term
Investment types (e.g., owner, shareholder, bondholder, equity, banks, venture, lender/loan)

Types of finance
Equity
Debt and lease financing
Debentures
Shares (e.g., ordinary, preference, ‘called-up’, share values)

Managing finance
Simple interest and compound interest
Future planning and present value
Sinking fund
Discounted cash flow techniques
Net present value
Capital gearing
Leverage

Company accounts
Trading position
Balance sheet analysis
Ratio analysis
Financial reporting
Cash flow analysis
LO3 **Evaluate different forms of company organisation in the contemporary construction industry**

*Company organisation*
Corporate governance
Operational strategies
Corporate ethics (e.g., corporate social responsibility, sustainability, labour practices)

*Organisation structures*
Span of control
Communication
Matrix organisations
Head office and site management structures
Learning and development (e.g., education, training, professional development)
Health, safety, and welfare provisions
Certification schemes (e.g., Construction Skills Certification Scheme, Considerate Constructors Scheme)

*Management philosophies*
Human resources development
Motivation and incentivisation
Leadership styles
Employment types (e.g., direct, sub-contract, agency labour)
Collaboration and communication

LO4 **Illustrate the different strategies used by construction companies to manage resources**

*Labour*
Skilled or semi-skilled
Sub-contract or direct labour
Incentive schemes
Human resources reviews
Materials
Ordering
Delivery strategies
Storage
Transport
Plant and equipment
Hire, lease, or purchase
Depreciation
Selection process
Setting hire rate

Project cost monitoring
Cost plan
Approved budget
Cost reporting
Roles in cost monitoring (e.g., client, quantity surveyor, project team)
## Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain the legal status of different types of construction companies</td>
<td><strong>P1</strong> Discuss the different types of companies and their legal status.</td>
<td><strong>M1</strong> Compare different company types and advise on a suitable type for a given context.</td>
</tr>
<tr>
<td><strong>P2</strong> Explain the process of company formation.</td>
<td><strong>P2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Explore different sources of finance available to a construction company and strategies used to manage finance</td>
<td><strong>P3</strong> Explore the different sources of capital available for borrowing by a company.</td>
<td><strong>M2</strong> Analyse the borrowing requirements for a given project.</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss a range of techniques for assessing the cost of borrowing.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Evaluate different forms of company organisation in the contemporary construction industry</td>
<td><strong>P5</strong> Discuss the strategic policies of a construction company.</td>
<td><strong>M3</strong> Assess company organisational structures that may support collaborative working practices.</td>
</tr>
<tr>
<td><strong>P6</strong> Explain the different organisational structures in different sizes of construction company.</td>
<td></td>
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</tr>
<tr>
<td><strong>LO4</strong> Illustrate the different strategies used by construction companies to manage resources</td>
<td><strong>P7</strong> Describe the different types of labour, and strategies used for their management, by construction companies.</td>
<td><strong>M4</strong> Discuss the factors to be considered when considering the purchase or hire of plant and equipment.</td>
</tr>
<tr>
<td><strong>P8</strong> Discuss the importance of cost control for projects and the different parties involved in managing costs.</td>
<td></td>
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</tr>
</tbody>
</table>
Recommended Resources

Print resources

KIRKHAM, R. (2014), *Ferry and Brandon’s Cost Planning of Buildings*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 36: Value Engineering & Cost Control
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.
Introduction

For a client, the process of procurement – obtaining the services of a main contractor to construct their project – is often complex. The selection of a contractor that will meet the client’s expectations is essential so that time, quality and cost constraints are met, with no delays, overruns or budgets exceeded. Tendering is the process of obtaining a price for the designed and specified works. The importance of contractor selection to the successful completion of a client’s project cannot be overstated.

This unit aims to give students the knowledge they need to be able to select a procurement route and an appropriate tendering method in the awarding of a project to a main contractor. Students will learn how to prepare a tender package in procuring a contractor for a client’s work. Many different procurement methods are available to achieve this: from open to closed systems.

Topics included in this unit are: tendering constraints and information; the documentation needed to send out a tender; the factors that affect procurement; the procurement methods that can be used to select a contractor.

On successful completion of this unit, students will be able to obtain an estimate for a client’s project, at the design stage, using a suitable procurement method. Students will also have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Define what constitutes a tender and the information required for this process
LO2 Explain the procedures and contractual arrangements for tendering
LO3 Analyse the factors that affect the selection of construction procurement methods
LO4 Prepare tender documentation for a given project.


**Essential Content**

**LO1** Define what constitutes a tender and the information required for this process

*Information required to produce a tender*
- Decision to tender
- Preliminary information received
- Type of client or stakeholder (e.g., private or commercial clients)
- Stage of the design drawings
- Provisional timescale
- Pre-contract health and safety plans
- Tender resource allocations
- Electronic or hardcopy tender process
- Type of work
- Capacity to tender

*Constraints on tendering*
- Time allocated to the compilation of tender documentation
- Selection of list of tenderers
- Allocated tendering time
- Return date and time
- Resource implications in terms of hardcopy
- Poor tender presentation (e.g., insufficient information sent out to contractors)
- Revisions to design

*Tender documentation*
- Covering invitation letter
- Form of tender
- Employers’ requirements
- Nominated and named contractors
- Tender submission breakdown
- List of drawings
- Drawings/data (e.g., design drawings, tender drawings, building information model data)
Specifications
Bill of quantities
Preliminaries
Pre-construction information
Contract information (e.g., form of contract to be used on the project, contract conditions and terms)
Tender documents (e.g., tender pricing document, tender return instructions, tender return envelope)
References to any code of practice for tendering procedures

LO2  Explain the procedures and contractual arrangements for tendering

Tendering stages
Decision to tender
Tender preparation strategy
Tendering arrangements
Pre-qualification questionnaire
Compiling lists of prospective tenderers
Selection criteria (e.g., experience, references, professional association status, ISO registration, recommendations, clients, preferences, interview, presentation, financial accounts, health and safety record, rotation on a select list, listing against financial capacity, previous performance feedback)

Types of tender
Open
Selective
Negotiated
Serial
Framework tendering
Single-stage and two-stage
Advantages and disadvantages
Criteria for the selection of type of contract

Types of contract/procurement (e.g., traditional, design and build, construction management, measured term)

Standard forms of contract (e.g., Joint Contracts Tribunal (JCT), New Engineering Contract (NEC), FIDIC, International Construction Contracts) Level of information provided at tendering stage

Criteria for the selection of tendering method

Type of contract
Size of project
Financial costs

LO3 Analyse the factors that affect the selection of construction procurement methods

Forms of procurement

Traditional (e.g., design-bid-build, bid-build, employer-designed)
Design and build (e.g., single-stage, two-stage)
Management
Private Finance Initiative (e.g., Build-own-operate-transfer (BOOT), Design-build-finance-maintain (DBFM), Design-build-finance-transfer (DBFT))
Engineering procurement and construction (EPC)
Engineering procurement and construction management (EPCM)
Framework agreements
Others

Issues associated with procurement of projects

Current issues (associated with procurement and contractual arrangements)
Government policy and strategy
Professional body requirements
Contract organisations (e.g., JCT, NEC, FIDIC)
Differences between public and private procurement
Industry developments and trends (e.g., building information modelling, digital asset management)
International trade agreements
Factors affecting procurement routes

Time constraints
Financial constraints (budget, costs and financial planning)
Quality
Client characteristics (e.g., government, institutional, private sector)
Project characteristics
Level of risk associated (e.g., apportionment of risk between client and contractor)
Environmental/sustainability
Stage of the design (e.g., fully designed, partially designed)
Complexity of project
Regulatory/legislation compliance

LO4 Prepare tender documentation for a given project

Project parameters
Client’s budget
Client’s agreed procurement strategy
Project management strategy
Available procurement time in relation to design stage
Construction information availability schedule
Level of specified quality
Policy/political constraints
Value for money
Level of client knowledge.
Contract type in relation to method of procurement

Tender documentation
Letter of invitation
Form of tender
Preliminaries (e.g., pre-construction information, site waste management plan)
Form of contract
Tender pricing document
Employer’s information requirements for BIM

Drawings
Specifications
Tender return slip
## Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Define what constitutes a tender and the information required for this process</td>
<td><strong>M1</strong> Compare the use of specifications and bills of quantities as tendering methods used for a privately funded project.</td>
<td><strong>D1</strong> Analyse the potential benefits of Building Information Modelling (BIM) in the tender process.</td>
</tr>
<tr>
<td><strong>P1</strong> Explain the information required to be produced prior to tendering.</td>
<td><strong>P2</strong> Illustrate the documentation required to formulate a tender for a major project.</td>
<td><strong>P3</strong> Explain the stages of a tender process and the criteria used in selecting tenders.</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss the advantages and disadvantages of different types of tender for a given project.</td>
<td><strong>M2</strong> Compare the different types of tendering available for a design and build project.</td>
<td><strong>M3</strong> Analyse the different influences on procurement between public and private projects.</td>
</tr>
<tr>
<td><strong>P5</strong> Explore the professional, legal and industry issues that influence procurement.</td>
<td><strong>P6</strong> Explain the project factors that inform the selection of a procurement route.</td>
<td><strong>P7</strong> Compile project parameters, to inform tender documentation, for a given project.</td>
</tr>
<tr>
<td><strong>P8</strong> Produce tender documentation (based on drawings and specifications provided by others) for a given project.</td>
<td><strong>M4</strong> Justify the approach to tender documentation in relation to the client’s agreed procurement strategy.</td>
<td><strong>D2</strong> Justify the selection of a contract type for a given form of tender.</td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the procedures and contractual arrangements for tendering.</td>
<td><strong>M3</strong> Analyse the different influences on procurement between public and private projects.</td>
<td><strong>D3</strong> Evaluate the relationship between procurement route, contract type and tender process in limiting risk for client and contractor.</td>
</tr>
<tr>
<td><strong>LO3</strong> Analyse the factors that affect the selection of construction procurement methods</td>
<td><strong>P5</strong> Explore the professional, legal and industry issues that influence procurement.</td>
<td><strong>P6</strong> Explain the project factors that inform the selection of a procurement route.</td>
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<td><strong>LO4</strong> Prepare tender documentation for a given project</td>
<td><strong>P7</strong> Compile project parameters, to inform tender documentation, for a given project.</td>
<td><strong>M4</strong> Justify the approach to tender documentation in relation to the client’s agreed procurement strategy.</td>
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Recommended Resources

Print resources
MORLEDGE, R., SMITH, A., APPIAH, S. (2021), *Building Procurement*, John Wiley & Sons

Links
This unit links to the following related units:
- Unit 4: The Construction Environment
- Unit 8: Mathematics for Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.
Unit 13: Building Information Modelling

Level: 4
Credits: 15
Ofqual Code: T/618/8092

Introduction

Building Information Modelling (BIM) is often assumed to be a software solution – a more advanced form of CAD, for producing construction information. However, while software can play an important part, BIM is actually an approach to information generation and management in a collaborative environment. The aim of BIM is to ensure that better information is created, shared and kept secure so that the design, construction, occupation and maintenance of our built assets can be more efficiently managed. In short, BIM is a collaborative approach that involves a clearly defined set of processes.

The aim of this unit is to give students the background knowledge and understanding of Building Information Modelling (BIM) in the context of the construction industry. Students will be introduced to the drivers and benefits associated with BIM, as well as the terminology that surrounds it.

The knowledge and skills gained in this unit will allow students to understand the importance of BIM in the context of current roles and responsibilities in the construction industry. Students will also gain an understanding of how this may influence future choices in their professional careers.

Learning Outcomes

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

LO1 Discuss the term Building Information Modelling (BIM) in the context of local, national and global developments in the construction industry

LO2 Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses

LO3 Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle

LO4 Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project.
Essential Content

LO1 Discuss the term Building Information Modelling (BIM) in the context of local, national and global developments in the construction industry

Definition of Building Information Modelling (BIM)

Key terms and definitions that relate to BIM
BIM levels
Project Information Model (PIM)
Asset Information Model (AIM)
Employer’s Information Requirements (EIR)
Organisational Information Requirements (OIR)
Asset Information Requirements (AIR)

The differences between traditional methods and a BIM-enabled process
Drawing vs model
Geometry vs information
The ‘digital twin’

The importance of BIM in the context of the construction industry
Collaborative practices
Common Data Environment (CDE)
Interoperability

International Standards
ISO 19650 (Organisation of information for construction projects)
ISO 55000 (Asset management overview)
ISO 16739 (Industry Foundation Classes [IFC] for data sharing)

Publicly Available Specification (PAS)
PAS 1192-1 (information management – capital/delivery phase)
PAS 1192-2 (information management – operational phase)
PAS 1192-3 (securing in building information modelling)
PAS 1192-4 (collaborative sharing and use of information for health and safety)
LO2  **Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses**

*Common Data Environment*

Graphical data

Non-graphical data

Benefits of a common data environment

Common Data Formats (e.g., DWG, IFC, COBie, DOCX, XLSX)

*Information producers*

*Information uses*

*Information management*

LO3  **Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle**

*Project Information Model*

Project Information Requirements (PM)

Design phase (e.g., design intent model, massing, 2D data, 3D data)

Construction phase (e.g., virtual construction model, details, specifications)

Information manager

*Asset Information Model*

Development from Project Information Model

Information management process

Asset Information Requirements

As-built information

Graphical data (e.g., drawings, models)

Non-graphical data (e.g., specifications, schedules, product information, maintenance information)

Data manager
LO4 **Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project**

*Potential benefits of BIM*
- Cost reduction
- Time savings
- Reducing waste
- Minimising errors
- Improved efficiency

*Design team*
- Architect
- Engineers (e.g., structural, civil, mechanical)

*Client/asset owner*
- Developer
- Owner

*Construction team*
- Main contractor
- Sub-contractors

*Occupier/asset user*
- Facilities manager/maintenance team
- Commercial occupier/user
- Residential occupier/user
## Learning Outcomes and Assessment Criteria

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<td><strong>P1</strong> Explain the term ‘Building Information Modelling (BIM)’ and how it relates to the construction industry.</td>
<td><strong>D1</strong> Evaluate the role of Building Information Modelling in meeting client, user and government targets for construction projects.</td>
</tr>
<tr>
<td><strong>P2</strong> Discuss the role of standards in defining the processes of Building Information Modelling and ensuring project deliverables and quality.</td>
<td><strong>M1</strong> Analyse the difference between Building Information Modelling and traditional forms of construction information.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Illustrate the key features of Common Data Environment for a given project in relation to information producers and information uses</td>
<td><strong>P3</strong> Explain the role of the Common Data Environment for construction projects.</td>
<td><strong>M2</strong> Assess the ways that different stakeholders make use of the Common Data Environment.</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss the benefits of the Common Data Environment.</td>
<td><strong>M2</strong> Assess the ways that different stakeholders make use of the Common Data Environment.</td>
<td><strong>D2</strong> Critically analyse the technologies and data formats that support collaboration and interoperability through the Common Data Environment.</td>
</tr>
<tr>
<td>Pass</td>
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</tr>
<tr>
<td><strong>LO3</strong> Explain the Project Information Model and the Asset Information Model in terms of their use through a project lifecycle</td>
<td><strong>P5</strong> Discuss the purpose of the Project Information Model and the Asset Information Model. <strong>P6</strong> Present Project Information Requirements and Asset Information requirements for a given project.</td>
<td><strong>D3</strong> Critically analyse how Information Requirement definitions impact on the potential benefits of a BIM-enabled project.</td>
</tr>
<tr>
<td><strong>LO4</strong> Assess the benefits of Building Information Modelling (BIM) for the stakeholders involved in a building project</td>
<td><strong>M3</strong> Analyse the transition from Project Information Model to Asset Information Model in terms of the information included in each.</td>
<td><strong>M4</strong> Evaluate the benefits of collaboration, through BIM, for members of a project design team.</td>
</tr>
<tr>
<td><strong>P7</strong> Discuss the ways in which a BIM-enabled project creates benefits for clients/owners. <strong>P8</strong> Explain the potential benefits of a BIM-enabled project for users/occupiers.</td>
<td><strong>P7</strong> Discuss the ways in which a BIM-enabled project creates benefits for clients/owners. <strong>P8</strong> Explain the potential benefits of a BIM-enabled project for users/occupiers.</td>
<td><strong>P7</strong> Discuss the ways in which a BIM-enabled project creates benefits for clients/owners. <strong>P8</strong> Explain the potential benefits of a BIM-enabled project for users/occupiers.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
SAXON, R. (2016), *Bim for Construction Clients*, NBS

Web resources
(General Reference)
(General Reference)
(General Reference)
www.thenbs.com The NBS Knowledge
(General Reference)

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 26: Digital Applications for Building Information Modelling
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 47: Advanced Building Information Modelling.
Unit 14: Principles of Refurbishment

Level: 4
Credits: 15
Ofqual Code: A/618/8093

Introduction

There are buildings all over the world of different types, styles, ages and condition. Once a building has been built, there comes a need to maintain and update the property, to keep it fit for the intended purpose or prepare it for a new use. Refurbishment is a broad term that covers adaptation, alteration and extension. The value of refurbishment to the construction industry is significant, with nearly half of the total value of construction coming from work to existing buildings. With a reduction of available land, legislative change and a drive for increased sustainability, the need to understand refurbishment is increasingly important.

This unit gives students the opportunity to analyse the underpinning concepts of refurbishment and the options available. Students will be able to use construction knowledge from other units and apply it to a refurbishment project, taking into account the key factors that influence a scheme.

On successful completion of this unit, students will be able to assess the suitability of a property for refurbishment, taking into consideration all applicable factors. The knowledge gained from the unit will be beneficial to those working in all aspects of the industry as a successful refurbishment project requires skills from all disciplines.

Learning Outcomes

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

LO1 Explore the factors that drive refurbishment and its potential benefits and challenges

LO2 Discuss different approaches to refurbishment

LO3 Illustrate the project process for a given refurbishment scheme

LO4 Prepare an initial scheme for a refurbishment project to meet a client brief.
**Essential Content**

**LO1** Explore the factors that drive refurbishment and its potential benefits and challenges

*Need for refurbishment*
- Ageing property stock
- Obsolescence (economic, functional, physical, social, legal)
- Demographic changes
- Legislative changes
- Deterioration of the fabric
- Safety of existing structure
- Preservation of the historic environment
- Decline in performance
- Environmental and sustainability needs
- Societal trends

*Benefits of refurbishment*
- Improved sustainability (e.g., better energy performance, reduction in materials)
- Retaining local/historical character
- Cost reduction (e.g., lower energy costs, lower ongoing maintenance costs)
- Improved visual appeal
- Increased safety (e.g., fire, environmental)

*Challenges of refurbishment*
- Safety (e.g., work to existing buildings, structural stability)
- Financial risks (e.g., value of ‘new’ vs value of refurbished)
- Availability of specialist trades/materials (e.g., work to historic buildings)
- Sustainability (e.g., ability of building to accommodate sustainable interventions)
LO2 Discuss different approaches to refurbishment

Types of refurbishment
- Preservation
- Conservation
- Restoration
- Retrofit
- Rehabilitation
- Renovation
- Remodelling

Scale of refurbishment
- Small (e.g., minor upgrades of the fabric, small-scale lateral extensions)
- Medium (e.g., major upgrades, larger lateral and vertical extensions, radical internal changes and alterations)
- Large (e.g., extensive alterations, upgrades and extensions, additional storey above or below ground, façade retention etc.)

LO3 Illustrate the project process for a given refurbishment scheme

Project initiation
- Identification of need
- Initial survey/inspection to ascertain the basic details of the property

Feasibility
- Detailed survey (structural appraisal and diagnosis of faults)
- Evaluation and options (e.g., initial cost estimate, proceed with refurb or demolish)

Detailed scheme design
- Legal considerations (planning, building regulations etc.)
- Information production

Tender

Construction
- Monitoring works
Checking quality
Managing changes

Handover
Commissioning
Defects (e.g., snagging, correcting defects, defects liability period)

Occupancy
Building regulation compliance
Certificate of occupancy

LO4 Prepare an initial scheme for a refurbishment project to meet a client brief

Existing information
As-built drawings
Survey reports
Structural reports

Client brief
Project type (e.g., residential, commercial, industrial)
Client need (e.g., improve performance, make safe, enhance commercial viability, change of use)
Budget

Initial schemes
Design drawings
Cost estimates
Client approval
Legislative compliance
Risk assessment

Detail/production design
Construction drawings
Specifications
Schedules
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Explore the factors that drive refurbishment and its potential benefits and challenges</td>
<td><strong>P1</strong> Explain why properties will require refurbishment throughout their lifecycle.</td>
<td><strong>M1</strong> Compare different forms of obsolescence and how they may contribute to the need for refurbishment.</td>
</tr>
<tr>
<td><strong>LO2</strong> Discuss different approaches to refurbishment</td>
<td><strong>P3</strong> Explain the different approaches to refurbishment.</td>
<td><strong>M2</strong> Analyse a range of refurbishment options and interventions for a given scheme.</td>
</tr>
<tr>
<td><strong>LO3</strong> Illustrate the project process for a given refurbishment scheme</td>
<td><strong>P5</strong> Examine the refurbishment process, including the planning process and building regulations.</td>
<td><strong>M3</strong> Analyse the different forms of information required for a refurbishment project.</td>
</tr>
<tr>
<td><strong>LO4</strong> Prepare an initial scheme for a refurbishment project to meet a client brief</td>
<td><strong>P6</strong> Discuss the monitoring of construction and commissioning of finished works to ensure quality.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Produce the information required for an initial refurbishment scheme to meet a client brief.</td>
<td><strong>P8</strong> Prepare a risk assessment for a refurbishment scheme, based on existing conditions.</td>
<td></td>
</tr>
<tr>
<td><strong>M4</strong> Prepare information and applications to meet regulatory requirements for a refurbishment project.</td>
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</tr>
<tr>
<td><strong>D3</strong> Justify a refurbishment scheme, highlighting how it addresses issues of obsolescence.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

BAKER, N., BAKER, N. (2009), *The Handbook of Sustainable Refurbishment*, Earthscan
GLOVER, P. (2009), *Building Surveys*, Elsevier
MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press
NOY, E. (2008), *Building Surveys and Reports*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 15: Principles of Alternative Energy
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 36: Value Engineering & Cost Control
- Unit 40: Surveying for Conservation, Renovation & Refurbishment.
Unit 15: Principles of Alternative Energy

Level: 4
Credits: 15
Ofqual Code: F/618/8094

Introduction
Buildings use about 40 per cent of global energy, 25 per cent of global water and 40 per cent of global resources in their construction and operation. Governments around the world have recognised the importance of tackling energy consumption in the built environment and have instituted legislation to address these issues. These resulting measures have often been supported by financial incentives to implement alternative energy systems and processes. They are also governed by rigorous targets and deadlines. Technologies that harness solar, wind and hydro energy are now established systems for generating power and heat. Along with other innovations, such as heat pumps and biofuel, these sustainable energy systems are often incorporated into the design of new construction projects.

The aim of this unit is to develop students' knowledge of current and future energy technologies and to be able to apply that knowledge to the analysis and assessment of their effectiveness. Students will also apply their knowledge and research to a design activity.

On successful completion of this unit, students will be able to research and design alternative energy systems and assess new technologies available to the construction industry.

Learning Outcomes

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

LO1 Examine the different contexts that inform discussions on environmental sustainability

LO2 Discuss types of alternative energy systems and how they support sustainability

LO3 Explain the factors that inform the selection of a renewable energy system in relation to a specific installation

LO4 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy.
Essential Content

LO1 Examine the different contexts that inform discussions on environmental sustainability

Definitions of sustainability
Environmental sustainability
Social sustainability
Economic sustainability
Cultural sustainability

Environmental context
Effects of CO2 emissions
Greenhouse effect
Waste products and management
Health issues
Impact of construction industry on the environment

Resource context
Non-renewable resources (e.g., fossil fuels, nuclear fuels)
Renewable resources (e.g., wind, solar, biomass)
Environmental cost of renewables (e.g., manufacture, transportation, installation)

Political context
Global agreements (e.g., Kyoto Agreement, Paris Accord)
National/regional targets
Carbon offset and carbon trading

LO2 Discuss types of alternative energy systems and how they support sustainability

Renewables
Solar (e.g., solar heating/hot water, photovoltaic systems)
Wind (e.g., wind turbines, windfarms (offshore, onshore), small-scale generation)
Hydro-electrical systems
Geothermal
Wave/tidal power  
Biomass (e.g., biofuel, biogas)

*Conservation*  
Combined heat and power (CHP)  
Heat pumps  
Heat exchangers  
Carbon-neutral fuels (e.g., microalgae)  
Energy storage

*Advances*  
Robotics (e.g., used for installation, maintenance)  
Optical furnaces (used to produce solar cells)  
Improved storage (e.g., liquid metal batteries, hydrogen cell)  
Solar systems (e.g., sun-tracking solar cells, solar energy harvesting from space, molten salt solar power)

**LO3** Explain the factors that inform the selection of a renewable energy system in relation to a specific installation

*Environmental factors*  
Effects of weather, light availability and quality  
Presence of natural resources needed to drive the system

*Political factors*  
Government targets/policies  
Regulatory requirements-obstacles

*Social factors*  
Aesthetics  
Neighbours  
Conservation

*Technical and design factors*  
Client requirements  
Building structure (e.g., Can building support proposed systems?)
Access
Required power output (e.g., electrical, heating, ventilation, cooling)
Regulatory requirements (e.g., planning restrictions, building regulations)

Cost factors
Tariffs and tariff calculations
Installation costs
Cumulative savings

Safety factors
Health and safety regulations
Safety factors in energy generation
Safety factors in energy storage

LO4 Present a strategy for a cost-effective upgrade to an existing building, utilising an appropriate form of alternative energy

Project characteristics
Building use (e.g., residential, commercial, industrial)
Scale
Energy requirements. (e.g., electrical load, heating requirements, ventilation requirements, cooling load)

Client requirements
Budget
Proposed building use

Strategy
System specification (e.g., energy production type, equipment required)
Installation method and requirements (e.g., method statement, health and safety plan, structural requirements, construction requirements, cost estimate)
Monitoring (e.g., monitoring equipment, energy production, energy use, cost)
### Learning Outcomes and Assessment Criteria

<table>
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<tr>
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<tbody>
<tr>
<td><strong>LO1</strong> Examine the different contexts that inform discussions on environmental sustainability</td>
<td><strong>P1</strong> Discuss the relationship between different forms of sustainability.</td>
<td><strong>M1</strong> Assess the political context for sustainability and how the construction industry may contribute to achieving local/regional/global targets.</td>
</tr>
<tr>
<td><strong>P2</strong> Describe the ways that the construction industry impacts on the environment.</td>
<td><strong>M2</strong> Assess the impact of advances in renewable energy to improve efficiency, performance and sustainability.</td>
<td><strong>D1</strong> Evaluate how different forms of alternative energy systems contribute to achieving a more sustainable construction industry.</td>
</tr>
<tr>
<td><strong>LO2</strong> Discuss types of alternative energy systems and how they support sustainability</td>
<td><strong>P3</strong> Explore the different types of energy systems available and their role in sustainable solutions.</td>
<td><strong>M3</strong> Analyse how a different renewable energy system would impact on the given project.</td>
</tr>
<tr>
<td><strong>P4</strong> Describe advances in renewable energy technology.</td>
<td><strong>M2</strong> Assess the impact of advances in renewable energy to improve efficiency, performance and sustainability.</td>
<td><strong>D2</strong> Evaluate how an alternative energy strategy meets client needs and addresses environmental, political and social factors.</td>
</tr>
<tr>
<td><strong>LO3</strong> Explain the factors that inform the selection of a renewable energy system in relation to a specific installation</td>
<td><strong>P5</strong> Review an existing renewable energy installation for a non-domestic building.</td>
<td><strong>M4</strong> Justify design decisions based on external, cost and design factors.</td>
</tr>
<tr>
<td><strong>P6</strong> Explain the factors that inform the choice of selected system for the given installation.</td>
<td><strong>P7</strong> Select an appropriate renewable energy system for an existing building.</td>
<td><strong>P8</strong> Present a strategy for an existing building to integrate a form of alternative energy.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


Web resources


Links

This unit links to the following related units:

- Unit 6: Digital Applications for Construction Information
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 18: Principles of Electrical Design & Installation
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 49: Advanced Electrical Design & Installation.
Unit 16: Principles of Public Health Engineering

Level: 4
Credits: 15
Ofqual Code: J/618/8095

Introduction

The role of a public health engineer is a very important and diverse one in the construction process. Public health engineers design systems for water supply and sanitation that help buildings work better for occupants, owners and the environment. This may vary from a drainage system in a hospital to a water-supply system in a high-rise apartment building.

This unit introduces students to the principles of public health engineering. They will develop a broad understanding of domestic hot- and cold-water services, and sanitation and rainwater systems that serve large commercial and complex multi-zone buildings.

On successful completion of this unit, students will be able to calculate, design and select appropriate pipework systems and plantroom equipment for hot- and cold-water services, and sanitation and rainwater systems for large commercial buildings.

Learning Outcomes

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

LO1 Explain the different types of domestic water services systems and above ground drainage that serve large buildings

LO2 Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment

LO3 Develop sustainable design strategies for public health engineering

LO4 Design and specify water and sanitation services for large non-domestic buildings.
Essential Content

LO1 Explain the different types of domestic water services systems and above ground drainage that serve large buildings

*Cold water*
Sources of water (e.g., water quality, hardness, water treatment, corrosion)
Distribution systems (e.g., direct, and indirect systems, boosted cold water systems, water storage, pressure reduction and control, domestic sprinkler systems)

*Hot water*
Hot water production (e.g., local vs central, vented and unvented, calorifiers, plate heat exchangers, local heaters)
Distribution systems (e.g., secondary circulation, pumps and balancing, trace heating, avoidance of dead legs)

*Above ground drainage*
Sanitary pipework systems (e.g., attributes, primary ventilated stack system, secondary ventilated stack system, ventilated and unventilated branches, stub stacks, pumped drainage systems)
Kitchen and laboratory drainage

*Rainwater systems*
Rainwater pipework systems (e.g., gravity and siphonic systems, gutters and roof outlets, paved area drainage, sound attenuation, soakaways)

LO2 Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment

*Cold water*
Water regulations
Categories of fluid
Contamination risks
Air gaps and backflow prevention
Legionella prevention and monitoring
Disinfection and flushing of systems
Standards and codes of practice
Commissioning and maintenance

**Hot water**
Legionella prevention vs scalding
Thermal balancing
Hot water temperatures
Building regulations
Mixers and blending of hot water
Thermostatic control
Safety features for unvented hot water

**Above ground drainage**
Limits of stack system
Trap seal loss
High rise building drainage
Invert levels
Secondary venting
Air admittance valves (AAV)
Positive air pressure attenuators (PAPA)
Offsets and vent termination

**Sewer capacities**

**Rainwater systems**
Green, brown, and blue roofs
Pitched roof types
Rainfall intensities
Sustainable Urban Drainage Systems (SUDS)
Rainwater attenuation

**Building regulations and codes of practice**
Commissioning
System testing
Balancing
Quality checks
Handover

**LO3** Develop sustainable design strategies for public health engineering

Certification schemes (e.g., BREEAM, LEED)

Water flow rates and leak detection methods
Requirements and solutions

Water consumption and water conservation measures
Types and techniques

Hot water generation
Combined Heat and Power (CHP)
Solar thermal

Grey water recycling systems
Benefits and pitfalls

Rainwater harvesting systems
Requirements and uses

**LO4** Design and specify water and sanitation services for large non-domestic buildings.

Cold water systems
Cold water storage requirements
Cistern sizing
Probability theory and loading units
Cold water pipe sizing
Pressure
Flow rates and velocity
Booster set sizing
Hot water systems
Hot water generator sizing
Reheat/recovery period
Storage, semi-storage or instantaneous
Hot water flow and return pipe sizing
Circulating pump size
Mass flow rate and pressure drop

Rainwater systems
Surface water run-off calculations
Storm return periods/rainfall intensities
Gutter and roof outlet sizing
Attenuation tank sizing
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain the different types of domestic water services systems and above ground drainage that serve large buildings</td>
<td><strong>M1</strong> Illustrate the operation of a hot and cold water and sanitation system for a given building type.</td>
<td><strong>D1</strong> Evaluate how different water, sanitation systems and plant choices impact on the construction and performance of a building.</td>
</tr>
<tr>
<td><strong>P1</strong> Identify the main hot and cold water and sanitation systems for large buildings. &lt;br&gt;<strong>P2</strong> Describe the main plant items for water and sanitation systems.</td>
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</tr>
<tr>
<td><strong>LO2</strong> Identify relevant design considerations for buildings when selecting water, drainage pipework, plant and equipment</td>
<td><strong>M2</strong> Analyse the way in which industry codes of practice influence the design of water and sanitation systems.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Explain the current legislation and codes of practice that influence the design and selection of water and sanitation systems. &lt;br&gt;<strong>P4</strong> Discuss the health and public safety issues that must be managed through water and sanitation installations for large buildings.</td>
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</table>

Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite  
Issue 2 – December 2022 © Pearson Education Limited 2022
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</table>
| **LO3** Develop sustainable design strategies for public health engineering | **P5** Explain how public health engineering solutions contribute to project sustainability.  
**P6** Produce a design strategy for a public health engineering installation in a given context. | **D2** Evaluate the impact of incorporating a sustainable public health scheme within a proposal. |
| **LO4** Design and specify water and sanitation services for large non-domestic buildings | **P7** Explain the parameters that inform the design of public health engineering services for a given large, non-domestic building.  
**P8** Produce drawings and specifications for water and sanitation services in a given large, non-domestic building. | **M4** Calculate the required plant and pipe sizes for a public health engineering design proposal. |
Recommended Resources

Print resources
MITCHELL, P. (2008), *Central Heating, Installation, Maintenance and Repair*, WritersPrintShop

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 22: Scientific Principles for Building Services
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 43: Advanced Surveying & Measurement.
Unit 17: Civil Engineering Technology

Level: 4
Credits: 15
Ofqual Code: R/618/8097

Introduction

This unit explores the role of professional civil engineers, their essential involvement in the construction and maintenance of infrastructure, and the key technologies they apply. The technologies and processes of civil engineering in the development of highways, bridges and substructures are crucial in supporting contemporary societies.

Topics included in this unit are: earthwork activities; temporary and permanent dewatering procedures; methods and techniques used to create substructures, highways and superstructures and the common hazards; technical problems and solutions associated with modern civil engineering activities.

On successful completion of this unit, students will be able to describe, analyse and evaluate modern civil engineering procedures, apply their skill and knowledge to the design of infrastructure, and produce solutions to address hazards and problems encountered in civil engineering projects.

Learning Outcomes

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

LO1 Explain the methods and techniques used in civil engineering for earthworks and substructures

LO2 Discuss the civil engineering technologies associated with road and bridge construction

LO3 Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality

LO4 Present a design proposal for a new infrastructure project.
Essential Content

LO1  **Explain the methods and techniques used in civil engineering for earthworks and substructures**

*Earthworks*

Excavation (e.g., topsoil, earth, rock, unclassified)
Shoring (e.g., raking shores, dead shores, flying shores)
Temporary support (e.g., trench sheeting, wailings and struts, trench boxes, raking, dead and flying shores)
Slope stability

*Dewatering*

Pumping (e.g., centrifugal pumps, displacement pumps, submersible pumps, air-lift pumps)
Evaporation (filter presses, drying beds, sludge lagoons)
Disposal of water (e.g., removal of solids, evaporation, sewerage systems, watercourses)
Water cut-off (e.g., grouting)

*Substructures*

Shallow foundations (e.g., strip, pad, raft)
Deep foundations (e.g., piles, mini-piles, pile walls, diaphragm walls, caissons)

LO2  **Discuss the civil engineering technologies associated with road and bridge construction**

*Roads and highways*

Traffic loads (e.g., class of highway)
Geotechnical parameters
Culverts
Subgrade strengthening (e.g., compaction, subsoil drainage, stabilisation)
Flexible paving (e.g., materials, wearing course, base course, sub-base, capping layer)
Rigid paving (e.g., reinforced, unreinforced, expansion joints)
Edging and kerbs
Drainage (e.g., gullies, drains, manholes, soakaways, retention ponds)

**Bridges**
Bridge types (e.g., beam, truss, cantilever, arch, tied arch, suspension, cable stayed)
Road bridges and overpasses
Rail bridges
Bridge elements (e.g., piers, pier caps, pilings, arches, bearings, abutments, decking)

**LO3** Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality

**Environment**
Materials (e.g., material selection, supply chain, transport)
Construction method and impact

**Structural**
Effectiveness of structural solution
Alternative solutions

**Economic**
Construction cost
Maintenance cost

**Quality**
Addressing client needs
Meeting regulatory requirements
Ensuring health and safety
Professional bodies (e.g., code of conduct, code of practice)
LO4 **Present a design proposal for a new infrastructure project**

*Client brief*
- Project type
- Stakeholder need
- Budget

*Feasibility*
- Geotechnical conditions
- Site access
- Structural requirements
- Environmental impact

*Initial design*
- Structural solution
- Material selection

*Initial cost estimate*
- Material costs
- Labour costs
- Plant costs

*Health and safety*
- Method statements
- Risk assessments
- Building regulations

*Presentation*
- Graphical material (e.g., drawings, photographs, charts)
- Written material (e.g., reports, specifications)
- Presentation type (e.g., report, audio-visual)
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain the methods and techniques used in civil engineering for earthworks and substructures</td>
<td><strong>P1</strong> Discuss earthworks and dewatering activities, equipment and techniques.</td>
<td><strong>M1</strong> Compare the effectiveness of different dewatering techniques in civil engineering.</td>
</tr>
<tr>
<td><strong>LO2</strong> Discuss the civil engineering technologies associated with road and bridge construction</td>
<td><strong>P3</strong> Identify the key factors that inform the design of roads, highways and overpasses.</td>
<td><strong>M2</strong> Assess the performance of rigid and flexible paving systems for road and highway design.</td>
</tr>
<tr>
<td><strong>LO3</strong> Evaluate the way a given civil engineering project addresses issues related to the environment, structural requirements, economics and quality</td>
<td><strong>P5</strong> Explain the construction method of a given civil engineering project.</td>
<td><strong>M3</strong> Analyse the relationship between environmental, structural and economic responses in a given civil engineering project.</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a design proposal for a new infrastructure project</td>
<td><strong>P7</strong> Identify the key stakeholders for an infrastructure project.</td>
<td><strong>M4</strong> Evaluate health and safety method statements and risk assessments for a new infrastructure proposal.</td>
</tr>
<tr>
<td><strong>P8</strong> Present a civil engineering design proposal for a new infrastructure project, including feasibility, cost and health and safety.</td>
<td><strong>P6</strong> Discuss how a given civil engineering project addresses environmental, structural, economic, quality and risk issues.</td>
<td></td>
</tr>
</tbody>
</table>

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Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite
Issue 2 – December 2022 © Pearson Education Limited 2022

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Recommended Resources

Print resources

Web resources
https://bit.ly/3I8DE00  ICE Virtual Library
(General Reference)

https://bit.ly/3fsrTP1  Institution of Civil Engineers
(Professional Body)

(General Reference)

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 8: Mathematics for Construction
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 21: Geotechnics & Soil Mechanics
- Unit 26: Digital Applications for Building Information Modelling
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 41: Highway Engineering
- Unit 42: Hydraulics
- Unit 47: Advanced Building Information Modelling.
### Unit 18: Principles of Electrical Design & Installation

| Level:      | 4       |
| Credits:   | 15      |
| Ofqual Code: | Y/618/8098 |

#### Introduction

While people have studied electricity since the 17th century and have had an awareness of the phenomenon as early as the 3rd millennium BCE, it was the 20th century that saw the rapid expansion of electrical devices and installation that has defined modern society. No longer limited to the presence of natural light, we are able to work, play and enjoy activities at any time. The availability of electrical current, to almost any location, has also led to a proliferation of devices that make many previously mundane tasks simple.

This unit aims to give students a broad understanding of electrical machines, distribution of electric energy and lighting design basics. Students will develop the skills needed to design simple electrical and lighting installations in compliance with relevant legislation and standards.

#### Learning Outcomes

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

- **LO1** Discuss the fundamentals of electricity, magnetism, transformers and circuits
- **LO2** Analyse the performance, operation and control of AC and DC motors
- **LO3** Explain the different methods of electricity generation and distribution
- **LO4** Present a proposal for a non-domestic lighting installation in a given project.
Essential Content

LO1 Discuss the fundamentals of electricity, magnetism, transformers and circuits

*Magnetic circuits*
- Magnetic flux
- Magnet types (e.g., permanent, electromagnet)
- Magnetic cores (e.g., ferromagnetic materials)
- Uses of magnetic circuits (e.g., motors, generators, relays)

*Transformers*
- Real vs ideal transformers
- Law of induction
- Construction (e.g., cores, windings, cooling, insulation)

*Electric circuits*
- Electrical field
- Movement of charge
- Electrical current (e.g., alternating, direct)
- Resistance
- Ohm’s Law
- Series circuits
- Parallel circuits
- Combination circuits

LO2 Analyse the performance, operation and control of AC and DC motors

*DC motors*
- Components (e.g., stator, armature, rotor, brushes)
- Lorentz force law
- Types (e.g., series, permanent magnet, shunt/parallel, compound)
- Operation and applications
**AC motors**
Components (e.g., alternator, stator, rotor, enclosure)
Types (e.g., brushless, induction, synchronous, shaded-pole)
Phases (single-phase motors, 2-phase motors, 3-phase motors)
Operation and applications

**AC motor advantages**
Long lifespan (durability)
Multi-phase configurations (e.g., can use mains current)
Produces less heat
Typically, more powerful (good for higher power applications)

**AC motor disadvantages**
Typically, larger, less applicable to portable systems
Requires higher startup current

**DC motor advantages**
Simple installation
Better speed control
Low maintenance
Produces less electromagnetic interference
Fast response (start/stop/acceleration)
Can run on battery power

**DC motor disadvantages**
Less efficient
Typically, more expensive
Higher failure rate (brushed type)
Cannot use mains electricity directly (requires transformer)

**Selection criteria**
Input power source
Environment (e.g., dry or wet, clean or dusty, ambient temperature)
Performance required (e.g., constant speed, torque output required, maintenance cycle)
LO3  **Explain the different methods of electricity generation and distribution**

*Types of electrical load*
- Resistive
- Inductive
- Capacitive

*Calculations for assessing electrical load*
- Commercial electrical load
- Domestic electrical load

*Generation and distribution*
- Non-renewable generation (e.g., coal, gas, nuclear)
- Renewable generation (e.g., solar, wind, hydro, wave)
- Transmission (e.g., overhead lines, underground lines)
- Substations (e.g., transformers, step-down)
- Consumer units

*Uninterruptible Power Supply (UPS)*
- Types (e.g., offline/standby, line-interactive, online/double-conversion)
- Batteries (e.g., battery types, series-parallel, testing)
- Uses (e.g., commercial, industrial, residential)

LO4  **Present a proposal for a non-domestic lighting installation in a given project**

*Project type (e.g., commercial, industrial, multi-occupancy residential)*

*Lighting requirements*
- Room types
- Lighting levels
- Lumens, candela, flux

*Lamps and luminaries*
- Incandescent
- Fluorescent (including compact fluorescent)
- Halogen (including tungsten halogen)
Mercury vapour
Metal halide
Sodium vapour (including high pressure and low pressure)
Light Emitting Diode (LED)

_Selection and specification of lamps and luminaries_
Lamp type and application
Lamp type and output
Lamp type and operational lifespan
Lamp type and energy consumption

_General and emergency lighting installations_

_Contracts_
Consultancy
Sub-contracts
Management
Installation
Maintenance

_National and local regulations_
Health and safety legislation
Installation safety and service safety (e.g., clothing, insulated matting, insulated tools, earthing, detection equipment)
Operational safety requirement (e.g., fuses, residual current devices)
Building regulations (including conservation of fuel and power)

_Installation testing and commissioning_
Certification
Sign-off
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Discuss the fundamentals of electricity, magnetism, transformers and circuits</td>
<td><strong>P1</strong> Explain the performance of electrical and magnetic circuits, including transformers. <strong>P2</strong> Illustrate the key principles of parallel and series circuits.</td>
<td><strong>M1</strong> Design a simple electrical circuit for a given non-domestic building. <strong>D1</strong> Evaluate the use of electrical or magnetic circuits for a given range of non-domestic applications.</td>
</tr>
<tr>
<td><strong>LO2</strong> Analyse the performance, operation and control of AC and DC motors</td>
<td><strong>P3</strong> Analyse the principles that underpin the operation and control of AC and DC motors. <strong>P4</strong> Calculate the performance of given AC and DC motors.</td>
<td><strong>M2</strong> Select a motor, based on performance needs, for a given non-domestic application. <strong>D2</strong> Assess the suitability of AC and DC motors for a given non-domestic context.</td>
</tr>
<tr>
<td>Pass</td>
<td>Merit</td>
<td>Distinction</td>
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<tr>
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</tr>
<tr>
<td><strong>LO3</strong> Explain the different methods of electricity generation and distribution</td>
<td><strong>P5</strong> Discuss different methods of electricity generation.</td>
<td><strong>M3</strong> Calculate the electrical load for a given non-domestic building to enable selection of a suitable distribution panel.</td>
</tr>
<tr>
<td><strong>P6</strong> Describe the equipment used for different methods of electrical distribution.</td>
<td><strong>M4</strong> Illustrate circuits and distribution for a non-domestic lighting design proposal.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Present a proposal for a non-domestic lighting installation in a given project</td>
<td><strong>P7</strong> Present a proposal for non-domestic lighting installation, including calculations to support design, selection of equipment and energy consumption for a given project.</td>
<td></td>
</tr>
<tr>
<td><strong>P8</strong> Discuss strategies to ensure health and safety during installation and operation of a non-domestic electrical installation.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Recommended Resources**

**Print resources**


**Links**

This unit links to the following related units:

- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 8: Mathematics for Construction
- Unit 15: Principles of Alternative Energy
- Unit 34: Further Mathematics for Construction
- Unit 49: Advanced Electrical Design & Installation.
Introduction

Buildings, bridges, roads and many other types of man-made structures are critical to the economic and social wellbeing of our society. We rely on these structures to provide us with suitable spaces and infrastructure to support our daily lives. In this unit, students will explore the fundamental principles of structural design, codes of practice and standards required to construct safe, effective static structures commonly used in today's building and infrastructure projects.

Topics included in this unit are: methods and techniques used to determine bending moments and shear forces in simply supported steel and reinforced concrete beams; deflection in simply supported steel beams; axial load carrying capacity of steel and reinforced concrete columns.

On successful completion of this unit, students will be able to determine and analyse forces within fixed structures and understand the fundamental concepts of structural design.

Learning Outcomes

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

LO1 Calculate bending moments and shear forces for simply supported steel and concrete beams

LO2 Determine deflection for different types of beams and loading conditions

LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns

LO4 Explore design methods for steel, reinforced concrete beams and columns.
Essential Content

**LO1** Calculate bending moments and shear forces for simply supported steel and concrete beams

*Loading*
Dead loads
Live loads
Wind loads
Point loads
Uniformly distributed loads

*Elasticity and plasticity of common construction materials*
Factors of safety
Building regulations
Health and safety regulations

*Bending moments*
Bending moment diagrams

*Shear forces*
Shear force diagrams

**LO2** Determine deflection for different types of beams and loading conditions

*Types of beam*
Simply supported
Cantilevered
Continuous
Fixed

*Loading conditions*
Uniformly distributed loads
Point loads
Deflection
Unit of deflection
Cantilever deflection
Simply supported deflection

LO3 Calculate the axial load carrying capacity of steel and reinforced concrete columns

Axial loading
Steel columns
Reinforced concrete columns
Foundations

Slenderness ratio

Effective length

Material properties

Corrosion resistance

Weathering

LO4 Explore design methods for steel, reinforced concrete beams and columns

Limit state design

Steel
Beam design and selection
Column design and selection

Reinforced concrete
Beam design and selection
Column design and selection
Building Information Modelling (BIM) for structures

Collaboration (e.g., roles, workflows, professional relationships)

Coordination (e.g., information coordination, information sharing, clash detection)

Common Data Environment
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Calculate bending moments and shear forces for simply supported steel and concrete beams</td>
<td><strong>P1</strong> Determine the following by calculations and diagrams: bending moments and shear force in simply supported steel beams with point loads and uniformly distributed loads.</td>
<td><strong>M1</strong> Produce valid factors of safety for live loads, dead loads and imposed loads, using current codes of practice and building regulations. <strong>D1</strong> Evaluate how maximum bending moments determine steel beam selection, using current codes of practice and approved documents in terms of economics and safety.</td>
</tr>
<tr>
<td><strong>P2</strong> Discuss the statutory requirements to ensure safety in structural designs.</td>
<td><strong>M2</strong> Analyse different support methods and their effect on deflection in fixed structures.</td>
<td><strong>D2</strong> Assess the most effective support method for a given scenario, in terms of ease and speed of construction, economics, safety and environmental factors.</td>
</tr>
<tr>
<td><strong>LO2</strong> Determine deflection for different types of beams and loading conditions</td>
<td><strong>P3</strong> Calculate the deflection for different types of beam under different loading conditions. <strong>P4</strong> Explain how deflection in beams affects structural stability.</td>
<td><strong>M3</strong> Analyse the load-carrying capacity, size, weight and corrosion resistance properties of different materials used for beams and columns in fixed structures.</td>
</tr>
<tr>
<td><strong>LO3</strong> Calculate the axial load carrying capacity of steel and reinforced concrete columns</td>
<td><strong>P5</strong> Describe the concepts of slenderness ratio and effective length. <strong>P6</strong> Determine the axial load-carrying capacity of steel columns and reinforced concrete columns.</td>
<td><strong>M4</strong> Evaluate the use of an alternative material in achieving a design solution, discussing the benefits or challenges associated with it. <strong>D3</strong> Assess the use of Building Information Modelling in the production of accurate structural design information and the collaborative environment of structural design.</td>
</tr>
<tr>
<td><strong>LO4</strong> Explore design methods for steel, reinforced concrete beams and columns</td>
<td><strong>P7</strong> Develop a design solution, including beam design and column design, for a given scenario. <strong>P8</strong> Produce drawings and specifications in support of a structural design solution.</td>
<td><strong>M4</strong> Evaluate the use of an alternative material in achieving a design solution, discussing the benefits or challenges associated with it. <strong>D3</strong> Assess the use of Building Information Modelling in the production of accurate structural design information and the collaborative environment of structural design.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


MOSLEY, W., HULSE, R., BUNGEY, J. (2012), *Reinforced Concrete Design*, Macmillan International Higher Education


Web resources

https://bit.ly/3BVZZ7y  Chartered Institution of Civil Engineering Surveyors
(Professional Body)

https://bit.ly/3fsrTP1  Institution of Civil Engineers
(Professional Body)

https://bit.ly/3ri3WrR  International Association for Bridge and Structural Engineering
(Professional Body)

https://bit.ly/3fbUjwj  The Institution of Structural Engineers
(Professional Body)
Links
This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 34: Further Mathematics for Construction
- Unit 35: Sustainable Methods of Construction
- Unit 41: Highway Engineering
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.
Introduction

The construction of buildings and infrastructure involves many different types of work and many different people. The skills required to successfully manage the diverse groups of people on a building site, and to monitor and assess their work, is critical to both the success of the project and the safety of those working on the project.

Topics covered in this unit include: reviewing construction information; monitoring quality; identifying and notifying of defects; site safety regulations; health and safety regulations; people management; performance management; site meetings; contractor and sub-contractor relations.

In this unit, students will develop the skills and techniques needed to manage the people and processes of a building site, ensuring the quality of work, safe working practices and the interactions of different ‘trades’.

Learning Outcomes

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

LO1 Review construction information to determine quality requirements
LO2 Illustrate the ways in which monitoring of construction projects ensures quality and safety
LO3 Explain the different stages in the management of a construction project
LO4 Discuss methods for assessing and improving the performance of site staff.
Essential Content

LO1 **Review construction information to determine quality requirements**

*Construction information*
Drawings
Specifications
Schedules
Building Information Modelling (BIM)

*Managing quality*
Client requirements
Building regulations
Health and safety regulations
Professional code of conduct

LO2 **Illustrate the ways in which monitoring of construction projects ensures quality and safety**

*Site visits and evaluation*
Patent defects
Latent defects
‘Walking the site’
Identifying defects
Recording defects
Notifying defects

*On-site testing/off-site testing*
Prototypes
Mock-ups
Testing facilities
Quality certification systems
Quality control responsibilities
Architect/designer
Civil engineer
Clerk of works
Client
Contractors/sub-contractors
Site staff

LO3 Explain the different stages in the management of a construction project

Construction design management
Client responsibilities
Professional responsibilities
Information recording and sharing

Statutory health and safety requirements
Site safety monitoring
Responsibilities
Notifications

Risk assessment and management

Construction project management principles
Project execution plan
Procurement route and contract
Risk management
Value management
Cost management and payment validation
Monitoring programme and costs
Resource management (e.g., materials, plant, labour)
Client reporting
Managing handover and occupation
LO4 Discuss methods for assessing and improving the performance of site staff

Working relationships
Effective communication
Motivation
Managing conflict
Managing change
Equality and diversity

Performance monitoring and evaluation
Supervision and supervisors
Target setting
Review
Self-evaluation
Supervisor evaluation
Peer evaluation
Training and development needs
Improving safety and reducing risk

Site manager responsibilities
Leadership techniques
Identifying staff training needs
Training and development planning
Continuing Professional Development (CPD)
<table>
<thead>
<tr>
<th>LO1</th>
<th>Review construction information to determine quality requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Document the quality requirements for a given project through the review of drawings, specifications and schedules.</td>
</tr>
<tr>
<td>P2</td>
<td>Explore the relationship between project quality requirements and statutory requirements.</td>
</tr>
<tr>
<td>M1</td>
<td>Assess the impact of changes to project quality that are necessary to meet statutory requirements.</td>
</tr>
<tr>
<td>D1</td>
<td>Evaluate the relationship between client requirements, statutory requirements and addressing defects with regard to the impact on quality and safety.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO2</th>
<th>Illustrate the ways in which monitoring of construction projects ensures quality and safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3</td>
<td>Discuss the role of site visits in monitoring progress and quality in construction projects.</td>
</tr>
<tr>
<td>P4</td>
<td>Describe the purpose of on-site testing of materials, components and systems.</td>
</tr>
<tr>
<td>M2</td>
<td>Analyse the difference between patent and latent defects and their associated implications for remedial actions.</td>
</tr>
<tr>
<td>D2</td>
<td>Evaluate the impact of health and safety violations on construction projects.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO3</th>
<th>Explain the different stages in the management of a construction project</th>
</tr>
</thead>
<tbody>
<tr>
<td>P5</td>
<td>Describe the key principles of construction project management.</td>
</tr>
<tr>
<td>P6</td>
<td>Discuss the importance of construction design management for ensuring site safety.</td>
</tr>
<tr>
<td>M3</td>
<td>Compare different techniques for planning and managing resources.</td>
</tr>
<tr>
<td>D2</td>
<td>Evaluate the impact of health and safety violations on construction projects.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LO4</th>
<th>Discuss methods for assessing and improving the performance of site staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>P7</td>
<td>Describe the methods for assessing the performance of team members.</td>
</tr>
<tr>
<td>P8</td>
<td>Discuss the importance of equality and diversity on company/team performance.</td>
</tr>
<tr>
<td>M4</td>
<td>Propose training and development strategies to improve team performance.</td>
</tr>
<tr>
<td>D3</td>
<td>Analyse the relationship between performance management and health and safety legislation.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
BARBER, J. (2002), *Health and Safety in Construction*, Thomas Telford

Web resources
https://bit.ly/3i91LdB  Chartered Institute of Building
(Professional Body)

(Professional Body)

https://bit.ly/3i8sirw  Chartered Institute of Personnel and Development
(Professional Body)
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 8: Mathematics for Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 29: Contracts & Management
- Unit 30: Project Management
Unit 21: Geotechnics & Soil Mechanics

Level: 4
Credits: 15
Ofqual Code: L/618/8101

Introduction

This unit explores the essential relationship between the things we construct and the capacity of the ground to support these constructions. The ability to understand, analyse and develop solutions related to soil and rock is a key aspect of the design and construction of buildings and infrastructure.

Topics included in this unit are: rock type; soil description and classification; methods and techniques used when undertaking site investigations and laboratory testing; determination of soil properties; the importance of these geotechnical procedures and resultant findings to civil engineers.

On successful completion of this unit, students will be able to analyse and evaluate modern geotechnical methods and apply these skills and knowledge to the initial design of infrastructure.

Learning Outcomes

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

LO1 Discuss rock types, their formation and uses in civil engineering and building projects
LO2 Explain the description and classification of soils using current codes of practice
LO3 Analyse soil properties determined by geotechnical procedures
LO4 Produce proposals to address identified geotechnical weaknesses and problems.
**Essential Content**

**LO1** Discuss rock types, their formation and uses in civil engineering and building projects

*Rock types, formation, and classification*
- Types (e.g., igneous, sedimentary, metamorphic)
- Formation (e.g., lithification, crystallisation and fractional crystallisation)
- Classification systems

*Weathering and weathering processes*
- Physical (e.g., freeze-thaw, exfoliation)
- Chemical (e.g., rainwater reactions, clays, soluble salts)
- Biological (e.g., trees, roots, animals, algae, lichen, bacteria)

*Discontinuous nature of rock mass*
- Mechanical vs Integral discontinuity
- Types of discontinuity (e.g., bedding, schistosity, foliation, joint, cleavage, fracture, fissure, folds, faults)

*The use of rock in civil engineering and construction*
- Foundations
- Walls and retaining walls
- Bridge piers and abutments
- Cement and mortars
- Erosion protection
- Filtration
- Pavements, roads
- Flooring, cladding, tiles

*Uncemented sediments*
- Earthen dams
- Railway ballast
- Fill materials
- Concrete aggregates
- Other
LO2  **Explain the description and classification of soils using current codes of practice**

*Soil sampling*

*Types of sampling (e.g., disturbed, undisturbed)*

*Soil types*

Very coarse (e.g., boulders, cobbles)
Coarse (e.g., sand, gravel)
Fine (e.g., clays, silts)
Organic (e.g., organic clay, sand, silt, peat)
Other (e.g., calcareous, plastic, sediments)

*Soil description and classification*

*Soil analysis*

Particle analysis (e.g., sieve, hydrometer)
Particle size distribution
Soil specific gravity
Soil plasticity index

LO3  **Analyse soil properties determined by geotechnical procedures**

*Shear strength*

Cohesion
Internal friction and angle of internal friction
Mohr’s Circle of Stress
Coulomb’s Strength Theory
Tests (e.g., direct shear, triaxial compression, unconfined compression, vane shear)
Stages (e.g., consolidation stage, shear stage)
Tests based on drainage conditions
Compressibility and consolidation
Stages (e.g., initial, primary, secondary)
Moisture content (e.g., effect on compression/compaction, effect on bearing capacity)

Soil density
Bulk density
Dry density
Density of solids
Saturated density
Submerged density
Density index
Moisture content
Void ratio

Liquid and plasticity indices
Atterberg limits test

California bearing ratio (CBR)

LO4 Produce proposals to address identified geotechnical weaknesses and problems

Project type (e.g., building, infrastructure)

Embankment design
Shear strength
Soil compaction
Road requirements
Rail requirements

Foundation design
Loading
Foundation type (e.g., pad, piling, strip, deep strip, raft)
Soil compressibility
Liquid and plasticity indices
Bearing capacity
**Highway design**
Highway/road type (e.g., residential, industrial, motorway)
Paving type (e.g., flexible, rigid)
California bearing ratio

**Health and safety requirements**
Site safety
Temporary works safety
Incident reporting
Certification
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Discuss rock types, their formation and uses in civil engineering and building projects</td>
<td><strong>P1</strong> Explain rock type formation and classification.</td>
<td><strong>M1</strong> Analyse the use of rock and uncemented sediments in civil engineering and building projects.</td>
</tr>
<tr>
<td><strong>P2</strong> Analyse the discontinuous nature of rock mass and the impact of weathering.</td>
<td><strong>P2</strong> Analyse the discontinuous nature of rock mass and the impact of weathering.</td>
<td><strong>P2</strong> Analyse the discontinuous nature of rock mass and the impact of weathering.</td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the description and classification of soils using current codes of practice</td>
<td><strong>P3</strong> Discuss the description and classification of soils based on particle size, specific gravity and plasticity indices, using current codes of practice.</td>
<td><strong>M2</strong> Analyse methods and techniques used in soil sampling and site investigation.</td>
</tr>
<tr>
<td><strong>P4</strong> Describe the processes and techniques used in soil sampling and site investigation.</td>
<td><strong>M2</strong> Analyse methods and techniques used in soil sampling and site investigation.</td>
<td><strong>M2</strong> Analyse methods and techniques used in soil sampling and site investigation.</td>
</tr>
<tr>
<td><strong>LO3</strong> Analyse soil properties determined by geotechnical procedures</td>
<td><strong>P5</strong> Explain different types of analysis used to measure soil properties.</td>
<td><strong>M3</strong> Evaluate results from soil properties testing.</td>
</tr>
<tr>
<td><strong>P6</strong> Analyse soil properties, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, and California bearing ratio.</td>
<td><strong>P6</strong> Analyse soil properties, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, and California bearing ratio.</td>
<td><strong>P6</strong> Analyse soil properties, including moisture content, density, specific gravity, shear strength compressibility, liquid and plasticity indices, and California bearing ratio.</td>
</tr>
<tr>
<td><strong>LO4</strong> Produce proposals to address identified geotechnical weaknesses and problems</td>
<td><strong>P7</strong> Identify geotechnical weaknesses and issues for a given site.</td>
<td><strong>M4</strong> Justify the approach to a design proposal in meeting identified geotechnical weaknesses.</td>
</tr>
<tr>
<td><strong>P8</strong> Present design proposals to address geotechnical problems for a given site.</td>
<td><strong>P8</strong> Present design proposals to address geotechnical problems for a given site.</td>
<td><strong>P8</strong> Present design proposals to address geotechnical problems for a given site.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
GRIBBLE, C., MCLEAN, A. (2017), *Geology for Civil Engineers*, CRC Press

Web resources
https://bit.ly/3i91LdB  Chartered Institute of Building
(Professional Body)

(General Reference)

https://bit.ly/3fsrTP1  Institution of Civil Engineers
(Professional Body)

https://bit.ly/3zMLmRZ  Thomas Telford
(General Reference)

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 41: Highway Engineering
- Unit 42: Hydraulics.
Unit 22: Scientific Principles for Building Services

Level: 4
Credits: 15
Ofqual Code: R/618/8102

Introduction

Building services engineering is based on the application of scientific principles, requiring an understanding of key mathematical formulae.

In this unit, students will develop an understanding of the scientific principles and mathematical concepts necessary to design and specify building services plant and equipment. Covering areas such as heat transfer, fluid flow, acoustics electrical networks and control systems, students will consider the way in which scientific principles underpin our understanding of the relationship between building services and human comfort.

By the end of this unit, students will have a grounding in the application of scientific principles in relation to the design and specification of building services, and an understanding of how these services are employed to support human activity with buildings.

Learning Outcomes

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

LO1 Calculate energy transfer rates in different building services contexts
LO2 Evaluate conditions of static and dynamic fluid flow to determine energy loss
LO3 Design electrical circuits for single-phase AC networks
LO4 Determine the effects of sound and vibration related to building services and human comfort.
Essential Content

LO1 Calculate energy transfer rates in different building services contexts

Heat transfer
Conduction
Convection
Radiation (e.g., black body, grey body)
Evaporation
Stefan's Constant
Insulated surfaces
Insulation and cost
Condensation risk (e.g., surface, interstitial)
Temperature gradients

Thermal comfort
Physiological factors
Psychological factors
Thermal indices
Predicting thermal comfort
Assessing thermal comfort
Reliability of design criteria

Calculations
Heat transfer rates through structure (e.g., composite structures, pipes and ducts, complex structures, thermally bridged structures, thermal conductivity, heat transfer coefficients)
Heat conduction rates (e.g., using star thermal resistance networks, using delta thermal resistance networks)
LO2 **Evaluate conditions of static and dynamic fluid flow to determine energy loss**

*Fluid flow*
Parameters (e.g., pressure, velocity, density, mass and volume, flowrate, viscosity, temperature)
Laminar flow
Turbulent flow
Boundary separation and transition
Reynolds number
Moody charts
Uniform and steady flow
Continuity of flow
Conservation of energy
Bernoulli’s equation
Volume and mass transfer
Measurement of fluid flow rates (e.g., Venturi meter, orifice plate, pitot-static tubes)

*Energy losses*
Frictional losses (e.g., in pipe networks, in duct networks)
Frictional coefficients
Zeta factors
Velocity pressure factors
Static regain in expansion equipment
Gravitational flow in flooded and partially flooded conduits (e.g., guttering, channels, drainage pipes and soil/waste stacks)
Formulae (e.g., Manning, Reynolds number, Crimp and Bruges, Darcy-Weisback, Chezy)
LO3 **Design electrical circuits for single-phase AC networks**

*Non-resonant circuits*
- Series
- Parallel and complex networks
- Resistance
- Capacitance and inductance
- Reactance and impedance
- Potential difference
- Current flow in non-resonant circuits and single-phase AC circuits
- Power factor
- True, reactive and apparent power
- Heating and magnetic effects of electric currents.

*Resonant circuits*
- Definition of circuit resonance
- Circuit conditions at resonance (e.g., coil and capacitor in series or parallel, resonant frequency, dynamic frequency)

*Power factor correction*
- Capacitance to improve power factor of an inductive load
- Benefits of power factor correction

LO4 **Determine the effects of sound and vibration related to building services and human comfort**

*Effects of sound and vibration*
- Transmission and propagation of sound
- Measurement of sound
- Room acoustics

*Transmission and propagation of sound*
- Sound power
- Frequency spectra (e.g., external sources, internal sources)
- Propagation of acoustic energy
- Sound insulation
- Sound attenuation
**Measurement of sound**

- Decibel scales
- Equivalent continuous noise levels
- Sound power levels (SPL)
- Sound intensity levels (SIL)
- Sound power produced by building services installations

**Room acoustics**

- Background and total sound levels
- Reverberation time
- Sound absorption
- Anti-vibration mountings
<table>
<thead>
<tr>
<th>Learning Outcomes and Assessment Criteria</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Calculate energy transfer rates in different building services contexts</td>
</tr>
<tr>
<td><strong>P1</strong> Determine heat transfer through different forms of composite structure.</td>
</tr>
<tr>
<td><strong>P2</strong> Determine the risk of interstitial condensation in multi-leaf plane structures.</td>
</tr>
<tr>
<td><strong>P3</strong> Calculate conduction rates used in various building services plant and equipment.</td>
</tr>
<tr>
<td><strong>M1</strong> Evaluate the impact of heat transfer on thermal comfort and efficiency of building services plant and equipment.</td>
</tr>
<tr>
<td><strong>D1</strong> Critically evaluate the efficiency of different forms of heat transfer for a given range of heat emitters, plant and equipment.</td>
</tr>
<tr>
<td><strong>LO2</strong> Evaluate conditions of static and dynamic fluid flow to determine energy loss</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss the types of fluid flow, fluid energy and the potential mechanisms of energy loss.</td>
</tr>
<tr>
<td><strong>P5</strong> Calculate the energy loss in pipe and duct networks, using appropriate formulae.</td>
</tr>
<tr>
<td><strong>M2</strong> Analyse the relationship between frictional energy loss under different gravitational flow conditions.</td>
</tr>
<tr>
<td><strong>D2</strong> Critically evaluate fluid flow and energy principles in relation to their application in the design and control of building services engineering.</td>
</tr>
<tr>
<td><strong>LO3</strong> Design electrical circuits for single-phase AC networks</td>
</tr>
<tr>
<td><strong>P6</strong> Discuss the difference between resonant and non-resonant circuits.</td>
</tr>
<tr>
<td><strong>P7</strong> Design resonant and non-resonant circuits, for single-phase AC networks; calculating current flow.</td>
</tr>
<tr>
<td><strong>M3</strong> Compare the effect of varying resistance, capacitance and inductance in parallel and series AC circuits on voltage, resistance and impedance.</td>
</tr>
<tr>
<td><strong>D3</strong> Analyse the methods to improve the power factor of a given circuit.</td>
</tr>
<tr>
<td><strong>LO4</strong> Determine the effects of sound and vibration related to building services and human comfort</td>
</tr>
<tr>
<td><strong>P8</strong> Explain the principles of sound and vibration on room acoustics and their impact on human hearing.</td>
</tr>
<tr>
<td><strong>P9</strong> Determine the transmission paths of sound from building services systems through different forms of structure.</td>
</tr>
<tr>
<td><strong>M4</strong> Assess the potential reduction of sound transmission through insulation and attenuation strategies, based on comparison of results of appropriate calculations.</td>
</tr>
<tr>
<td><strong>D4</strong> Evaluate different forms of anti-vibration mounting to minimise building services acoustic sound power levels.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


Web resources

https://bit.ly/3xirWTC **Building Services Research and Information Association**
(Professional Body)

https://bit.ly/3xbOxB5 **Chartered Institution of Building Services Engineers**
(Professional Body)

(General Reference)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation.
Unit 23: Construction Economics & Sustainability

Level: 4
Credits: 15
Ofqual Code: H/618/8136

Introduction

Construction is both a major influence on, and is influenced by, the economy. The construction sector has considerable impact on local, regional and national economies. However, it is also highly dynamic and responds to fluctuations in broader global economies.

When considering construction economics, we must also consider other factors that will influence the cost and viability of construction projects. Both political and social factors have a role in shaping the way that construction projects can be achieved. Thus, during the planning and execution phases of a project, a quantity surveyor must be aware of and seek to integrate the influence that social, political and economic factors will have on project costs, procurement and design.

Students will gain insight into the ways that political, social and economic factors influence construction. Through this, they will consider the relationship between these factors and how they are reflected in a project and in the broader economy. To integrate this knowledge, students will examine projects to evaluate the way that construction economics, combined with societal and political factors, may influence construction costs and procurement route.

Learning Outcomes

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

LO1 Discuss the political, economic, social and environmental factors that influence the construction industry

LO2 Assess the relationship between economic factors, material and labour costs

LO3 Explore strategies for construction procurement that address economic, social, environmental and political challenges

LO4 Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success.
Essential Content

LO1  Discuss the political, economic, social and environmental factors that influence the construction industry

Construction sector
Supply and demand
Equilibrium
Stakeholders

Political influences
Legislation
Taxation
Tax credits, deductions and subsidies
Political uncertainty

Economic influences
Economic model (e.g., free market economy, command/planned economy)
Investment (e.g., investor types, investment types, return on investment (ROI))
Economic indicators (e.g., GDP, Retail Price Index, manufacturing activity, employment statistics)
Economic subsidies
Market influence (e.g., inflation/deflation, recession/depression)
Interest rates
Regional variations
Profit

Social influences
Demographic changes
Social trends
Attitudes

Environmental influences
Environmental impact (e.g., carbon emissions, materials and scarcity, energy use)
Environmental initiatives (e.g., industry goals, government targets)
LO2 **Assess the relationship between economic factors, material and labour costs**

*Factors influencing material costs*
- Material type (e.g., raw, processed, product)
- Material supply (e.g., local, international, import taxes, tariffs, customs)
- Transport
- Availability (e.g., scarcity, sustainability, renewable)

*Factors influencing labour costs*
- Labour availability (e.g., demographics, trades, professions, skills shortages)
- Labour relations (e.g., unionised labour, casual labour, professionals)
- Labour practices (e.g., working hours, role definitions)

LO3 **Explore strategies for construction procurement that address economic, social, environmental and political challenges**

*Procurement types*
- Traditional
- Design-Build (e.g., single-stage, two-stage)
- Management
- Private Finance Initiative/Public-Private Partnership (e.g., Design-Build-Operate (DBO), Build-Own-Operate-Transfer (BOOT))
- Other (e.g., framework agreements, engineering procurement and construction (EPC), fast-track construction, partnering, prime contracting)

*Procurement in response to*
- Economic factors (e.g., cost, time, ROI)
- Social factors (e.g., stakeholders (individual, public, private, institutional), employment, environmental factors, political factors)
LO4 Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success

*Presentation type*
- Report
- Audio/visual

*Audience*
- Professional
- Non-professional
- Peer

*Project/development type*
- Residential
- Commercial
- Institutional

*Procurement*
- Procurement route
- Contract type

*Drivers/influences*
- Economic
- Political
- Social
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Discuss the political, economic, social and environmental factors that influence the construction industry</td>
<td><strong>P1</strong> Explain the ways that economic models may influence construction projects. <strong>M1</strong> Analyse the impact of the economic ‘market’ on construction costs.</td>
<td><strong>D1</strong> Critically evaluate the ways that global economics influences construction.</td>
</tr>
<tr>
<td><strong>LO2</strong> Assess the relationship between economic factors, material and labour costs</td>
<td><strong>P3</strong> Review a set of general arrangement drawings, selected details and door/window schedules to determine the factors that influence material and labour costs. <strong>P4</strong> Produce an outline bill of quantities related to a given project. <strong>M2</strong> Compose a Schedule of Works.</td>
<td><strong>D2</strong> Critically analyse the dynamic relationships between material and labour costs with inflation.</td>
</tr>
<tr>
<td><strong>LO3</strong> Explore strategies for construction procurement that address economic, social, environmental and political challenges</td>
<td><strong>P5</strong> Discuss the ways that different procurement routes respond to social, political, and economic drivers. <strong>P6</strong> Examine the relationship between procurement route and sustainability.</td>
<td><strong>M3</strong> Analyse the influence of government policy on the procurement route for public projects.</td>
</tr>
<tr>
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<tr>
<td><strong>LO4</strong> Present an analysis of an existing or proposed development in relation to the economic, social and political factors influencing its success</td>
<td><strong>P7</strong> Examine the ways in which a construction project responds to political, social and economic influences. <strong>M4</strong> Justify an approach to presenting project analysis in meeting audience needs.</td>
<td><strong>D3</strong> Present a critique of a project's procurement route in response to political, social and economic drivers.</td>
</tr>
<tr>
<td><strong>P8</strong> Present the outcomes of the analysis of a construction project.</td>
<td></td>
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</tr>
</tbody>
</table>
Recommended Resources

Print resources
GRUNEBERG, S., FRANCIS, N. (2019), The Economics of Construction, (Economics of Big Business), Agenda Publishing
MCDONOUGH, W., BRAUNGART, M. (2010), Cradle to Cradle: Remaking the Way We Make Things, North Point Press
MYERS, D. (2016), Construction Economics, Taylor & Francis

Web resources
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 25: Quantity Surveying Practice
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 54: Advanced Quantity Surveying Practice.
Unit 24: Principles of Off-site Construction

Level: 4
Credits: 15
Ofqual Code: Y/618/8103

Introduction

Construction in the 21st century is (in most cases) still carried out along the same principles as medieval construction. Large amounts of material are delivered to a building site where weather conditions and physical constraints can cause not just delays and defects but often unattractive working conditions. Off-site construction offers a range of potential benefits for increasing the efficiency, accuracy and quality of the end product.

In this unit, students will explore different approaches to off-site construction, focusing on building development and delivery. This includes modular construction, factory construction, automation and robotics, and 3D printing. Students will consider the way in which off-site processes and technologies may influence building design and delivery.

By the end of this unit, students will be able to assess potential options for off-site production and develop design and manufacturing strategies to enable building delivery.

Learning Outcomes

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

LO1 Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery

LO2 Explore the ways that design is influenced by different forms of off-site construction

LO3 Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery

LO4 Present a proposal for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery.
Essential Content

LO1 Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery

Forms of off-site construction
Component based
Panelised
Unit based

Delivery benefits
Affordability
Sustainability
Reduced material waste
Reduced material transport cost
Better building fabric control/tolerance

Production benefits
Quality control
Speed and efficiency of manufacture and assembly
Factory controlled working conditions
Health and safety
Economies of scale (e.g., labour, plant hire, material, waste, purchasing)
Automation

LO2 Explore the ways that design is influenced by different forms of off-site construction

Non-volumetric pre-assembly
Pre-assemble units/elements
Pre-assembled cladding panels
Precast concrete sections
Pre-assemble structural steelwork
**Volumetric pre-assembly**
Complete volumetric units
Factory finished units (e.g., bathroom pods, kitchen pods, plant rooms, etc.)
3-D printing

**Volumetric modular units**
Cross Laminated Timber (CLT)
Steel Framing Systems (SFS)
Re-purposing other modular units (e.g., grain silos, shipping containers)

**Panelised off-site construction**
Timber framed panels
Steel framing systems
Sandwich panel systems
Pre-cast concrete panels/sections

**LO3** Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery

**Efficiency**
Time on-site
Consistent and controlled quality
Economies of scale (e.g., labour, materials, purchasing)
Waste minimisation
Safety (e.g., better control of working conditions, limited time on-site)

**Sustainability**
Social (e.g., responding to changing demographics, flexibility of building use)
Economic (e.g., potential for lower building cost, better building fabric resulting in lower operating costs)
Environmental (e.g., reduced carbon emissions, reduced transport, more efficient use of materials)
Cultural
Cost of delivery
Potential benefits of offsite construction
Speed of delivery
Reduced time and labour on-site
Economies of scale
Economies of multi-skilled labour
Potential challenges of offsite construction
Future labour shortage (growing skills gaps)
Factory set-up costs (e.g., location, access to labour)

LO4 Present a proposal, for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery

Proposal
Site information
Site type (e.g., greenfield, brownfield, rural, urban)
Off site method (e.g., component-based, panelised, unit-based)
Justification
Quality
Efficiency
Cost

Presentation of proposal
Research
Proposal
Drawings (e.g., sketches, diagrams, technical information)
Data
Presentation type (e.g., audio-visual, written report, etc.)
Audience (e.g., specialist, non-specialist)
Feedback/reflection
## Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain the different forms of off-site construction and how they provide potential benefits for building production and delivery</td>
<td><strong>P1</strong> Explore the different forms of off-site construction.</td>
<td><strong>D1</strong> Critically analyse the way in which a specific off-site construction method will support the achievement of design outcomes and cost-effective production.</td>
</tr>
<tr>
<td><strong>P2</strong> Discuss the benefits of off-site construction for building production and delivery.</td>
<td><strong>M1</strong> Compare the benefits and challenges of different types of off-site construction.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Explore the ways that design is influenced by different forms of off-site construction</td>
<td><strong>P3</strong> Discuss the relationship between design and construction.</td>
<td><strong>M2</strong> Evaluate the merits of a specific method of off-site construction to support a specific design outcome.</td>
</tr>
<tr>
<td><strong>P4</strong> Explore the ways in which specific off-site construction methods may influence design decisions.</td>
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<tr>
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</tr>
<tr>
<td><strong>LO3</strong> Discuss the benefits of a selected off-site construction method or technology in relation to efficiency, sustainability and cost of project delivery</td>
<td><strong>M3</strong> Analyse the relationship between design, efficiency, sustainability and cost for a selected off-site construction method in meeting a given brief.</td>
<td><strong>D2</strong> Evaluate comments and feedback, in response to a presentation, to inform future off-site construction proposals.</td>
</tr>
<tr>
<td><strong>P5</strong> Explore a given brief to select a suitable method of off-site construction. <strong>P6</strong> Discuss how the selected off-site construction method achieves efficiency, sustainability and cost effectiveness for a given brief.</td>
<td></td>
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</tr>
<tr>
<td><strong>LO4</strong> Present a proposal, for off-site construction of a given building type, highlighting the benefits of the method for quality, efficiency and cost of delivery</td>
<td><strong>M4</strong> Justify a position, in response to presentation comments, through the detailed explanation of a strategy.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Prepare research, analysis and information necessary to support a proposal for off-site construction, in response to a given brief. <strong>P8</strong> Present, to a diverse audience, an off-site construction proposal, highlighting the achievement of quality, efficiency and cost effectiveness.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
HAIRSTANS, R. (2017), Building Offsite, ARCA Media
HICKEY, T. (2014), Construction Technology: Designing Sustainable Homes, Gill Education
SINOPOLI, J. (2009), Smart Buildings Systems for Architects, Owners and Builders, Butterworth-Heinemann

Web resources
(General Reference)

https://bit.ly/3l8DEO0 ICE Virtual Library
(General Reference)

(General Reference)

(Professional Body)

(General Reference)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 19: Principles of Structural Design
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling
- Unit 53: Advanced Off-site Construction.
Unit 25: Quantity Surveying Practice

Level: 4
Credits: 15
Ofqual Code: D/618/8135

Introduction

The quantity surveyor plays an important role in the administration of a contract for both the client and the main contractor. The client’s appointed quantity surveyor is often known as the professional quantity surveyor (PQS) as they tend to be chartered. The internationally recognised quantity surveying associations are the Royal Institution of Chartered Surveyors (RICS), Chartered Institute of Building (CIOB) and the Chartered Institution of Civil Engineering Surveyors (CICES), as well as others.

The quantity surveyor plays an important role in the design and construction team. They are involved initially in the client’s feasibility studies when a project requires to be budgeted so that the client is aware of the cost of a project. A design is then produced, based on the feasibility study, and the quantity surveyor supports the tendering and procurement of a main contractor to undertake the work. This may be via the use of a bill of quantities (BoQ) produced by the quantity surveyor or through a specification for the project.

The function of the quantity surveyor then moves on to the construction stage of a project. Here they are involved with the payments made to contractors from the client. This process is known as the valuation of the works and is undertaken on a regular time interval, or pre-determined stages of the project. The quantity surveyor will visit a site, measure the work produced to date and certify a payment for the client to make. Further functions of a quantity surveyor are to formulate the final costs for a client in the form of a final account. This may involve the resolution of any disputes and or claims made by the main contractor to a mutual agreement.
Learning Outcomes

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

LO1 Explain the role of the quantity surveyor

LO2 Explain the activities of a quantity surveyor in the pre-construction phases of a project

LO3 Assess the processes of quantity surveying during the construction phase of a project

LO4 Present a case study that considers the role and activities of a quantity surveyor for a given project.
Essential Content

LO1 Explain the role of the quantity surveyor

Types
Professional quantity surveyor (PQS)
Main contractor’s quantity surveyor
Professional bodies and professional recognition

Advice and guidance provided by quantity surveyor
Financing projects (feasibility)
Procurement routes
Tendering procedures
Contract selection
Main contractor selection recommendations

Administrative responsibilities
Contracts
Budgeting
Cost control

Professional development
Identifying own development needs
Continuing Professional Development (CPD)
Supporting the development of others
Professional bodies and maintaining professional knowledge

Relationship with other professionals
Design team (e.g., architects, interior designers)
Consultants (e.g., engineers, project managers)
Construction team (e.g., contractors, sub-contractors, suppliers)
LO2  **Explain the activities of a quantity surveyor in the pre-construction phases of a project**

*Feasibility*
- Strategic definition (e.g., procurement route selection, main contractor selection)
- Preparation and brief (e.g., financial feasibility of the proposed project)
- Comparison of designs

*Cost value engineering*
- Revision of client’s specifications to suit budgets
- Costing of design revisions
- Reconciliation of value engineering within the overall budget

*Procurement*
- Procurement strategy during project phases (e.g., concept, development, technical design)
- Contract selection
- Change control procedures

*Tendering activities*
- Preparation of documentation (e.g., specifications, contracts)
- Updating information
- Contract documentation (e.g., letters of intent, selection of suitable contracts, completion of contracts for signature by parties, filing and contract administration)
- Contractor selection (e.g., background checks, financial checks, interviews)
- Contractor negotiation and appointment

LO3  **Assess the processes of quantity surveying during the construction phase of a project**

*Financial control*
- Valuations of work to date
- Compilation of financial certificates
- Predicted expenditure
- Valuation of variations
- Measurement against agreed rates
Dispute resolution
Administration of the contract in terms of conditions
Record keeping regarding claims
Site measurements and inspections
Agreement of claims
Resolution of disputes between main contractor and client

Valuations
Monthly valuations
Certification
Measurement of variations
Agreement of quotations

Variations to contract
Acceptance under contract terms
Pricing of variation against bill of quantities (BoQ) or rates
Dayworks
Offsets against contingencies

Final accounts
Omissions and additions account
Adjustment of provisional sums
Adjustment of prime cost sums
Measurement of variations
Calculation of final account sum

LO4 Present a case study that considers the role and activities of a quantity surveyor for a given project

Project type
Building (new or refurbishment)
Civil engineering/infrastructure project

Project budget
Initial client's budget
Revisions to a budget, as required
**Procurement strategy**
Type of procurement
Advantages and benefits of your procurement selection

**Cost control**
Aspects of cost control on your project
Control against the contract sum
Variations and how to accommodate these in final summaries

**Contract administration**
Communications between parties
Valuations and payments
Certification records

**Case-study presentation type**
Report
Audio-visual

**Audience**
Professional
Non-professional
Peer
## Learning Outcomes and Assessment Criteria

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</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Explain the role of the quantity surveyor</td>
<td><strong>M1</strong> Compare the roles of the professional quantity surveyor and the main contractor’s quantity surveyor.</td>
<td><strong>D1</strong> Analyse the professional status of a quantity surveyor in terms of the benefits that it brings to the role.</td>
</tr>
<tr>
<td><strong>P1</strong> Describe the different types of quantity surveyor and their role within a project.</td>
<td><strong>P2</strong> Discuss the way that a quantity surveyor may support a client through contracts and cost management.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the activities of a quantity surveyor in the pre-construction phases of a project</td>
<td><strong>M2</strong> Analyse the interactions between the design team and the quantity surveyor.</td>
<td><strong>D2</strong> Evaluate the role of the quantity surveyor in defining tender and procurement strategies.</td>
</tr>
<tr>
<td><strong>P3</strong> Describe the role of the quantity surveyor in the feasibility stage of a project.</td>
<td><strong>P4</strong> Illustrate ways in which cost control and value engineering contribute to the project budget.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Assess the processes of quantity surveying during the construction phase of a project</td>
<td><strong>M3</strong> Explain the relationship between financial control and valuation.</td>
<td></td>
</tr>
<tr>
<td><strong>P5</strong> Describe the role of the quantity surveyor during the construction phase.</td>
<td><strong>P6</strong> Discuss the contract administration activities of a quantity surveyor during the construction phase.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Present a case study that considers the role and activities of a quantity surveyor for a given project</td>
<td><strong>M4</strong> Explain how a client’s budget for a given project can be controlled.</td>
<td><strong>D3</strong> Evaluate the influence that a quantity surveyor may have on the outcome of a given project, in relation to budget, cost control and administration.</td>
</tr>
<tr>
<td><strong>P7</strong> Discuss the pre contract administration of a given project.</td>
<td><strong>P8</strong> Describe how a given project is financially controlled.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
PITTARD, S., SELL, P. (2017), BIM and Quantity Surveying, Routledge
SEELEY, I. (1997), Quantity Surveying Practice, Macmillan International Higher Education

Web resources

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 23: Construction Economics & Sustainability
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 39: Personal Professional Development
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 54: Advanced Quantity Surveying Practice.
Unit 26: Digital Applications for Building Information Modelling

Level: 4
Credits: 15
Ofqual Code: D/618/8104

Introduction

Building Information Modelling (BIM) and the use of data in the planning, construction and operation of built assets has become commonplace for both large and small projects. The ability to manage projects throughout their lifecycle, using a common data set, has the potential to impact on the built environment in numerous ways such as supporting efficiency, reducing costs and driving sustainability. However, for this to be achieved there is a need for the development of consistent, accurate and accessible data.

While BIM is, effectively, a process of information management through a project lifecycle, it is most often based on the use of digital applications to generate project data. In this, the model is central in the process of designing and producing information that will facilitate construction and, later, the operation of the built asset.

In this unit, students will explore the key processes in using digital applications to produce data and construction information that will enable the BIM process. Through completion of this unit, students may have the opportunity to achieve vendor certification in industry-standard Building Information Modelling systems.

Learning Outcomes

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

LO1 Discuss the role of model data in a BIM-enabled project
LO2 Model and modify common building elements for a given project
LO3 Generate 2D and 3D views of a building model to present key features of a given project
LO4 Assemble construction information using appropriate views, generated within a BIM application, for a given project.
**Essential Content**

**LO1 Discuss the role of model data in a BIM-enabled project**

*Model features*
- Geometric model vs information model
- Parametric modelling
- ‘Intelligent’ models

*BIM project data*
- Project model
- Asset Model
- Common Data Environment
- Collaboration

*Model components*
- Grids
- Levels
- Walls
- Doors
- Windows
- Substructures
- Roofs
- Structural elements
- Mechanical elements
- Tagging and categories

*Model users and contributors*
- Client team
- Design team
- Cost management team (e.g., cost consultant, quantity surveyor)
- Construction team
- Facilities management team
LO2  Model and modify common building elements for a given project

Walls
- Wall structure/layers
- Wall materials
- Wall alignment (e.g., inner face, outer face, centre line, structural face)
- Joining walls (e.g., corner, intersection, ‘T’-joins)

Doors and windows
- Door types
- Window types
- Door and window symbols
- Generating schedules

Stairs
- Stair layouts (e.g., straight, quarter-turn/L-shaped, winders, spiral, half-turn, ‘U-shaped’)
- Stair elements (e.g., riser, tread, nosing, landings, stringers)
- Stair construction (e.g., timber, concrete, steel)
- Railings (e.g., railing material, railing height, building regulation requirements)

Ramps
- Ramp layout (e.g., straight, quarter-turn, half-turn)
- Ramp pitch (e.g., rise vs length, building regulation requirements)
- Ramp construction (e.g., timber, concrete, steel)
- Railings (e.g., railing material, railing height, building regulation requirements)

Floors
- Floor construction (e.g., suspended timber, reinforced concrete, precast panels)
- Floor layers (e.g., structure, finish surface, ceiling below)
- Floor to wall junctions
- Floor openings (e.g., stair openings, ramp openings)
Columns
Column grids
Column type (e.g., steel, reinforced concrete)
Column to floor junction

Structural elements
Columns (e.g., column grids, column construction, column to floor junctions)
Beams (e.g., beam types, materials)
Trusses (e.g., truss types, materials)

Landscape/topography
Site information (e.g., boundaries, contour lines)
Contour heights

Mechanical elements
Plant (e.g., boiler systems, air conditioning/air handling)
Ductwork
Pipework

Modifying common elements
Align
Offset
Mirror
Split (e.g., wall split, floor split)
Move
Copy
Rotate
Trim
Extend (e.g., extend to intersection, extend to corner, extend to boundary)
LO3  Generate 2D and 3D views of a building model to present key features of a given project

View features
Scale
Detail level
Visibility (e.g., background depth/view range, hidden elements, hiding tagged elements/categories, overriding standard visibility settings)
Hiding/isolating elements

View types
Plans (e.g., floor plan, ceiling plan, site plans, cut level above floor, amount of detail to include, visibility of material in cut elements)
Elevations (e.g., view depth to show background, interior and exterior elevations, furniture and fittings in interior elevations, visibility of materials)
Sections (e.g., building section, detail sections, level of detail, material visibility)
3D views (e.g., axonometric, perspective, exterior and interior 3D views, 3D detail views)
Renderings (e.g., materials, lighting, perspective view, managing rendering time)

LO4  Assemble construction information using appropriate views, generated within a BIM application, for a given project

Dimensions
Units
Terminators
Fonts and font sizes
Dimension strings
Angular dimensions

Annotations
Section markers
Elevation markers
Detail bubbles
Notes and leaders
Sheet views
Title blocks and project information
Sheet numbering
View scale
View titles/numbers
Schedules (e.g., door schedules, window schedules)
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Discuss the role of model data in a BIM-enabled project</td>
<td><strong>M1</strong> Assess the value of parametric modelling for generating data in a BIM-enabled project.</td>
<td><strong>D1</strong> Evaluate the ways in which model data, developed within BIM applications, may ensure consistency of information and statutory compliance.</td>
</tr>
<tr>
<td><strong>P1</strong> Explain the role of data in a BIM-enabled project.</td>
<td><strong>P2</strong> Describe the key components in a model for a BIM-enabled project.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Model and modify common building elements for a given project</td>
<td><strong>M2</strong> Analyse stairs, ramps and railings, generated within BIM-enabled applications, to ensure compliance with building regulations.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Create common construction elements for a given project using industry-standard BIM applications.</td>
<td><strong>P4</strong> Undertake modifications to construction elements, in a BIM application, to meet the needs of a given project.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Generate 2D and 3D views of a building model to present key features of a given project</td>
<td><strong>M3</strong> Adjust views to ensure the level of detail and depth are sufficient to show information required for a given project.</td>
<td><strong>D2</strong> Justify the selection of model views used in the production of construction information for a given project.</td>
</tr>
<tr>
<td><strong>P5</strong> Define plan, section and elevation views for a given project.</td>
<td><strong>P6</strong> Produce 3D rendered views of key features or details of a given project.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Assemble construction information using appropriate views, generated within a BIM application, for a given project</td>
<td><strong>M4</strong> Review sheet views to ensure consistency of title blocks, sheet numbering and view scales.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Integrate dimensions, notes and annotations into model views to support construction information.</td>
<td><strong>P8</strong> Place model views into sheet views to provide construction information for a given project.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
https://bit.ly/3BVKNr5 Autodesk – What is BIM in construction? (General Reference)

Links
This unit links to the following related units:
- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 47: Advanced Building Information Modelling.
Unit 27: Law & Legal Frameworks in Quantity Surveying

Level: 4
Credits: 15
Ofqual Code: Y/618/8134

Introduction

The quantity surveyor must act in accordance with appropriate legislation for all stakeholders. This ensures that they take a fair, equal and consistent approach in their professional dealings with clients and main contractors.

Throughout the course of a project, a quantity surveyor will be called on to undertake different types of work in support of the specific stage of the project and the overall project goals. This will range from contract preparation and tendering, to cost management and, in some cases, mediation of disputes.

In this unit, students will become familiar with the key legal frameworks and processes that inform and govern the activities of quantity surveying.

Learning Outcomes

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

LO1 Discuss the legal context of a quantity surveyor
LO2 Explain the management of confidential data
LO3 Assess the quantity surveyor’s role in contractual dispute mediation
LO4 Investigate property legislation in relation to quantity surveying.
Essential Content

LO1 Discuss the legal context of a quantity surveyor

The contractual position of a quantity surveyor

Contractual relationships (e.g., direct contract to a client, contracted to a main contractor, employed in quantity surveying practice, freelance/self-employed, bespoke contract)

Professional bodies (e.g., Royal Institution of Chartered Surveyors, Chartered Institution of Civil Engineering Surveyors)

Professional liability

Working relationships with stakeholders and consultants (e.g., project manager, architect, engineers, contractors, sub-contractors)

Legal context

Behaving in accordance with commercial trading legislation

Preparing contracts for authorisation and signing by parties

Processing payments and taxation requirements

Ensuring contractual time constraints are met (e.g., payment terms, completion dates etc.)

Protection of client and project confidential data and information

Complying with appropriate procurement legislation

Production of tax returns

Financial laws

Public procurement regulations for a country

Private procurement regulations

Local bylaws

Consumer legislation (e.g., purchase of goods and services, sale of goods and services, rental and lease of goods)

Insider trading legislation

Fraud law

Company law (e.g., employment legislation, employer liability)

Bribery acts
Money laundering legislation
International legislative agreements.

Building regulations
Health and safety
Local, regional and national building codes

**LO2 Explain the management of confidential data**

*Types of data*
- As-built project data
- Tendering and procurement values
- Company trade accounts
- Suppliers’ and sub-contractors’ data
- Company financial accounts
- Other financial data

*Management of data*
- Legal protection of data (e.g., GDPR EU Regulations)
- Local and international data protection legislation
- Data manager roles
- Legal ownership (e.g., architects’ design drawings, client-supplied information)
- Time periods for retention of data
- Digital or paper retention
- Digital security (e.g., firewalls, encryption, keychain and password protected systems)
- Hierarchical access controls
- How data is archived when no longer required to be retained

**LO3 Assess the quantity surveyor’s role in contractual dispute mediation**

*Arbitration*
- Professional arbitration through a professional association (e.g., RICS, CIOB, CICES, RIBA)
- Acting as a mediator between parties to the dispute
Compiling a submission for arbitration as the main contractor’s quantity surveyor

Compiling a submission for arbitration as the professional quantity surveyor (PQS)

Agreeing an arbitrator, if determined through contract terms

Agreeing a venue for arbitration

Arranging meetings between parties

Conducting meetings

Report writing/note taking

Arbitration summary agreed and issued

*Adjudication*

Appointment of arbitrator

Reference to any contract-named Building Disputes Tribunal adjudicator

Reference to local/national tribunal arrangements

Agreement of appointed adjudicator

Submissions to adjudicator by parties

Formal reviewing period of documentary evidence

Production of adjudication report

Release of report by party to the adjudication by payment

*Court proceedings*

Dispute between parties

Resolution using contract terms and conditions

Obtaining services of a solicitor/barrister

Formal court submission

Attending hearings

Reaching a verdict

Award

Compensation

Recovery of debt due
LO4 Investigate property legislation in relation to quantity surveying

*Acquisition of land*
- Current use
- Government/local authority zoning regarding housing
- Planning permissions
- Land registration searches
- Procurement through auction
- Private purchase
- Anonymous bidding process
- Direct approach by developer or through an agent
- Government requirements to register land in owner’s name
- Acquisition of land for public works processes and procedures
- Compulsory purchase acquisition

*Conveyance of title*
- Existing title deeds
- Valuation of land
- Agreement of purchase price
- Searches
- Land registration requirements
- Conveyancing
- Transfer of title upon payment
- New deeds registered
- Payment of any government taxes

*Boundaries*
- Establishing boundary markers
- Title deed drawings
- Access and egress from land
- Fence lines and ownership
- Party walls, party structures
## Learning Outcomes and Assessment Criteria

<table>
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<tr>
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<td><strong>LO1 Discuss the legal context of a quantity surveyor</strong></td>
<td><strong>P1 Describe the contractual position of a quantity surveyor.</strong></td>
<td><strong>M1 Analyse the legislation and regulations that a quantity surveyor must comply with in maintaining a legally neutral position.</strong></td>
</tr>
<tr>
<td><strong>P2 Explain the legal context of a quantity surveyor working directly for a client.</strong></td>
<td><strong>D1 Evaluate the legislative requirements in maintaining a fair and equal commercial operation.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO2 Explain the management of confidential data</strong></td>
<td><strong>P3 Describe the different types of confidential data that must be protected and secured.</strong></td>
<td><strong>M2 Evaluate a contract in terms of what data has to be secured to comply with appropriate data protection laws.</strong></td>
</tr>
<tr>
<td><strong>P4 Illustrate the different ways to avoid data breaches.</strong></td>
<td><strong>D2 Analyse the consequences of a data breach and the penalties that may be incurred.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO3 Assess the quantity surveyor's role in contractual dispute mediation</strong></td>
<td><strong>P5 Discuss the difference between arbitration and adjudication.</strong></td>
<td><strong>M3 Evaluate arbitration and adjudication in terms of their benefits to a client.</strong></td>
</tr>
<tr>
<td><strong>P6 Explain the role of a quantity surveyor in arbitration and adjudication.</strong></td>
<td><strong>D3 Justify the use of alternative resolution methods against taking court action in a dispute.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO4 Investigate property legislation in relation to quantity surveying</strong></td>
<td><strong>P7 Describe how land is acquired for built environment development purposes.</strong></td>
<td><strong>M4 Analyse how legal ownership of land is defined.</strong></td>
</tr>
<tr>
<td><strong>P8 Explain the processes associated with the conveyancing of land.</strong></td>
<td><strong>D4 Evaluate the role of a quantity surveyor in the processes of land acquisition and conveyancing.</strong></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
NOLAN-HALEY, J. (2001), *Alternative Dispute Resolution in a Nutshell*, West Academic

Web resources
https://bit.ly/3rFxwOx **Designing Buildings Wiki – Conveyancing** (General Reference)
Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 39: Personal Professional Development
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.
**Unit 28: Group Project (Pearson-set)**

**Level:** 5  
**Credits:** 15  
**Ofqual Code:** H/618/8105

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**Introduction**

While working in a team is an important skill in construction projects, collaboration goes beyond just teamwork. The success of a project relies not only on the ability of each person in a team to do their work but also on each individual's awareness of how their work relates to the work of others, how to ensure that information is shared effectively and that roles and responsibilities are clear.

Through this collaborative project-based unit, students will explore how to define roles in a collaborative team, recognising the skills (and ‘skills gaps’) of each member of the group. Together, students will work to develop a construction project based on their research and analysis, in response to the Pearson-set ‘theme’.

Content in this unit will typically include role identification and allocation, collaborative structures, human resources management, project management, procurement, tender documentation, information/data sharing, meetings, health and safety, project costing and Building Information Modelling (BIM).

*Please refer to the accompanying Pearson-set Assignment Guide and the Theme Release document for further support and guidance on the delivery of the Pearson-set unit.*

**Learning Outcomes**

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

- **LO1** Assess individual and group skills to allocate roles within a collaborative team
- **LO2** Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling
- **LO3** Prepare tender documentation, undertaking work appropriate to a defined role within a team
- **LO4** Evaluate own work, and the work of others, in a collaborative team.
Essential Content

LO1 **Assess individual and group skills to allocate roles within a collaborative team**

*Roles and responsibilities*
Skills auditing
Evaluating personality and teams (e.g., Belbin Team Inventory, Myers Briggs Personality Type Indicator)

*Human resources management*
Core job dimensions (e.g., skill variety, task identity, task significance, autonomy, feedback)
Job design (e.g., job rotation, job enlargement, etc.).

LO2 **Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling**

*Project planning*
Client requirements
Setting goals
Defining ‘deliverables’
Task definition
Identifying risks/risk management
Communications planning

*Resource management*
Human resources
Physical resources
Supply chain
Waste management

*Project scheduling*
Scheduling tools
Milestones
Blocks
LO3  **Prepare tender documentation, undertaking work appropriate to a defined role within a team**

*Tender documentation*
- Construction drawings
- Specifications
- Schedules of work
- Cost plan
- Health and safety legislation
- Building Information Modelling (BIM)

LO4  **Evaluate own work, and the work of others, in a collaborative team**

*Reflective practice*
- Schön’s ‘The Reflective Practitioner’
- Gibbs’ ‘Reflective Cycle’
- Reflection vs description

*Reflection in practice*
- Project lifecycle
- Post-implementation review
### Learning Outcomes and Assessment Criteria

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<td><strong>LO1</strong></td>
<td>Assess individual and group skills to allocate roles within a collaborative team</td>
<td></td>
</tr>
<tr>
<td><strong>P1</strong></td>
<td>Evaluate own skills and the skills of others through skills auditing and review.</td>
<td>M1 Discuss the allocation of roles within a collaborative team to meet overall project needs.</td>
</tr>
<tr>
<td><strong>P2</strong></td>
<td>Develop role descriptions and responsibilities within a team.</td>
<td>D1 Justify the allocation of roles and responsibilities within a team, recognising individual skills and ambitions vs project requirements.</td>
</tr>
<tr>
<td><strong>LO2</strong></td>
<td>Plan a construction project, based on the Pearson-set theme, in collaboration with others to ensure good practice in resource management, staffing and project scheduling</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong></td>
<td>Develop a project plan to ensure successful achievement of completed project.</td>
<td>M2 Interpret events and activities in a project plan to indicate milestones and risks.</td>
</tr>
<tr>
<td><strong>P4</strong></td>
<td>Illustrate resource planning (both physical and human) as well as time planning.</td>
<td>D2 Critically evaluate the relationships between project planning and tender documentation, highlighting ways in which tender information responds to project planning.</td>
</tr>
<tr>
<td><strong>LO3</strong></td>
<td>Prepare tender documentation, undertaking work appropriate to a defined role within a team</td>
<td></td>
</tr>
<tr>
<td><strong>P5</strong></td>
<td>Develop construction drawings and specifications.</td>
<td>M3 Evaluate the ways in which Building Information Modelling (BIM) can provide greater efficiency in collaborative preparation of tender documentation.</td>
</tr>
<tr>
<td><strong>P6</strong></td>
<td>Prepare a cost plan.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong></td>
<td>Produce a pre-construction health and safety method statement.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong></td>
<td>Evaluate own work, and the work of others, in a collaborative team</td>
<td></td>
</tr>
<tr>
<td><strong>P8</strong></td>
<td>Undertake a continual review of own work, recording it throughout the project.</td>
<td>M4 Evaluate own personality profile in relation to own working practices.</td>
</tr>
<tr>
<td><strong>P9</strong></td>
<td>Review own working practices in relation to that of other members of the team, identifying areas of good practice.</td>
<td>D3 Critically evaluate the success of a project by considering individual and group working practices in relation to assigned roles and personality profiles.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
BELBIN, R. (2010), *Team Roles at Work*, Routledge

Links
This unit links to the following related units:
- Unit 1: Construction Design Project (Pearson-set)
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 30: Project Management
- Unit 39: Personal Professional Development.
Introduction

The successful management of a project relies on ensuring that work is undertaken in accordance with the terms of the contract that exists between client and contractor. In construction, a contract is the legally binding agreement between the client (who wants a project built) and the main contractor (who is responsible for constructing the project). Time, quality and costs are covered by such contracts to ensure that a client receives a project that has been specified by their designer to a budget and at an agreed handover date for completion.

The overall aim of this unit is to give students a working knowledge of contracts so that they can manage a project team in accordance with the agreed terms and conditions of the contract. The principal person responsible for this is often the quantity surveyor and it is their responsibility to ensure compliance with the conditions of the contract.

On successful completion of this unit, students will be able to run and administer a project using the contract terms and conditions that have been agreed between a client and the main contractor. Students will also have the fundamental knowledge and skills to progress to a higher level of study.

Learning Outcomes

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

LO1 Discuss the different stakeholders and contractual relationships that may develop during a construction project
LO2 Explain the criteria that inform the selection of a construction contract
LO3 Examine different forms of standard construction contract and their application to built environment projects
LO4 Prepare an appropriate form of contract for a selected project, specifying the terms and conditions.
Essential Content

LO1 Discuss the different stakeholders and contractual relationships that may develop during a construction project

Stakeholders
Client/developer
Users
Finance/investment organisations

Consultants
Architects/designers
Engineers
Cost consultants
Project managers
Other consultants

Contractors
Main/general contractor
Sub-contractors
Manufacturers/suppliers
Novation

Procurement route
Traditional
Design and build
Admeasure
Construction management
Contractor led
Design build finance and operate (e.g., Public Private Partnership, Private Finance Initiative, Design Build Operate)
Framework agreements
Engineering procurement and construction contract (EPC)
Engineering procurement and construction management contract (EPCM)

Relationships within different contract types
LO2  **Explain the criteria that inform the selection of a construction contract**

*Project factors*
- Project type (e.g., residential, commercial, industrial)
- Nature of works (e.g., maintenance, capital works)
- Client type (e.g., private, commercial, institutional, government)
- Client information requirements (e.g., BIM requirements, data requirements)
- Size of project
- Value of project
- Complexity of project
- Knowledge and expertise of the employer or client
- Location

*Contract selection factors*
- Time (e.g., quick start and shorter completion date)
- Cost (e.g., lump sum or re-measured costs against a schedule of rates)
- Quality (e.g., materials and workmanship defined in specification)
- Level of risk to be apportioned across all stakeholders
- Client and main contractor balance of risk
- Form of pricing (e.g., fixed price, variable price)
- Design responsibility (e.g., architect design, contractor design)
- Warranties and guarantees required
- Basis of contract sum and payment options (e.g., phased, monthly)
- Employer’s control over sub-contractors (e.g., nominated, named, novated)

LO3  **Examine different forms of standard construction contract and their application to built environment projects**

*Contract information/documents*
- Contract agreement
- Scope of work definition
- General conditions
- Special conditions
- Cost information (e.g., bill of quantities)
Work schedule
Drawings/data
Specifications
Insurance requirements

The Joints Contracts Tribunal (JCT) Suite of Contracts

Traditional (e.g., JCT Standard Building Contract 2011 (the ‘with Quantities’ and ‘without Quantities’ versions), JCT Intermediate Building Contract 2011, JCT Minor Works Building Contract 2011)

Traditional (re-measured) (e.g., JCT Standard Building Contract 2011 (the ‘with Approximate Quantities’ version), JCT Measured Term Contract 2011)

Design and Build (e.g., JCT Design and Build Contract 2011, JCT Major Project Construction Contract 2011)

Construction Management (e.g., JCT Construction Management Appointment 2011, JCT Management Building Contract 2011)

Partnering (e.g., JCT-Constructing Excellence Contract 2011, PPC2000 (2013 edition))

The New Engineering Contract (NEC) suite

New Engineering Contract (NEC3)

Engineering Construction Contract (ECC) and options A to F

International Federation of Consulting Engineers Contract Suite (FIDIC):

Conditions of Contract for Works of Civil Engineering Construction:

The Red Book (1987)

Conditions of Contract for Electrical and Mechanical Works, including Erection on Site: The Yellow Book (1987)


Other types of contract (e.g., ICC Minor Works Version 2011, GC/Works series)
Prepare an appropriate form of contract for a selected project, specifying the terms and conditions

Contract documents
Distinction between contract and non-contract documents
Articles of agreement
Conditions of and appendices to the different forms of contract
Forms of contract used (construction and civil engineering projects)

Supply chain
Supply chain management (e.g., nominated, named and other sub-contractors)
Manufacturers/suppliers contract conditions (e.g., tendering arrangements, information requirements, main contract implications, forms and agreement)
Sub-contractors contract conditions (e.g., domestic, directly employed, tendering criteria)

Quality
Materials
Goods
Standards of workmanship
Specification
Statutory obligations
Methods of working
Testing
Defects and removal of defective work
Quality assurance
Other clauses of the contract (e.g., certificate of making good defects, defects liability period)

Specific conditions
Articles of agreement
Payment terms
Variations
Insurances
Contractors’ main responsibilities
Testing and defects
Architects/engineer instructions

Risks

*Time*

Limitation of liability
Possession
Extensions of time
Extensions and delays to contract period

*Costs*

Loss and expense
Performance damages
Performance bonds
Retention
Bonus for early completion
Termination
Price adjustments
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Discuss the different stakeholders and contractual relationships that may develop during a construction project</td>
<td><strong>M1</strong> Analyse the different relationships between contractor, client and consultants in a range of procurement routes.</td>
<td><strong>D1</strong> Evaluate the risks associated with construction projects and how contracts manage risk for the parties involved.</td>
</tr>
<tr>
<td><strong>P1</strong> Explain the different stakeholders involved in a publicly financed project.</td>
<td><strong>P2</strong> Illustrate the contractual relationships that may exist in a given construction project.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the criteria that inform the selection of a construction contract</td>
<td><strong>M2</strong> Assess the way in which a contract supports the assurance of quality through warranties and guarantees.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Discuss the relationship between project size, type and complexity on contract selection.</td>
<td><strong>P4</strong> Explore how time, cost and quality are managed through a construction contract.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Examine different forms of standard construction contract and their application to built environment projects</td>
<td><strong>M3</strong> Compare forms of standard contracts in terms of their applicability for a given project.</td>
<td><strong>D2</strong> Justify the selection and preparation of a standard form of construction contract in ensuring quality of the project and managing liability.</td>
</tr>
<tr>
<td><strong>P5</strong> Discuss standard forms of contract for building and infrastructure projects.</td>
<td><strong>P6</strong> Explain how contract information/documents support a standard form of contract.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Prepare an appropriate form of contract for a selected project, specifying the terms and conditions</td>
<td><strong>M4</strong> Discuss how collaboration between contractors and subcontractors influences contractual arrangements.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Revise a standard form of contract to meet the requirements of a client/stakeholder group.</td>
<td><strong>P8</strong> Explain the rationale for defining selected terms and conditions in the preparation of a contract.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 54: Advanced Quantity Surveying Practice.
Unit 30: Project Management

Level: 5
Credits: 15
Ofqual Code: R/618/8133

Introduction

Management is a key feature of a project from conception, through design and construction stages, into end-user and end-of-life cycles. Throughout this process, a project manager is called upon to manage stakeholders, facilitate communication and information sharing, and support different groups to ensure they are working to schedule, budget and contract.

Project managers will need to have sound knowledge, skills and competencies to manage all aspects of a complex construction project. This role may be fulfilled by a client representative or an external appointment.

The aim of this unit is to explore theories and practices relating to project management, the project manager role and managing stakeholders throughout the project process.

Topics covered in this unit include: project management as a discipline and suitability for a range of construction industry activities; project stakeholder types and their management; project manager roles and responsibilities; project management plans.

On completion of this unit, students will be able to apply the theories and practices of project management to real-world scenarios. In doing so, they will develop transferable skills as well as equipping themselves with industry-standard tools to work as effective members of a project management team.

Learning Outcomes

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

LO1 Discuss the theory and practice of project management and the context of the profession

LO2 Explain the roles, relationships and management of stakeholders in a construction project

LO3 Describe the activities of a project manager through the different phases of a construction project

LO4 Present a project management strategy for a given construction project.
Essential Content

LO1 Discuss the theory and practice of project management and the context of the profession

Project management
Definition of a project
The purpose of project management
The role of the Project Manager (e.g., responsibilities, attributes, competencies)
Project management vs construction management

Key concepts
Project goal
Resources (e.g., human, physical, data, scarcity, sustainability)
Timeline
Dependency
Milestones
Risks
Success

Professional recognition
Association for Project Management (APM)
Project Management Institute (PMI)
International Project Management Association (IPMA)
Green Project Management (GPM)
Others

Standards
PMI – Project Management Body of Knowledge (PMBOK Guide)
APM – Body of Knowledge
IPMA – Project Excellence Baseline (PEB)
GPM – Projects Integrating Sustainable Methods (PRISM)
ISO Standards (e.g., ISO 9000, ISO 10006:2003)
Others

*Project management methodologies*
- Gantt charts
- Critical Path Method (CPM)
- Program Evaluation and Review Technique (PERT)
- PRINCE2 (Projects in Controlled Environments)
- Other (e.g., Agile, Lean, Scrum)

**LO2** *Explain the roles, relationships and management of stakeholders in a construction project*

*Definition of ‘stakeholder’*
‘individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion.’ (Project Management Institute, 2001)

*Internal stakeholders*
- Investors (e.g., banks, shareholders)
- Client
- Consultants (e.g., architects, designers, engineers, cost consultants)
- Contractors (e.g., main contractor, sub-contractors, suppliers)
- Management (e.g., facilities managers, operators)

*External stakeholders*
- Users (e.g., residents, occupiers)
- Others (e.g., local government, general public, statutory agencies)

*Stakeholder relationships*
- Contractual relationships
- Financial relationships
- Statutory relationships (e.g., statutory bodies, government bodies)
- Moral/ethical relationships (e.g., professional bodies, equality and diversity, codes of conduct)
Stakeholder management
Stakeholders' power and interests
Monitoring stakeholder views
Communicating project information (e.g., keeping stakeholders informed)
Managing conflicts

LO3 Describe the activities of a project manager through the different phases of a construction project

Construction project process models
RIBA Plan of Work
OGC Gateway
Designing Building Wiki Project Plans
Other

Project initiation
Working with/appointment of consultants (e.g., architects, engineers, cost consultants)
Feasibility

Project planning
Scope statement and documentation
Project goals (e.g., SMART goals, CLEAR goals)
Work breakdown (e.g., milestones, dependencies)
Communication plan (e.g., information sharing, data sharing)
Risk management plan

Project execution
Assigning resources
Setting up tracking
Updating plans
Modifying plans
BIM in project management
Project monitoring
Concurrent with project execution
Measuring progress (e.g., time, potential delays, costs)
Project reporting (e.g., progress, cost, quality, material use, sustainability)
Health and safety (e.g., monitoring, notifying)

Project closure
Project completion
Snagging lists/punch lists
Final project evaluation

LO4 Present a project management strategy for a given construction project

Project type (e.g., residential, commercial, industrial, cultural)

Project stakeholders

Project management strategy
Scope
Goals
Timeline (e.g., Gantt chart, dependencies, milestones)
Resources (e.g., physical, materials, human)
Communications (e.g., information requirements, BIM data)

Presentation
Format (e.g., report, audio-visual)
Material (e.g., graphical, written, data)
<table>
<thead>
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<tbody>
<tr>
<td><strong>Pass</strong></td>
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<tr>
<td><strong>LO1</strong> Discuss the theory and practice of project management and the context of the profession</td>
</tr>
<tr>
<td><strong>P1</strong> Explain the function and benefits of project management for construction projects.</td>
</tr>
<tr>
<td><strong>P2</strong> Describe the role of professional bodies and standards in project management.</td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the roles, relationships and management of stakeholders in a construction project</td>
</tr>
<tr>
<td><strong>P3</strong> Discuss the different parties that may be considered internal and external stakeholders in a construction project.</td>
</tr>
<tr>
<td><strong>P4</strong> Assess the different types of stakeholder relationships in a construction project.</td>
</tr>
<tr>
<td><strong>Merit</strong></td>
</tr>
<tr>
<td><strong>M1</strong> Compare different project management concepts and standards, and their potential to support sustainability.</td>
</tr>
<tr>
<td><strong>M2</strong> Assess the power and interests of different stakeholders in a construction project and their influence on the management of the project.</td>
</tr>
<tr>
<td><strong>Distinction</strong></td>
</tr>
<tr>
<td><strong>D1</strong> Analyse the way that different project management methodologies may address stakeholder interests in a construction project.</td>
</tr>
<tr>
<td>Pass</td>
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</tr>
<tr>
<td><strong>LO3</strong> Describe the activities of a project manager through the different phases of a construction project</td>
</tr>
<tr>
<td><strong>P6</strong> Discuss the role of the project manager during the construction phase, including health and safety requirements.</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a project management strategy for a given construction project</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
AXELOS (2018), Directing Successful Projects with PRINCE2®, Tso, the Stationery Office

Web resources
https://bit.ly/2TK5OUk Association for Project Management (APM)
(Professional Body)

(General Reference)

(Professional Body)
Links

This unit links to the following related units:

- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 11: Financial Management & Business Practices in Construction
- Unit 13: Building Information Modelling
- Unit 20: Site Supervision & Operations
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 43: Advanced Surveying & Measurement
- Unit 44: Maintenance & Operations
- Unit 54: Advanced Quantity Surveying Practice.
Unit 31: Advanced Structural Design

Level: 5
Credits: 15
Ofqual Code: M/618/8107

Introduction

With the development of new materials and processes, along with technologies that allow us to design and model more complex structures, the influence on structural design has become increasingly challenging. The ability to conceive and accurately model complex buildings, bridges, roads and other types of structure, pushes both the aesthetic and technical envelope in which structural and civil engineers now operate.

In managing the design and construction of modern structures, the civil or structural engineer must be able to carry out increasingly complex calculations, dealing with dynamic conditions, while maintaining an awareness of the overall design intention.

Extending areas of study from Unit 19: Principles of Structural Design, this unit will support students to extend their ability to design, test and quantify more complex structural conditions.

Learning Outcomes

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

LO1 Explain strategies to resist deflection due to wind loadings on fixed structures
LO2 Determine bending, shear and deflection for complex support conditions
LO3 Design complex columns and piled foundations based on calculation
LO4 Explore the design of tensile structures.
Essential Content

LO1 **Explain strategies to resist deflection due to wind loadings on fixed structures**

*Wind loading*
- Calculating wind loading
- Wind loading on tall buildings
- Shear forces
- Lateral load
- Uplift load
- Torsional load

*Managing wind loading*
- Building form
- Stiffening

LO2 **Determine bending, shear and deflection for complex support conditions**

*Bending*
- Supported timber beams
- Steel cantilever beams
- Reinforced concrete cantilevers
- Steel three-pin frames

*Shear*
- Supported timber beams
- Steel three-pin frames

*Deflection*
- Supported timber beams with point loads and uniformly distributed loading
- Steel cantilever beams with point loads and uniformly distributed loading
- Reinforced concrete cantilever beams with point loads and uniformly distributed loading
Structural connections
Beam-to-beam connections
Beam-to-column connections
Types of connection
Bolt fixings
Welded connections
Fin plates
Splices
Bracing connections

LO3 Design complex columns and piled foundations based on calculation

Axial loading
Carrying capacity of timber columns
Carrying capacity of reinforced concrete piled foundations
Carrying capacity of steel piled foundations

Eccentric loading
Buckling
Stress

Piled foundations
End bearing piles
Friction piles
Sheet piles
Micropiling
Helical piles

Structural design information
CAD drawings
Building Information Modelling (BIM)
Calculations
LO4 **Explore the design of tensile structures**

*Linear structures*
Suspension bridges
Cable-stayed beams/trusses

*Three-dimensional structures*
Tensegrity structures
Tensairity structures

*Surface-stressed structures*
Pre-stressed membranes
Gridshell
Fabric structure
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain strategies to resist deflection due to wind loadings on fixed structures</td>
<td><strong>P1</strong> Calculate wind loads on fixed structures. <strong>P2</strong> Discuss methods to resist or manage wind loading.</td>
<td><strong>M1</strong> Analyse the relationship between building form and wind loading. <strong>D1</strong> Calculate and size the type of lateral stiffening required to resist wind loading for a given structure.</td>
</tr>
<tr>
<td><strong>LO2</strong> Determine bending, shear and deflection for complex support conditions</td>
<td><strong>P3</strong> Calculate bending and shear in complex support conditions. <strong>P4</strong> Determine deflection in complex support conditions.</td>
<td><strong>M2</strong> Evaluate structural connections in relation to complex support conditions. <strong>D2</strong> Critically analyse the use of different materials to determine their structural efficiency in managing bending, shear and deflection.</td>
</tr>
<tr>
<td><strong>LO3</strong> Design complex columns and piled foundations based on calculation</td>
<td><strong>P5</strong> Calculate the axial load-carrying capacity of complex columns, with eccentric loading and reinforced concrete piled foundations. <strong>P6</strong> Prepare design information for a structure utilising piled foundations and steel columns.</td>
<td><strong>M3</strong> Discuss the benefits of using Building Information Modelling (BIM) in the structural design workflow. <strong>D3</strong> Assess the most effective foundation type for a given scenario in terms of ease and speed of construction, economics, safety and environmental factors.</td>
</tr>
<tr>
<td><strong>LO4</strong> Explore the design of tensile structures</td>
<td><strong>P7</strong> Discuss the differences between types of tensile structures. <strong>P8</strong> Design a simple tensile structure for a given scenario.</td>
<td><strong>M4</strong> Compare tensile structural solutions to a given scenario. <strong>D4</strong> Using research and calculations, justify the choice of a tensile structure solution for a given scenario.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


MOSLEY, W., HULSE, R., BUNGEY, J. (2012), *Reinforced Concrete Design*, Macmillan International Higher Education


Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 13: Building Information Modelling
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 34: Further Mathematics for Construction
- Unit 41: Highway Engineering
- Unit 42: Hydraulics
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.
Unit 32: Advanced Construction Drawing & Detailing

Level: 5
Credits: 15
Ofqual Code: T/618/8108

Introduction

The information required to construct buildings and infrastructure is at the heart of the construction process. As structures become more complex, the types of information required become equally complex. The ability to produce, manage and understand construction information continues to be a key skill in all sectors of the industry.

The aim of this unit is to give students an in-depth consideration of the ways that construction information is created, managed and shared throughout the lifecycle of a built asset. As well as understanding the different types of information required for complex projects, students will explore the development and use of standards to ensure consistency and interoperability of the data captured and shared, both in a geometric and non-geometric fashion.

In this unit, students will engage in the ways that construction drawing and detailing have evolved. They will gain knowledge and skills in documenting projects using modern methods and technologies.

Learning Outcomes

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

LO1 Explore the methods to ensure consistent development and management of construction information

LO2 Examine the relationship between CAD and BIM data in the production and management of construction information

LO3 Discuss the types of information required throughout the lifecycle of a construction project

LO4 Prepare an information package for a given construction project.
Essential Content

**LO1** Explore the methods to ensure consistent development and management of construction information

*Standards*
Office standards (e.g., drawing templates, sheet formats, hatching)
Industry standards (e.g., file formats, information packages)
Classification systems (e.g., Uniclass, Omniclass)
Standard and open data formats (e.g., DWG, DXF, IFC)
Common Arrangement of Works (CAWS)
BIM standards (e.g., ISO 19650-1, ISO 19650-2, ISO 19650-3, ISO 19650-5)

*General arrangement drawings*
Splitting complex plans, match lines
Room/space delineation
Annotation
Cross-referencing

*Detail drawings*
Identifying detail needs
Detail annotation
Level of Definition (Level of Detail)

*Specifications*
Specification types (e.g., performance specification, prescriptive specification, technical specification, outline specification)
Standard specifications (e.g., NBS, MasterFormat)
Bills of quantities (BOQ)

*Information coordination and communication*
Information checking (e.g., drawing review, clash checking, document checking)
Coordination (e.g., specification with drawings, details with specification, schedules with specification/drawings)
Transmittal (e.g., ‘paper-based’, digital)
Information sharing systems (e.g., shared servers, cloud-based, commercial products)

**LO2** Examine the relationship between CAD and BIM data in the production and management of construction information

*CAD*
Graphic (2D/3D) representation of project geometry
Benefits (e.g., speed of information production, low learning curve)
Challenges (e.g., only graphical/geometric, ‘information’ is in other documentation, manual coordination)

*BIM*
Detailed information about ‘assets’
‘Intelligent’ model data (e.g., materials, assemblies, costing info)
Benefits (e.g., project data can be within a ‘single model’, inherent coordination, supports project process, data enables multiple stakeholders)
Challenges (e.g., steep learning curve, overly complex for small projects, requires financial/training investment)

*Linking CAD and BIM* (e.g., BIM for overall coordination, CAD for detail drawings)

**LO3** Discuss the types of information required throughout the lifecycle of a construction project

*Strategic definition*
Client requirements
Business case
Project risks

*Preparation and briefing*
Site information (e.g., survey data, soil information, site access)
Budget information
Project programme
Sustainability outcomes
Information requirements
Concept design
Initial design drawings/models
Initial engineering drawings/models
Initial cost plans
Outline specification
Planning application(s)

Spatial coordination
Design studies
Architectural and engineering information
Spatially coordinated design

Technical design
Construction information (general arrangement, details)
Final specifications
Construction phase plan
Building regulation application(s)
Contract information
Bills of quantities/specifications
Construction information (based on approach to tender)

Manufacturing and construction
Health and safety file
Fire safety information
Project manual (e.g., systems documentation, maintenance information)
Defects list

Handover and post-occupancy
Final health and safety file
Final fire safety information
Final building manual
‘As-built’ information (e.g., ‘As-built’ drawings, final Asset Information Model, BIM data)

Effect of procurement route on project information production
Effectiveness of BIM in managing information throughout project phases

LO4 Prepare an information package for a given construction project

Project type (e.g., residential, commercial, industrial, infrastructure)

Client information
Project brief (e.g., needs, expectations)
Budget
Timescale

Consultant information
Survey information
Structural information
Building services information
Other
Coordinating consultant information

General arrangement drawings
Site plans
Floor plans
Building sections
Elevations

Detail drawings
Wall details
Roof details
Window details
Door details

Schedules
Door schedules
Window schedules
Finish schedules
Other

Specifications
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<tr>
<td><strong>LO1</strong> Explore the methods to ensure consistent development and management of construction information</td>
</tr>
<tr>
<td><strong>P2</strong> Explain the use of industry standards in the preparation of drawings and specifications.</td>
</tr>
<tr>
<td>Pass</td>
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<tr>
<td>------</td>
</tr>
</tbody>
</table>
| **LO3** Discuss the types of information required throughout the lifecycle of a construction project | **P5** Explain the types of information required at different stages of a construction project.  
**P6** Describe the purpose of information in the handover and post-occupancy phase that ensures ongoing health and safety. | **M3** Analyse how information requirements are informed by the choice of procurement route for a project.  
**D2** Evaluate the ways in which appropriate use of BIM and CAD tools may provide efficient production and management of information throughout the different phases of a project. |
| **LO4** Prepare an information package for a given construction project | **P7** Review project type, client and consultant information to inform development of construction information package.  
**P8** Produce a required construction information package, using industry-standard CAD/BIM tools. | **M4** Justify the use of CAD or BIM tools in the production of different types of construction information for a given project. |
Recommended Resources

Print resources
BALLAST, D. (2009), Architect's Handbook of Construction Detailing, John Wiley & Sons
CROTTY, R. (2013), The Impact of Building Information Modelling, Routledge
YEE, R. (2012), Architectural Drawing, John Wiley & Sons

Web resources
(General Reference)
(General Reference)
(General Reference)
(General Reference)

Links
This unit links to the following related units:
• Unit 1: Construction Design Project (Pearson-set)
• Unit 2: Construction Technology
• Unit 4: The Construction Environment
• Unit 6: Digital Applications for Construction Information
• Unit 13: Building Information Modelling
• Unit 26: Digital Applications for Building Information Modelling
• Unit 28: Group Project (Pearson-set)
• Unit 33: Construction Technology for Complex Buildings Projects
• Unit 47: Advanced Building Information Modelling.
Unit 33: Construction Technology for Complex Buildings Projects

Level: 5
Credits: 15
Ofqual Code: A/618/8109

Introduction

This unit focuses on the erection of buildings with complex requirements through the use of modern systems and methods of construction. Students will analyse the principles of buildability in terms of health and safety, efficiency, economy, sustainability and quality. The importance of developing a sustainable construction strategy is emphasised and students will explore the techniques and procedures involved in the safe and sustainable demolition of buildings. The importance of clear technical communication is also examined during and after the build process.

This unit is designed to give students a thorough understanding of the technology involved in complex buildings. Students will discover how scientific solutions are applied to complex building projects through technology, the choice of materials, buildability and construction methods. Particular emphasis is placed on the consideration of sustainability and health and safety in the construction of complex structures.

On successful completion of this unit, students will have applied suitable strategies, processes and methods of construction to meet prevailing conditions. They will be able to justify selected materials and construction methods used in complex buildings against set criteria and choose systems to facilitate alternative uses of buildings.

Learning Outcomes

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

LO1 Discuss the characteristics of complex construction projects and their challenges
LO2 Define strategy for the preparation, materials and substructures for a given large-scale construction project
LO3 Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project
LO4 Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project.
Essential Content

**LO1 Discuss the characteristics of complex construction projects and their challenges**

*High rise buildings (e.g., multi-occupancy residential, hotels, office buildings)*
Substructure (e.g., depth requirements, soil stability, hydrostatic pressure)
Wind-loading and vertical stiffness
Vertical circulation and emergency escape
Goods delivery, waste disposal
Working conditions (e.g., working at height)

*Medical buildings (e.g., hospitals, laboratories)*
Hygiene (e.g., materials, maintenance)
Isolation (e.g., maintaining separation between contamination areas, air pressure systems, air filtration)
Specialist services (e.g., oxygen supply/distribution, emergency power systems, clean rooms)
Vehicle access (e.g., ambulance areas, helipads)

*Commercial buildings (e.g., shopping centres, multi-use office/commercial)*
Managing human traffic
Goods delivery, waste disposal
Complex building regulations (e.g., different uses, conflicting requirements)
Parking requirements

*Cultural buildings (e.g., museums, concert halls, stadiums)*
Acoustics (e.g., materials, acoustic separation, reverberation)
Security (e.g., protecting museum assets, managing large crowds)
Fire safety (e.g., means of escape for large groups)

*Residential buildings (e.g., single occupancy (houses), multi-occupancy (apartment buildings), specialist residential (elderly care, sheltered accommodation, etc.))*

*Industrial buildings (e.g., factories, production halls and large distribution centres)*
Acoustics (e.g., managing loud machinery noise, controlling breakout noise)
Equipment load (e.g., fixed equipment, mobile equipment, floor loading, cranes, gantries)
Dealing with rainwater (e.g., large roof areas, large hardscape areas)
Long-span structures
Environmental impact (e.g., construction impact, operational impact, emissions)
Electrical loads (e.g., high voltage requirements, substations, safety)

Transport building (e.g., airports, rail terminals, underground/subway stations, seaports)
Human traffic (e.g., separating incoming and outgoing passengers, restricted areas)
Vibration
Security
Long-span structures
Maintenance

Infrastructure (e.g., road/highway junctions/interchanges, rail bridges, large-span bridges, tunnels)
Environmental impact (e.g., local environment, material supply and use)
Long span structures
Human safety
Working conditions (e.g., working with active traffic, working at height)

Public services buildings (e.g., police stations, prisons, fire stations)
Separation of areas (e.g., accessible by general public vs secure)
Security
Specialist equipment requirements

Utilities (e.g., power stations, electrical distribution structures, dams)
Environmental impact (e.g., local environment, emissions, waste)
Safety (e.g., working with high voltage, pressure vessels, working at height)

Sustainability
Environmental (e.g., environmental impact, material use, material scarcity, CO2 emissions, noise pollution)
Social (e.g., impact on local community, demographics)
Economic (e.g., job creation, local disruption during construction)
Cultural (e.g., local history, archaeology, changing demographics)

LO2 Define strategy for the preparation, materials and substructures for a given large-scale construction project

Existing site conditions
Soil type
Bearing capacity
Water table
Seismic activity

Project requirements
Project type
Access
Superstructure proposal
Drainage (e.g., roof drainage, site drainage, sustainable urban draining systems (SUDS))
Subsurface services (e.g., electrical, water, sewerage)

Site preparation
Dewatering
Soil stabilisation
Foundation type and location (e.g., piling locations, materials)
Equipment and plant requirements

Statutory requirements
Health and safety (e.g., method statements, risk assessments)
Site safety certifications
Site staff certifications
Building regulations
LO3 Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project

Superstructure
Managing loads and movement (e.g., wind loading, live loads, dead loads, thermal expansion)
Primary structure (e.g., concrete frame, steel frame, composite)
Secondary structure (e.g., curtain wall support, cladding support)
Roof structure (e.g., roof structure, roof decking, green roofs, roof drainage)
Floor construction (e.g., in-situ reinforced concrete, T-beam, hollow block, waffle slabs, precast, pre-stressed, post-tensions planks)
Column grid

Building services
Primary service supplies
Metering and access
Secondary and back-up power
Hot and cold water
Gas, electricity
Heating, ventilation and air conditioning
Communications
Waste removal

Fire safety
Statutory regulations
Sprinklers
Emergency lighting
Smoke handling
Refuge rooms
Escape stairs
Flame spread

Equipment and plant requirements
LO4 Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project

Demolition methods
Explosives
Hand demolition
Machine demolition
Other (e.g., gas expansion, hydraulic expansion, thermic reaction)

Construction information for demolition
As-built drawings
Building Manual (e.g., specifications, materials, maintenance records)
Building Information Modelling (BIM) asset data

Sustainability
Re-use or reclamation of standard components and assemblies
Specification of recyclable materials
Material separation

Material handling
Contaminated or dangerous material handling (e.g., asbestos, chemicals)
Material transport
Material disposal

Statutory regulations
Adjacent buildings
Health and safety regulations
Access for safe demolition
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Discuss the characteristics of complex construction projects and their challenges</td>
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<tr>
<td><strong>P1</strong> Explain the structural needs of different types of complex construction projects.</td>
<td><strong>M1</strong> Assess the relationship between structural solution and specialist technical requirements for different types of construction project.</td>
<td><strong>D1</strong> Analyse how complex projects may require additional levels of health and safety.</td>
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<tr>
<td><strong>P2</strong> Describe the safety, security and sustainability needs of different types of complex construction projects.</td>
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<tr>
<td><strong>LO2</strong> Define strategy for the preparation, materials and substructures for a given large-scale construction project</td>
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<tr>
<td><strong>P3</strong> Examine existing site conditions and project information to inform a strategy for site safety, preparation, materials and substructure.</td>
<td><strong>M2</strong> Compare different approaches to material and construction method to determine their suitability for a given complex building project.</td>
<td><strong>D2</strong> Evaluate the ways in which an approach to large-scale construction project superstructure informs the approach to fire safety.</td>
</tr>
<tr>
<td><strong>P4</strong> Develop a strategy that provides for the preparation of the site, safe working, suitable materials and substructure for a given complex building project.</td>
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<tr>
<td><strong>LO3</strong> Develop an information package for the superstructure, building services and fire safety of a given large-scale construction project</td>
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<tr>
<td><strong>P5</strong> Compile drawings, specification and data to enable an information package for superstructure, building services and fire safety.</td>
<td><strong>M3</strong> Discuss the ways in which fire safety is addressed in large-scale projects to meet statutory regulations.</td>
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<tr>
<td><strong>P6</strong> Present an information package for a large-scale project, including superstructure, building services and fire safety.</td>
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<tr>
<td><strong>LO4</strong> Propose solutions that meet the requirements for safe demolition and disposal of materials for a large-scale construction project</td>
<td><strong>P7</strong> Explain the different methods for large-scale construction demolition and their suitability for different types of project. <strong>M4</strong> Analyse the importance of construction information in the process of preparing for and undertaking demolition works.</td>
<td><strong>D3</strong> Justify the need for re-use, reclamation or recycling during demolition to support sustainability through a building lifecycle.</td>
</tr>
<tr>
<td><strong>P8</strong> Define a strategy for demolition of a large-scale construction project, including the transport and disposal of materials.</td>
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</table>
Recommended Resources

Print resources


Web resources

https://bit.ly/3zRsIlz  BRE
(General Reference)

https://bit.ly/3rKsWPc  Chartered Association of Building Engineers
(Professional Body)

(Professional Body)

https://bit.ly/3i91LdB  Chartered Institute of Building
(Professional Body)

https://bit.ly/3fsrTP1  Institution of Civil Engineers
(Professional Body)

https://bit.ly/3zMJUIR  The Concrete Centre
(General Reference)

https://bit.ly/3fbUjwj  The Institution of Structural Engineers
(Professional Body)
**Links**

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 31: Advanced Structural Design
- Unit 47: Advanced Building Information Modelling.
Unit 34: Further Mathematics for Construction

Level: 5
Credits: 15
Ofqual Code: M/618/8110

Introduction

The understanding of more advanced mathematics is important in the civil engineering and building services engineering industries. Students will be introduced to additional topics that will be relevant to them as they progress to the next level of their studies; advancing their knowledge of mathematical theory gained in the Level 4 Unit 8: Mathematics for Construction.

The aim of this unit is to teach students to analyse and model civil engineering or building services engineering situations using mathematical techniques.

Among the topics included in the unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation in an engineering context. Students will expand their knowledge of calculus to discover how to model and solve problems using first and second order differential equations.

On successful completion of this, unit students will be able to use applications of number theory in practical construction situations, solve systems of linear equations relevant to construction applications using matrix methods, approximate solutions of contextualised examples with graphical and numerical methods, and review models of construction systems using ordinary differential equations. As a result, they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.
Learning Outcomes

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

LO1 Apply instances of number theory in practical construction situations

LO2 Solve systems of linear equations relevant to construction applications using matrix methods

LO3 Approximate solutions of contextualised examples with graphical and numerical methods

LO4 Review models of construction systems using ordinary differential equations.
Essential Content

**LO1** Apply instances of number theory in practical construction situations

*Number theory*
- Bases of a number (e.g., denary, binary, octal, duodecimal, hexadecimal) and converting between bases
- Types of numbers (e.g., natural, integer, rational, real, complex)
- The modulus, argument and conjugate of complex numbers
- Polar and exponential form of complex numbers
- The use of de Moivre’s Theorem in engineering
- Complex number applications (e.g., electric circuit analysis, information and energy control systems)

**LO2** Solve systems of linear equations relevant to construction applications using matrix methods

*Matrix methods*
- Introduction to matrices and matrix notation
- The process for addition, subtraction and multiplication of matrices
- Introducing the determinant of a matrix and calculating the determinant for a $2 \times 2$ matrix
- Using the inverse of a square matrix to solve linear equations
- Gaussian elimination to solve systems of linear equations (up to $3 \times 3$)

**LO3** Approximate solutions of contextualised examples with graphical and numerical methods

*Graphical and numerical methods*
- Standard curves of common functions, including quadratic, cubic, logarithm and exponential curve
- Systematic curve sketching knowing the equation of the curve
- Using sketches to approximate solutions of equations
- Numerical analysis using the bisection method and the Newton–Raphson method
- Numerical integration using mid-ordinate rule, the trapezium rule and Simpson’s rule
LO4 **Review models of construction systems using ordinary differential equations**

*Differential equations*

Formation and solutions of first-order differential equations

Applications of first-order differential equations (e.g., RC and RL electric circuits, Newton's laws of cooling, charge and discharge of electrical capacitors, complex stresses and strains)

Formation and solutions of second-order differential equations

Applications of second-order differential equations (e.g., mass-spring-damper systems, information and energy control systems, heat transfer, automatic control systems and beam theory and RLC circuits)

Introduction to Laplace transforms for solving linear ordinary differential equations

Applications involving Laplace transforms (e.g., electric circuit theory, load frequency control, harmonic vibrations of beams and engine governors)
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Apply instances of number theory in practical construction situations</td>
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<tr>
<td><strong>P1</strong> Apply addition and multiplication methods to numbers that are expressed in different base systems.</td>
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<tr>
<td><strong>P2</strong> Solve construction problems using complex number theory.</td>
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<tr>
<td><strong>P3</strong> Perform arithmetic operations using the polar and exponential form of complex numbers.</td>
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<tr>
<td><strong>M1</strong> Deduce solutions of problems using de Moivre's Theorem.</td>
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<tr>
<td><strong>D1</strong> Test the correctness of a trigonometric identity using de Moivre's Theorem.</td>
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<td><strong>LO2</strong> Solve systems of linear equations relevant to construction applications using matrix methods</td>
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<tr>
<td><strong>P4</strong> Ascertain the determinant of a $3 \times 3$ matrix.</td>
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<td><strong>P5</strong> Solve a system of three linear equations using Gaussian elimination.</td>
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<td><strong>M2</strong> Determine solutions to a set of linear equations using the inverse matrix method.</td>
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<td><strong>D2</strong> Validate all analytical matrix solutions using appropriate computer software.</td>
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<tr>
<td><strong>LO3</strong> Approximate solutions of contextualised examples with graphical and numerical methods</td>
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<td><strong>P6</strong> Estimate solutions of sketched functions using a graphical estimation method.</td>
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<td><strong>P7</strong> Identify the roots of an equation using two different iterative techniques.</td>
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<td><strong>P8</strong> Determine the numerical integral of construction functions using two different methods.</td>
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<td><strong>M3</strong> Evaluate construction problems to formulate mathematical models using numerical and graphical methods.</td>
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<td><strong>D3</strong> Critique the use of numerical estimation methods, commenting on their applicability and the accuracy of the methods.</td>
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<tr>
<td><strong>LO4</strong> Review models of construction systems using ordinary differential equations</td>
<td><strong>P9</strong> Determine first-order differential equations using analytical methods. <strong>P10</strong> Determine second-order homogeneous and non-homogenous differential equations using analytical methods. <strong>P11</strong> Calculate solutions to linear ordinary differential equations using Laplace transforms.</td>
<td><strong>M4</strong> Analyse how first-order differential equations are used to solve structural or environmental problems. <strong>D4</strong> Evaluate first- and second-order differential equations when generating the solutions to construction problems.</td>
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</table>
Recommended Resources

Print resources

Links
This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 7: Surveying, Measuring & Setting-out
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 10: Measurement & Estimating
- Unit 16: Principles of Public Health Engineering
- Unit 21: Geotechnics & Soil Mechanics
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 41: Highway Engineering
- Unit 43: Advanced Surveying & Measurement
- Unit 49: Advanced Electrical Design & Installation.
Unit 35: Sustainable Methods of Construction

Level: 5
Credits: 15
Ofqual Code: T/618/8111

Introduction

The construction industry seeks to be dynamic and forward thinking but, in reality, most buildings are still constructed using many of the same materials and processes that have been utilised for centuries. While there is accumulated knowledge in the use of ‘tried-and-tested’ methods, these are not always the most efficient or cost effective. Combined with this is the fact that the construction industry is one of the largest contributors to CO2 emissions and is under increasing pressure, and legislation, to improve its processes and practices.

However, the industry faces further challenges. As one of the most important sectors of the global economy, it is imperative that construction is able to meet the demands for housing, office, institutional and commercial development. Continuing to build using traditional methods will not be sufficient. One of the ways in which the sector is exploring how to address sustainability and increase productivity is through the development and implementation of alternative forms of construction.

On successful completion of this unit, students will have examined how the construction industry impacts on the environment, explored alternative construction methods that are fit for purpose, considered government policy implications and health and safety constraints associated with alternative construction methods, and designed a fit-for-purpose structure using an alternative construction method.
Learning Outcomes

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

LO1  Examine how the construction industry impacts on the environment and how changes in the industry can create broader social and economic benefits

LO2  Explore sustainable construction methods that are fit for purpose in a given context

LO3  Discuss the potential benefits and challenges associated with different forms of sustainable construction

LO4  Present a design proposal, utilising a selected sustainable construction method, and explain how it is ‘fit for purpose’ in the given context.
Essential Content

LO1 Examine how the construction industry impacts on the environment and how changes in the industry can create broader social and economic benefits

Environmental impact
Global warming
Carbon emissions
Construction statistics (e.g., carbon emissions, energy consumption)

Social and economic factors
Industry contribution to national economies
Government targets (e.g., carbon reduction, energy use)
International agreements/accords (e.g., Paris Agreement, Kyoto Protocol)
Housing demand (e.g., affordable homes, housing market)
Urbanisation (greenfield use, brownfield sites)

Sustainability protocols
Passivhaus/Passive House
BREEAM
LEED
SAP (Standard Assessment Procedure)
Code for Sustainable Homes

LO2 Explore sustainable construction methods that are fit for purpose in a given context

Timber systems
Timber frame
Cross-laminated timber

Off-site manufacture
Prefabrication
Panelised systems (e.g., structural insulated panels (SIP), ceramic composite panels)
Volumetric systems
Modularisation/componentisation
Other

*Traditional*
Rammed earth
Cob/adobe
Sandbag
Straw bale
Other

**LO3 Discuss the potential benefits and challenges associated with different forms of sustainable construction**

*Potential benefits*
Improved working conditions (e.g., off-site construction in controlled environment)
Reduced environmental impact (e.g., reduced waste, lower emissions, better component/building performance, better use of renewables)
Faster construction (e.g., off-site construction has less impact from adverse weather, automated systems can operate longer hours, modular/panelised systems require less time on site)
More reliable/higher quality (e.g., off-site construction works at lower tolerances, less human error, technology integration throughout process)

*Challenges*
Market acceptance (e.g., public perception of ‘new’, untested at larger-scale buildings)
Industry investment (e.g., cost of off-site facilities, retraining of staff, closing ‘skills gaps’)
Legislation and regulation (e.g., some building regulations do not support alternative methods, complex health and safety regulations (off-site+on-site))
LO4 **Present a design proposal, utilising a selected sustainable construction method and explain how it is ‘fit for purpose’ in the given context**

*Client requirements*
Building use
Budget
Environmental targets

*Project type*
Residential (e.g., multi-occupancy, apartments, flats)
Commercial (e.g., office buildings, shopping centres)
Cultural (e.g., museums, theatres, stadiums, exhibition halls)
Industrial (e.g., factories, warehouses, garages)
Medical/scientific (e.g., hospitals, clinics, laboratories)

*Project scale*
Single-storey vs multi-storey
Long-span
High traffic (e.g., large number of occupants/users)

*Design proposal*
Strategy
Feasibility (e.g., construction costs, operational costs)
Drawings/models (e.g., plans, sections, elevations, details)
Permissions (e.g., planning permissions, building regulations, health and safety)
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1 Examine how the construction industry impacts on the environment, and how changes in the industry can create broader social and economic benefits</strong></td>
<td><strong>P1 Explore how the construction industry has an impact on the environment.</strong></td>
<td><strong>D1 Evaluate the potential for environmental protection through the specification of sustainable construction methods.</strong></td>
</tr>
<tr>
<td><strong>P2 Examine how social and economic factors have an effect on the construction industry.</strong></td>
<td><strong>M1 Assess how effective government targets and national statistics have been on environmental protection.</strong></td>
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</tr>
<tr>
<td><strong>LO2 Explore sustainable construction methods that are fit for purpose in a given context</strong></td>
<td><strong>P3 Examine the development of sustainable construction methods using examples.</strong></td>
<td><strong>M2 Compare sustainable construction methods in terms of effectiveness, cost and performance.</strong></td>
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<tr>
<td><strong>P4 Explore sustainable construction methods and their application to different building types.</strong></td>
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</table>
| **LO3** Discuss the potential benefits and challenges associated with different forms of sustainable construction. | **P5** Explore the potential benefits of sustainable methods of construction.  
**P6** Explain the challenges associated with sustainable methods of construction. | **M3** Illustrate the ways in which different sustainable methods of construction may address challenges.  
**D2** Justify the use of a chosen sustainable construction method in meeting a range of challenges. |
| **LO4** Present a design proposal, utilising a selected sustainable construction method, and explain how it is ‘fit for purpose’ in the given context. | **P7** Produce design and technical information to support a proposed sustainable method of construction for a given building type.  
**P8** Present a design proposal that utilises sustainable methods of construction. | **M4** Evaluate the integration of health and safety, building regulations and statutory requirements in a sustainable construction proposal. |
Recommended Resources

Print resources
MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links
This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 15: Principles of Alternative Energy
- Unit 23: Construction Economics & Sustainability
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 47: Advanced Building Information Modelling.
Unit 36: Value Engineering & Cost Control

Level: 5
Credits: 15
Ofqual Code: L/618/8132

Introduction

A client’s project needs to meet three essential outcomes. The first is value, the second time and the last quality. Value is the primary one that includes costs associated with the design, installation, operating and maintaining of the client’s project. A client in today’s economy expects a project to deliver ‘value for money’ against the functional use of the completed project. If alternatives can be explored that deliver the same outcomes for less expenditure, then substantial cost savings can be made. Value engineering, value planning and value analysis are all terms that are associated with such processes in ensuring that a client receives the best possible outcome for their project investment.

Savings should not be seen as short-term goals but as longer term – over the life of a building from cradle to grave. This is termed ‘lifecycle costing’ and explores the costs associated with the whole life of a building. It may be prudent to spend more initially, to gain long-term savings over the life of a building. The quantity surveyor or cost consultant can, therefore, advise a client on initial expenditure and where their investment in the project gives the greatest engineered value in the long run. This is often the role of the professional quantity surveyor, engaged as the client's consultant.

In this unit, students will explore the application of value engineering principles to scenarios or case studies in order to develop an understanding of how they are applied in a construction context. Students will also explore the various methods used to control costs. Through an understanding of cost control and value engineering, students will develop their knowledge and skills in order to manage and reconcile project costs.

Learning Outcomes

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

LO1 Explain the principles of value engineering in construction projects
LO2 Apply value engineering principles to a construction project
LO3 Describe the principles of cost control in construction projects
LO4  Demonstrate the application cost analysis for a given construction project.

**Essential Content**

**LO1**  **Explain the principles of value engineering in construction projects**

*Value planning*
- Information gathering stages
- Idea planning
- Definitions, clarifications, agreement, approval planning
- Initial planning stages design, feasibility
- Strategic briefing planning
- Revisions of design into final design/specification
- Project brief, integration of value concepts into the technical design
- Production of final specification/drawings
- Resource analysis

*Value engineering*
- Identification of costs associated with whole project lifecycle
- Identification of unnecessary costs and functions
- Assessment of the availability of resources
- Analysis of building methods
- Site limitations
- Environmental impact analysis
- Sustainability analysis
- Identification of best value alternatives
- Development of alternative solutions
- Selection of alternatives in meeting strategic brief
- Full costing of alternatives
- Approval and inclusion of alternatives
- Allocation of costs to alternative solutions
Value analysis
Breakdown of project into packages
Earned value analysis of packages
Actual outputs
Planned outputs
Measurement of actual against planned resources
Charts and plotting graphs
Benchmarking

LO2 Apply value engineering principles to a construction project

Project information
Client’s detailed brief
Working drawings
Specifications

Analysis of project
Functionality
Sustainability
Environmental impact
Budget cost breakdown
Alternative specifications versus functionality

Alternative proposals
Material alternatives
Construction process alternatives (e.g., methods, time)
Procurement alternatives
Costing of alternative proposals
Lifecycle costing evaluations (e.g., construction costs, energy costs, environmental impact, operational costs)
Acceptance of proposals from client
Calculation of re-valued costs/savings made
Revision of budget
LO3 Describe the principles of cost control in construction projects

Client's perspective
- Tendering procedures to obtain a contractor
- Tender adjudication
- Tender figures analysed against budget
- Cost-reduction measures
- Revision to budget
- Award of contract
- Variations to contract
- Contract cost monitoring and reporting
- Final account

Main contractor perspective
- Control of materials (e.g., analysis of estimated costs, purchase against estimated costs, reduction in wastage, alternative specifications, offsite prefabrication)
- Control of labour (e.g., use of labour-only subcontractors on agreed output rates, domestic subcontract packages, directly employed labour, calculation of a project's total labour hours)
- Control of plant (e.g., plant costs, total plant hours, transport costs, mobilisation costs)
- Control of subcontractors (e.g., nominated and named, domestic packages, values within estimate, actual nett package values)
- Cost value reconciliation (e.g., main contractor's costs vs valuations, time intervals conducted, calculation of revenue/value, calculation of total expenditure, adjustments to costs (materials delivered not invoiced, time lag on invoices, delays, losses))
- Reconciliation of costs vs revenue
- Comparison against projected project margin
- Charts and management graphic records
- Reporting to company directors
- Action planning

Cost control relationships
- Managing expectations
- Avoiding and managing conflicting aims
- Working to ensure quality and safety
LO4  **Demonstrate the application cost analysis for a given construction project**

*Project definition*
Project type
Project scale
Project estimate
Predicted expenditure versus revenue
Costs to date
Revenue to date
Variations to date
Architects’ instruction to date
Cost adjustment data
Re-plotting of margin analysis chart

*Cost benefit analysis*
Analysis of costs and calculation against time interval
Analysis of revenue to date
Calculation of profit margin or loss
Cost adjustment for future unrecoverable expenditure
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th></th>
<th>Pass</th>
<th>Merit</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Explain the principles of value engineering in construction projects</td>
<td><strong>P1</strong> Describe the concepts of value planning and value engineering.</td>
<td><strong>M1</strong> Analyse value planning alongside value engineering.</td>
<td><strong>D1</strong> Evaluate the benefits of value analysis and value engineering for a given project.</td>
</tr>
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<td></td>
<td><strong>P2</strong> Discuss the ways in which value engineering seeks to balance quality, cost and sustainability.</td>
<td></td>
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</tr>
<tr>
<td><strong>LO2</strong> Apply value engineering principles to a construction project</td>
<td><strong>P3</strong> Produce a value analysis of a project.</td>
<td><strong>M2</strong> Calculate the lifecycle costs of alternative value engineered proposals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>P4</strong> Describe alternative value proposals for a project.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Describe the principles of cost control in construction projects</td>
<td><strong>P5</strong> Describe cost control from the client and contractor perspective.</td>
<td><strong>M3</strong> Analyse the potential areas of difference in cost control between client and contractor.</td>
<td><strong>D2</strong> Justify revised proposals in achieving the project margin.</td>
</tr>
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<td></td>
<td><strong>P6</strong> Discuss the potential areas of conflict in cost control.</td>
<td></td>
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</tr>
<tr>
<td><strong>LO4</strong> Demonstrate the application cost analysis for a given construction project</td>
<td><strong>P7</strong> Describe the concept of cost benefit analysis.</td>
<td><strong>M4</strong> Devise alternative proposals to pull a contract back onto target margins.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>P8</strong> Produce a cost value reconciliation for a specific construction project.</td>
<td></td>
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</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
https://bit.ly/3f8vGAP  
Designing Buildings Wiki – Cost Control in Building Design and Construction (Article)

Designing Buildings Wiki – Value Engineering (Article)

Royal Institution of Chartered Surveyors (Professional Body)

Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 23: Construction Economics & Sustainability
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 29: Contracts & Management
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 54: Advanced Quantity Surveying Practice.
Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation

Level: 5
Credits: 15
Ofqual Code: A/618/8112

Introduction

Modern high-rise and multi-zone buildings have complex requirements for heating, cooling and ventilation. Their scale, number of occupants and need for better performance and efficiency, mean that the design and installation of systems for heating, cooling and ventilation are critical.

This unit supports students to build an understanding of the broad application of technologies and design techniques used to satisfy the requirements in large commercial or complex/multi-zone buildings.

Topics included in this unit include: hydraulic and control strategies for heating, sustainable technologies, ventilation systems for forced air and passive ventilation, complex distribution and plan strategies for air conditioning, and related design and installation factors.

Learning Outcomes

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

LO1 Discuss the HVAC systems and technologies that serve large commercial or complex/multi-zone buildings

LO2 Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems

LO3 Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems

LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building.
Essential Content

LO1 Discuss the HVAC systems and technologies that serve large commercial or complex/multi-zone buildings

*Heating*
Sources of heat
Distribution
Heat exchange
Types of heating methods/emitters
Efficient design principles
Renewables
Fuel sources

*Ventilation*
Central, zonal and local systems
Supply, extract and combined systems
Air handling plan
Filtration
Ductwork
Pressure cascades/containment
Heat recovery and efficient operation

*Air conditioning*
Sources of cooling
Water and refrigerant distribution
Water-based systems
Refrigerant-based systems
Air-distributed systems
Means of cooling air, dehumidifying and humidifying
Terminal devices
Design and installation factors
Client requirements
Project type
Performance requirements
Health and safety requirements

LO2 Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems

Heating
Centralised vs decentralised plant
Temperature grades
Pumps, valves
Boiler selection
Typical schematics for system types

Ventilation
Requirement for ventilation
Identify specialist air handling components
Air handling unit configuration and build quality
Specialist filtration or extract systems
Constant volume vs variable- or demand-based systems
Specialist HVAC systems
Consider the material requirements for cleaning, hygiene, chemical resistance and fire rating

Air conditioning
Distribution distance
Terminal devices
Combined ventilation and cooling systems
Temperature and humidity, setpoints
Legislation and regulation
Building regulations
Public health regulations
Professional codes of practice
Health and safety legislation
Site safety requirements
Energy consumption regulations
Emissions regulations

LO3 Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems

General
Regulations and compliance requirements (e.g., building regulations, public health regulations)
National and international sustainability targets (e.g., climate accords, international agreements, national targets)
Assessment and certifications (e.g., BREEAM, LEED, Energy Performance Certificates (EPC), Display Energy Certificates)
Credit systems (e.g., Renewable Energy Credits (REC), Renewables Obligation Certificates (ROC), Renewable

Heating
Renewable and biofuel sources
Combined heat and power (CHP)
Heat pumps
Solar collectors
Waste heat
Condensing boilers

Ventilation
Heat recovery
Fan and motor technologies
Variable air volume systems and active demand based
Cooling
Tri-generation
Links to CHP and waste heat
Adiabatic cooling
F-gas regulations
Compressor and control technologies
Free cooling
High-efficiency refrigerant systems
High-efficiency water systems
Air source vs ground/water
Source heat pumps

LO4 Present a proposal for an advanced HVAC system for a complex/multi-zone building

Heating
Plant sizing for large-scale projects
Delta Ts throughout network
Control and turndown of plant

Ventilation
Plant sizing for large-scale projects
Air volumes
Operation and control of plant

Cooling
Plant sizing for large-scale projects
Water-based cooling
Limitations in refrigerant pipework distances
Control and turndown of plant
Construction information

Plant equipment selection and specification (e.g., heat generation, cooling system, ventilation fans, calculations for sizing)
Component selection and specification (e.g., heat emitters, terminal devices, air-handling, ductwork, calculations for sizing)
Drawings (plant room layout, ductwork schematics, heat emitter locations, ventilation intake and terminal locations)

Commissioning

Testing of water supply and quality (e.g., hot and cold water)
Heating system (e.g., heat production, heat distribution, heat recovery, temperature control)
Cooling system (e.g., air conditioning components, temperature control)
Ventilation (e.g., air changes, supply and return air, ductwork, acoustics)
Waste systems
HVAC system controls
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tr>
<td><strong>LO1</strong> Discuss the HVAC systems and technologies that serve large commercial or complex/multi-zone buildings</td>
<td></td>
<td><strong>D1</strong> Propose changes to an existing HVAC installation in order to better meet current legislative and regulatory requirements.</td>
</tr>
<tr>
<td><strong>P1</strong> Discuss the HVAC systems commonly used for commercial buildings.</td>
<td><strong>M1</strong> Illustrate the HVAC operation of a given complex/multi-zone building.</td>
<td></td>
</tr>
<tr>
<td><strong>P2</strong> Review plant items and distribution methods for advanced HVAC systems.</td>
<td></td>
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</tr>
<tr>
<td><strong>LO2</strong> Analyse the design requirements for large commercial or complex/multi-zone buildings when specifying heating, ventilation or air conditioning components and systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Discuss the current legislation and codes of practice that influence the design and selection of HVAC systems.</td>
<td><strong>M2</strong> Assess the impact of regulation and legislation on the selection of HVAC components and systems.</td>
<td></td>
</tr>
<tr>
<td><strong>P4</strong> Review an existing HVAC system, for a given complex/multi-zone building, with regard to the way it meets current legislation and regulation requirements.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Explain how sustainability can be integrated into the design, installation and operation of large-scale and complex HVAC systems.</td>
<td><strong>P5</strong> Discuss the economic and legislative drivers for sustainability in HVAC systems. <strong>P6</strong> Assess the effectiveness of different approaches to sustainability in HVAC system design, installation and operation.</td>
<td><strong>D2</strong> Justify the specification and design of an HVAC system for a given large-scale building in how it provides a sustainable solution to the heating, cooling and ventilation needs. <strong>M3</strong> Demonstrate how different sustainable HVAC strategies result in lower power consumption and/or lower emissions.</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a proposal for an advanced HVAC system for a complex/multi-zone building.</td>
<td><strong>P7</strong> Specify the plant, distribution system and components, based on calculation, for the HVAC system of a given large-scale building. <strong>P8</strong> Produce the construction information required to support the installation and commissioning of an HVAC system in a given large-scale building.</td>
<td><strong>M4</strong> Compare alternative HVAC systems designs to determine the optimal solution for a given large-scale building.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
AL-SHEMMERI, T., PACKER, N. (2021), *Building Services Engineering*, John Wiley & Sons
BUTCHER, K. (2005), *Heating, Ventilating, Air Conditioning and Refrigeration*, Chartered Institution of Building Services Engineers

Links
This unit links to the following related units:
- Unit 3: Science & Materials
- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 13: Building Information Modelling
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 48: Thermofluids & Acoustics
- Unit 49: Advanced Electrical Design & Installation
- Unit 50: Building Management Systems.
Unit 38: Advanced Quantities for Complex Building Projects

Level: 5  
Credits: 15  
Ofqual Code: F/618/8113

Introduction

This unit has been designed to enable students studying construction, civil engineering and building services engineering to apply, analyse and measure a range of components and elements found in large-scale buildings or structures, and to produce quantities within the function of a quantity surveyor.

Topics included within this unit are: estimating techniques, standard methods of measurement, taking-off dimensions, preparation of bills of quantities, estimating data collection and the assembly of an estimate for a work package.

On successful completion of this unit, students will be in a position to take-off quantities from drawn information and to prepare estimates for work packages. Students will also have the fundamental knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Apply measurement techniques to a range of complex situations
LO2 Produce measured quantities for a range of elements and components on large-scale projects
LO3 Develop relevant contract preamble and preliminary items for given situations
LO4 Create measured bills of quantities and schedules using both manual and computer techniques.
Essential Content

**LO1 Apply measurement techniques to a range of complex situations**

Standard techniques applied to the measurement of large-scale projects or developments

Production of bills of quantities for work sections

Production of schedules (e.g., reinforcement, door, window, ironmongery, finishes)

Measurement of variations on a project

Production of sub-contract

Production of supply packages

Production of final accounts

Specialist works

Maintenance works

Refurbishment works

**LO2 Produce measured quantities for a range of elements and components on large-scale projects**

Substructures

Foundations (e.g., footings, pilings, basements, underpinning)

Earthworks (e.g., site stabilisation, retaining walls, culverts)

Superstructures

Concrete and steel framed buildings (e.g., in situ, pre-cast and pre-stressed concrete structures, brick and masonry structures)

Cladding and curtain walling (e.g., secondary structure, cladding materials, curtain wall systems)

Masonry buildings (e.g., brick, concrete block)

Roofs and roofing (flat roofs, pitched roofs, green roofs, flashing, cladding, parapets)

Windows and doors (e.g., internal doors, external doors, fire-ratings, casement windows, double-hung windows)
Finishes (e.g., internal, external, flooring, wall treatments, flame spread ratings)
Stairs and lifts (e.g., internal stairs, escape stairs, passenger lifts, goods lifts, firefighter lifts)

*Building engineering services*
- Plumbing
- Heating
- Ventilation
- Air conditioning
- Electrical installations
- Above and below ground disposal systems

*Building Information Modelling (BIM) for measuring*

Opportunities and challenges

**LO3** Develop relevant contract preamble and preliminary items for given situations

*Production of preamble clauses*
- Forms of contract
- Contract conditions
- Parties to the contract
- Definitions
- Units
- Method of measurement
- Procurement process
- Extent of works
- Tender process
- Tender documents

*Production of preliminary clauses*
- Preconstruction activities
- Statutory approvals
- Quality procedures
- Insurance
Performance bonds and warranties
Possession
Reporting procedures by main contractor
Pre-construction health and safety plan
Site waste management plan (SWMP)
Contractors’ items (e.g., transport, supervision, accommodation, waste)

Moving and handling
Temporary services connections
Scaffolding
Temporary works

LO4 Create measured bills of quantities and schedules using both manual and computer techniques

Bills of quantities
Method of measurement (e.g., NRM, SMM7 (Legacy), CESMM, ICMS, IPMS)
Categorising Works (e.g., Common Arrangement of Work Sections (CAWS), Uniclass, Omniclass)
Elemental or Works Package preparation
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Apply measurement techniques to a range of complex situations</td>
<td><strong>M1</strong> Differentiate between a sub-contract and a supply package.</td>
<td><strong>D1</strong> Critically evaluate manual vs digital taking-off techniques.</td>
</tr>
<tr>
<td><strong>P1</strong> Produce a schedule for an element.</td>
<td><strong>P2</strong> Produce a sub-contract package.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Produce measured quantities for a range of elements and components on large-scale projects</td>
<td><strong>M2</strong> Take-off quantities using digital methodology.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Take-off quantities for a complex substructure element.</td>
<td><strong>P4</strong> Take-off quantities for a complex superstructure element.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Develop relevant contract preamble and preliminary items for given situations</td>
<td><strong>M3</strong> Justify the inclusion of preliminary clauses for a project.</td>
<td><strong>D2</strong> Critically analyse the preamble clauses of a contract in relation to stakeholders needs in a given project.</td>
</tr>
<tr>
<td><strong>P5</strong> Identify an appropriate form of contract for a given construction project.</td>
<td><strong>P6</strong> Develop contract preamble and preliminary clauses for a complex project.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Create measured bills of quantities and schedules using both manual and computer techniques</td>
<td><strong>M4</strong> Compare the accuracy of manual vs digital taking-off techniques.</td>
<td><strong>D3</strong> Justify the use of digital or manual taking-off for specific work sections of a bill of quantities.</td>
</tr>
<tr>
<td><strong>P7</strong> Produce a bill of quantities for a work section using manual techniques.</td>
<td><strong>P8</strong> Produce a bill of quantities for a work section using digital techniques.</td>
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</tbody>
</table>
Recommended Resources

Print resources


Web resources

(General Reference)

(Professional Body)

Links

This unit links to the following related units:

- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.
Unit 39: Personal Professional Development

Level: 5
Credits: 15
Ofqual Code: J/618/8114

Introduction

As a professional, learning is a continuous and lifelong process. In the construction industry there are constant changes in technology, materials, processes, legislation and practice. In order to stay up to date, it is necessary to recognise the potential of both structured, classroom-based learning and the learning gained through professional activities ‘on the job’.

This unit provides a framework in which students have the opportunity to reflect on and contextualise the learning they gain from working in the industry. In coordination with tutors and their employers, students will define the scope, duration and content of their expected work-based learning experience. Throughout the period of their work-based learning experience, students will be expected to record and reflect on their own learning.

Learning Outcomes

By the end of this unit, students will be able to:
LO1 Assess personal learning needs and opportunities in the context of employment
LO2 Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor
LO3 Record personal progress and the feedback of others; responding as appropriate to own future development
LO4 Evaluate own learning, based on personal experience and comments from others, in order to plan for the future.
Essential Content

LO1 Assess personal learning needs and opportunities in the context of employment

Learning styles
Visual, aural, verbal, physical, logical, social, solitary
Identifying own learning style

Continuous Professional Development (CPD)
Training vs development
Personal need vs employer need

Identifying personal needs
Skills audit
Future plans

Employer needs
Skills gaps
Company goals

Industry needs
Supporting equality and diversity
Ensuring quality in the built environment
Improving health and safety

LO2 Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor

Setting goals
SMART goals (specific, measurable, attainable, relevant, time-bound)
Learning goals vs employment goals

Learning plan
Goals
Actions
Resources
Professional recognition

Professional bodies
CPD requirements of professional recognition
Professional recognition levels (e.g., technician, registered, chartered, fellow)
Professionalism (e.g., codes of conduct, codes of practice)

LO3 Record personal progress and the feedback of others; responding as appropriate to own future development

Employer feedback
360-degree feedback
Performance management

Learning/development record
Reflection vs description

LO4 Evaluate own learning, based on personal experience and comments from others, in order to plan for the future

Reflective practice
Kolb: Learning Cycle
Gibbs: Reflective Model
Brookfield: ‘Four Lenses’

Evaluating success
Measurement
Learning from failure

Future planning
CPD and lifelong learning Personal Development Planning (PDP) Career goals, personal goals, company goals
Developing management skills (managing work, managing people, dealing with conflict)
<table>
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<tr>
<td><strong>Pass</strong></td>
</tr>
<tr>
<td><strong>LO1</strong> Assess personal learning needs and opportunities in the context of employment</td>
</tr>
<tr>
<td><strong>P2</strong> Undertake a skills audit to define areas of personal development/training needs.</td>
</tr>
<tr>
<td><strong>LO2</strong> Plan and manage own personal learning journey, through consultation with employer and/or tutor/instructor</td>
</tr>
<tr>
<td><strong>P4</strong> Present a personal development plan to an employer and/or tutor.</td>
</tr>
<tr>
<td><strong>LO3</strong> Record personal progress and the feedback of others; responding as appropriate to own future development</td>
</tr>
<tr>
<td><strong>P7</strong> Assess own learning and development through reflection and 360-degree feedback.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

RAELIN, J. (2008), *Work-Based Learning*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 12: Tender & Procurement
- Unit 20: Site Supervision & Operations
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 44: Maintenance & Operations.
Unit 40: Surveying for Conservation, Renovation & Refurbishment

Level: 5
Credits: 15
Ofqual Code: L/618/8115

Introduction

A building survey is a systematic inspection of a property to record its size and condition at any given time. The surveyor records the methods of construction, key features and their condition. What if the building is 300 years old, or even 100 years old? Is it the same process, are the same skills and knowledge required?

This unit introduces students to the process, techniques and underpinning knowledge required to undertake a survey of a building. The focus is on surveying the condition of the fabric rather than a measured survey. However, where appropriate, consideration will be given to taking measurements to record the condition of the building. Students will consider the different styles and methods of construction, how to analyse them and how they typically fail over time. The unit takes a practical approach, drawing on initial learning and knowledge and applying it to surveying a property and producing a professional, detailed survey report for a variety of end users.

Successful completion of this unit will give students a good understanding of the built environment and the methods of surveying it. The unit will be useful to any students working in the conservation, conversion and adaptation fields. However, those following a management or technician route will also benefit from the knowledge of historic methods of construction.

Learning Outcomes

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

LO1 Examine an existing building to determine its character and the need for renovation or refurbishment

LO2 Analyse a given building to determine the range of methods/systems used in its construction

LO3 Assess mechanisms of failure and deterioration in buildings

LO4 Present a building survey report in support of a proposed renovation or refurbishment scheme.
Essential Content

LO1 Examine an existing building to determine its character and the need for renovation or refurbishment

*Residential property*
- Private residential
- Multi-occupancy (e.g., flats, apartments)

*Commercial buildings*
- Retail (e.g., shop, restaurant, shopping mall)
- Office (e.g., small office building, high-rise office building)
- Multi-use (e.g., office, retail, residential)

*Cultural buildings*
- Museums/galleries
- Performance halls

*Industrial buildings*
- Factories
- Warehouses

*Medical buildings*
- Hospitals
- Clinics
- Laboratories

*Interiors*
- Residential interiors
- Commercial interiors
- Medical interiors

*Renovation vs refurbishment*
- Renovation (e.g., substantive changes, structural modifications, extension)
- Refurbishment (e.g., minimal changes, making good, upgrading, includes preservation, conservation and restoration)
Issues for historic buildings

Architectural periods (e.g., Victorian, Georgian, Edwardian, Modernist)

Preservation (e.g., protection from further deterioration, maintaining as much as possible, minimal changes, safety and history driven)

Conservation (e.g., unaltered condition, reversible changes, maintain original materials, history driven)

Restoration (e.g., return to original, use of original materials and processes, aesthetically driven)

LO2 Analyse a given building to determine the range of methods/systems used in its construction

Framed construction

Timber framing (e.g., machined timber, green timber)

Iron and steel framing

Framed construction infill (e.g., wattle and daub, brick, stone, concrete, timber)

Timber cavity walls

Insulation in framed construction

Masonry construction

Dry stone

Dressed stone

Concrete block

Brick

Mud brick (e.g., adobe)

Masonry cavity walls

Insulation in masonry construction

Curtain walling

Secondary structure

Curtain walling material (e.g., glass, composite panels, stone panels)

Other construction methods

Rammed earth

Cobb
**Roof construction**
Roof form (e.g., flat, pitched, mansard, dome, conical)
Roof framing (e.g., timber, steel, truss, masonry)
Roof covering (e.g., slate, clay tiles, thatch, green roof, battens, felt, asphalt, bitumen)

**LO3 Assess mechanisms of failure and deterioration in buildings**

**Structural failure**
Lateral and vertical movement
Subsidence
Material failure
Overloading
Component removal
Alterations
Poor design
Change of use

**Deterioration due to water penetration**
Damp
Timber rot (e.g., dry and wet)
Corroded metals
Erosion
Freeze/thaw
Corrosion

**Other mechanisms of failure and deterioration**
Fungal attack
Insect attack on timber and masonry
Fire
Thermal movement (e.g., expansion, shrinkage)
Human impact (e.g., vandalism, arson, accidental damage)
LO4  **Present a building survey report in support of a proposed renovation or refurbishment scheme**

*Undertaking a building survey*

Health and safety considerations
Dangerous structures
Deleterious materials
Fragile structures

*Statutory regulations for historic buildings*

*Recording information*

Detailed notes
Sketches
Photographs
Measurements
Levels
Electronic data collection methods

*Level of work*

Renovation
Refurbishment
Conservation

*Presenting information*

Survey report styles
Formats
Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Examine an existing building to determine its character and the need for renovation or refurbishment</td>
<td><strong>P1</strong> Discuss different building types and their characteristics.</td>
<td><strong>D1</strong> Critically analyse the relationship between architectural style, building type and materials in a given building.</td>
</tr>
<tr>
<td><strong>P2</strong> Discuss the difference between conservation, preservation and restoration in historic buildings.</td>
<td><strong>M1</strong> Evaluate the development of architectural styles in relation to cultural context.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Analyse a given building to determine the range of methods/systems used in its construction</td>
<td><strong>P3</strong> Explore the methods of construction in a given building.</td>
<td><strong>M2</strong> Evaluate the relationship between material and construction method.</td>
</tr>
<tr>
<td><strong>P4</strong> Analyse the way that roof structure and wall structure work together for a given building.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Assess mechanisms of failure and deterioration in buildings</td>
<td><strong>P5</strong> Differentiate between mechanisms of failure and deterioration in the fabric of a building.</td>
<td><strong>M3</strong> Evaluate the condition and defects, and determine reasons for failure in a given building.</td>
</tr>
<tr>
<td><strong>P6</strong> Analyse building defects and explain the mechanism of their failure.</td>
<td><strong>D2</strong> Justify a proposal for conservation/renovation or restoration of a given building, with reference to surveyed defects.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Present a building survey report in support of a proposed renovation or refurbishment scheme</td>
<td><strong>P7</strong> Plan and undertake a survey of a given building in relation to a proposed renovation or refurbishment scheme.</td>
<td><strong>M4</strong> Record the construction methods and condition of a given building.</td>
</tr>
<tr>
<td><strong>P8</strong> Produce a professional building survey report in support of a renovation or refurbishment scheme.</td>
<td><strong>M4</strong> Record the construction methods and condition of a given building.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


GLOVER, P. (2009), *Building Surveys*, Elsevier


Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 19: Principles of Structural Design
- Unit 23: Construction Economics & Sustainability
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 35: Sustainable Methods of Construction
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.
Unit 41: Highway Engineering

Level: 5
Credits: 15
Ofqual Code: D/618/8118

Introduction
The quick and flexible means of transport afforded to us by motor vehicles has transformed modern life. This ease of mobility is made possible by the construction and maintenance of our road system. The increased volume of traffic and the need to have an efficient road network to transport resources requires us to become more proactive in developing innovative highway solutions. In recent years, we have seen the introduction of ‘smart motorways’ and ‘guided busways’, however we require more creative and resourceful solutions for the future.

This unit explores the planning, design, construction and maintenance of our road infrastructure, including the supporting structures such as tunnels, bridges and full pavement construction.

On successful completion of this unit, students will be able describe a new route process for a highway and explain civil engineering aspects, including pavement types. They will also be able to appraise improvements to the existing road infrastructure.

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

LO1 Evaluate how a new highway route is identified, planned and designed
LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways
LO3 Specify a form of pavement construction for a given highway provision
LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning.
Essential Content

LO1  Evaluate how a new highway route is identified, planned and designed

*Highway identification and planning*
Assessment of traffic volumes
Variables affecting traffic volumes
Land acquisition procedures (including alignment design)
Public consultation (e.g., environmental impact assessment, public meetings, statutory requirements, health and safety)
Funding arrangements (e.g., proposed tolls, taxes)

*Highway design*
Horizontal and vertical alignment
Environmental impact assessment requirements
Proposed assessment of interchanges with existing infrastructure (including bridges, tunnels and junctions)
Provision and integration of any electronic toll collection infrastructure
Drainage systems (including sustainable urban drainage systems)
Highway users and user needs (e.g., general public, heavy goods vehicles, emergency use, access and maintenance)

LO2  Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways

*Earthwork operations methods*
Cut and fill balancing
Ground stabilisation techniques (e.g., lime injection, geogrid, retaining walls, specialist plant required)
Forming of embankments (retaining walls, angle of repose, stabilisation)
Engineering control of earthwork operations
Formation testing
Bridges
Formation of abutments
Active and passive span arrangement
Bridge deck and bearing details to be used
Architectural requirements of the structures
Typical types of highway bridges used

Tunnel provision
Formation of tunnel (e.g., cut and cover, pipe jacking, boring)
Boring machinery
Soils conditions
Proposed destination for surplus material
Maintenance arrangements
Materials used for tunnel linings

LO3 Specify a form of pavement construction for a given highway provision

Flexible pavement construction
Materials (e.g., dense bitumen macadam, high-density macadam, pervious macadam, mastic asphalt, hot rolled asphalt)
Properties and uses of aggregates
Common construction methods
Environmental performance
Skid resistance
Deterioration
Sub-base materials

Rigid pavement construction
Concrete (e.g., mix details, reinforcement, joint details)
Use of pavement trains
Environmental performance
Skid resistance
Deterioration
Sub-base materials
LO4 **Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning**

*Improvement to existing highway infrastructure*
- Use and effectiveness of ‘smart’ motorways
- Utilisation of redundant infrastructure
- Traffic management systems
- Technology to improve public transport systems
- Safety measures

*Maintenance planning and techniques*
- Common degradation processes for highway structures
- Essential or routine repair to concrete supporting infrastructure
- Renewing worn out pavement surfaces
- Repair schedule and asset management (e.g., surveying road conditions, digital asset management)
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1 Evaluate how a new highway route is identified, planned and designed</strong></td>
<td><strong>P1 Discuss how the route of a new section of highway is identified and planned.</strong></td>
<td><strong>M1 Analyse the relationship between highway use and traffic volumes.</strong></td>
</tr>
<tr>
<td><strong>P2 Explain the role of public consultation in higher planning.</strong></td>
<td><strong>D1 Critically analyse the properties of materials required for structural application in bridges and tunnels.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO2 Assess the methods of earthwork operations, bridges and tunnelling used in connection with the provision of highways</strong></td>
<td><strong>P3 Analyse the earthwork operations required for construction of a new highway in a developed area with difficult terrain.</strong></td>
<td><strong>M2 Evaluate the need for ground stabilisation associated with bridge and tunnel construction for a new highway.</strong></td>
</tr>
<tr>
<td><strong>P4 Review the earthwork processes involved in the formation of tunnels and bridges for a new highway.</strong></td>
<td><strong>D2 Justify the specification of a pavement type for a new highway, based on performance characteristics.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO3 Specify a form of pavement construction for a given highway provision</strong></td>
<td><strong>P5 Assess the requirements of a given highway construction proposal.</strong></td>
<td><strong>M3 Compare flexible and rigid pavement construction for a new highway.</strong></td>
</tr>
<tr>
<td><strong>P6 Specify the pavement type for a new highway construction.</strong></td>
<td><strong>D3 Critically evaluate proposed improvements to a highway infrastructure scheme to identify alternative approaches to improve performance and reliability.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO4 Present a proposal for improvements that can be made to a given highway infrastructure, including maintenance techniques and planning</strong></td>
<td><strong>P7 Present improvements to a given existing and new highway provision.</strong></td>
<td><strong>M4 Assess the techniques and methods that may improve the effectiveness and conditions of a given highway project.</strong></td>
</tr>
<tr>
<td><strong>P8 Discuss common highway faults and effective maintenance regimes as preventative measures for a given project.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources


Web resources


https://bit.ly/3f5HovJ  The Institute of Highways Engineers  (Professional Body)
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 36: Value Engineering & Cost Control
- Unit 42: Hydraulics
- Unit 43: Advanced Surveying & Measurement
- Unit 47: Advanced Building Information Modelling.
Unit 42: Hydraulics

Level: 5
Credits: 15
Ofqual Code: H/618/8119

Introduction

The action, management and distribution of fluids in relation to built structures is critical. In civil engineering, it is necessary to ensure that we are able to manage the pressures that water may put on structures, either through its flow or the forces exerted and how to resist these. In building services, the balance between necessary pressures to ensure flow and distribution of fluids (through heating/cooling systems or domestic water supplies), and the sizing of pipes to support this flow, will determine efficiency and effectiveness of a system.

However, fluids are dynamic; their behaviour changes based on a range of factors. Thus, the ability to estimate and manage their forces, rates of flow and suitable systems for control requires specialised calculations, equipment and maintenance.

In this unit, students will explore principles of hydrostatic and hydrodynamic fluids, calculate a range of factors and use these calculations to arrive at practical hydraulic solutions.

Learning Outcomes

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

LO1 Calculate forces related to fluids at rest and in motion
LO2 Develop practical solutions for the distribution of fluids within correctly sized pipes
LO3 Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems
LO4 Calculate the hydrostatic pressure exerted on substructures for a given context.
Essential Content

LO1 **Calculate forces related to fluids at rest and in motion**

Flow calculation
Bernoulli’s equation
Hydraulic radius
Velocity distribution
Reynolds number
Darcy-Weisback equation
Manning’s equation

*Energy*
The energy principle
The energy equation
Hydraulic grade
Energy grade
Energy loss/gain
Friction losses

LO2 **Develop practical solutions for the distribution of fluids within correctly sized pipes**

Flow in pipes
Darcy-Weisback equation
Chezy’s equation (Kutter’s equation)
Discharge
Head loss
Pipeline discharge
Orifice equation

*Open channel flow*
Steady/uniform flow
Manning’s equation
Specific energy/critical depth
Subcritical/supercritical flow
Non-uniform flow

LO3  **Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems**

*Fluid properties*
Density
Viscosity

*Fluid behaviour*
Viscous flow
Laminar flow
Turbulence
Boundary layer

LO4  **Calculate the hydrostatic pressure exerted on substructures for a given context**

*Hydrostatic pressure*
Forces on plane
Forces on submerged surfaces
Pascal's law
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Calculate forces related to fluids at rest and in motion</td>
<td><strong>M1</strong> Discuss the differences and similarities between different types of hydrodynamic systems and calculations.</td>
<td><strong>D1</strong> Assess pipework sizes to determine their efficiency in a given context.</td>
</tr>
<tr>
<td><strong>P1</strong> Solve a Darcy-Weisback equation for a given pressure pipe system.</td>
<td><strong>P2</strong> Solve a Manning's equation for a given open channel flow situation.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Calculate the head loss for a given pipeline.</td>
<td><strong>P4</strong> Define pipe sizes for a given set of flow parameters.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Develop practical solutions for the distribution of fluids within correctly sized pipes</td>
<td><strong>M2</strong> Evaluate pipe sizes to determine the flow type that will occur.</td>
<td></td>
</tr>
<tr>
<td><strong>LO3</strong> Apply concepts of physics to develop solutions to hydrostatic and hydrodynamic problems</td>
<td><strong>M3</strong> Compare proposed solutions to a hydraulics problem, highlighting the merits of different solutions.</td>
<td><strong>D2</strong> Critically analyse proposals for subsurface structures in response to the hydrostatic pressure in a given context.</td>
</tr>
<tr>
<td><strong>P5</strong> Evaluate a hydraulic condition in order to determine the parameters of the problem.</td>
<td><strong>P6</strong> Illustrate a proposed solution to a hydraulic problem, using drawings or models.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Calculate the pressure exerted on a foundation wall in a given context.</td>
<td><strong>P8</strong> Determine the pressure exerted on a subsurface floor in a given context.</td>
<td></td>
</tr>
</tbody>
</table>
**Recommended Resources**

**Print resources**


WYNN, P. (2014), *Hydraulics for Civil Engineers*, Inst of Civil Engineers Pub

**Web resources**

https://bit.ly/3BVZZ7y  
Chartered Institution of Civil Engineering Surveyors  
(Professional Body)

https://bit.ly/3fsrTP1  
Institution of Civil Engineers  
(Professional Body)

**Links**

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 8: Mathematics for Construction
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 21: Geotechnics & Soil Mechanics
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 45: Advanced Materials.
Unit 43: Advanced Surveying & Measurement

Level: 5
Credits: 15
Ofqual Code: Y/618/8120

Introduction

As technology advances, it is a means to enhance and improve the services that surveyors and civil engineers can provide to the construction industry. As the built environment increases in complexity, there is a need to apply systems and skills to ensure that the position of construction works are accurately controlled and monitored.

In this unit, students will use total station and Global Navigation Satellite System (GNSS). The unit focuses on instrument functionality to determine precise coordinate values and the processes required to produce industry-standard surveying outputs.

On successful completion of this unit, students will be able to setup a precise control network and combine the use of total station and GNSS functionality to produce accurate survey data for different construction uses.

Learning Outcomes

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

LO1 Explain the principles of GNSS, including modes of use, and relationships between coordinate systems

LO2 Conduct a 3D traverse survey of a control network to a ‘local grid’ to produce 3-dimensional coordinates, including corrections

LO3 Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods

LO4 Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error.
Essential Content

LO1 **Explain the principles of GNSS, including modes of use, and relationships between coordinate systems**

*Modes of occupation*
- Context and principles
- System components
- Communication and solutions

*Modes of operation*
- Differential
- Static
- Real Time Kinematic (RTK)
- Post processing Continuously Operating Reference Stations (CORS)
- Transformations (localisation) and residual errors

LO2 **Conduct a 3D traverse survey of a control network to a ‘local grid’ to produce 3-dimensional coordinates, including corrections**

*Total station methods of observation*
- Control networks
- Local and national coordinate systems
- Instrument settings, configuration and functionality
- Closed 3D traverse (e.g., horizontal planes, vertical planes)
- Production of 3D coordinate values and adjustments

LO3 **Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods**

*Total station*
- Working whole to part
- Instrument positioning and orientation to control
- Set up methods – risks and best practice
Topographic survey mode – organisation of topographic data

Codes and attributes

**GNSS**

Modes of occupation and best practice

Limitations of use

Organisation of topographic data (e.g., codes, attributes)

*Survey outputs and client deliverables*

Data transfer

CAD based modelling

Building Information Modelling (BIM)

2D drawing production

Post-processing (e.g., analysis of data, visual processes, software)

**LO4** Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error

*With total station*

Control error and base lines

Instrument settings as a source for error (e.g., EDM settings, prism constant, atmospherics, ATR, remote operation, coordinate systems, user scale factor, point filters, data management)

Strengths and weaknesses of on-board functionality, i.e. assisted workflows

*With GNSS*

Expected and actual accuracy

Limitations of use

Transformation residual errors with selected control stations and best practice

*Evaluation of ground length between total station and GNSS derived coordinates*
<table>
<thead>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Explain the principles of GNSS, including modes of use, and relationships between coordinate systems</td>
<td><strong>P1</strong> Describe the context and principles of GNSS. <strong>P2</strong> Illustrate the relationships between coordinate systems in GNSS. <strong>M1</strong> Assess the modes of operation in GNSS and their different uses.</td>
<td><strong>D1</strong> Analyse the impact of transformation and residual errors on the accuracy of GNSS coordinates.</td>
</tr>
<tr>
<td><strong>LO2</strong> Conduct a 3D traverse survey of a control network to a 'local grid' to produce 3-dimensional coordinates, including corrections</td>
<td><strong>P3</strong> Discuss the difference between local and national coordinate systems. <strong>P4</strong> Undertake a 3D traverse survey to obtain 3-dimensional coordinates and correction. <strong>M2</strong> Assess the impact of instrument settings and configuration on the accuracy of a 3D traverse survey.</td>
<td><strong>D2</strong> Critically evaluate the efficiency of producing topographic survey data from 3D data, obtained via GNSS and total station, using CAD or BIM applications.</td>
</tr>
<tr>
<td><strong>LO3</strong> Produce industry-standard survey output based on completion of a comprehensive topographic survey of landscape features and built structures, using total station and GNSS methods</td>
<td><strong>P5</strong> Carry out a comprehensive topographic survey using GNSS and total station methods. <strong>P6</strong> Prepare industry-standard survey outputs, including location of landscape features and built structures. <strong>M3</strong> Analyse the different levels of information and detail provided in CAD, BIM and 2D drawing output of survey data.</td>
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<tr>
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</tr>
<tr>
<td><strong>LO4</strong></td>
<td>Analyse the potential benefits and challenges of using total station and GNSS surveying methods, including sources of error</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong></td>
<td>Assess the benefits and challenges of using total station and GNSS for surveying.</td>
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</tr>
<tr>
<td><strong>P8</strong></td>
<td>Report on the sources of error and approaches to correction in the use of total station and GNSS for surveying.</td>
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</tr>
<tr>
<td><strong>M4</strong></td>
<td>Evaluate the use of total station and GNSS in surveying to identify best practice for their use.</td>
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</tr>
<tr>
<td><strong>D3</strong></td>
<td>Justify the selection of digital surveying tools and software, based on their accuracy and ability to provide suitable data.</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
https://bit.ly/3BVZZ7y  Chartered Institution of Civil Engineering Surveyors  
(Professional Body)
https://bit.ly/3fsrTP1  Institution of Civil Engineers  
(Professional Body)
(Professional Body)
(Professional Body)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 7: Surveying, Measuring & Setting-out
- Unit 10: Measurement & Estimating
- Unit 11: Financial Management & Business Practices in Construction
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 20: Site Supervision & Operations
- Unit 24: Principles of Off-site Construction
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 27: Law & Legal Frameworks in Quantity Surveying
- Unit 28: Group Project (Pearson-set)
- Unit 30: Project Management
- Unit 31: Advanced Structural Design
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 41: Highway Engineering
- Unit 44: Maintenance & Operations
- Unit 46: Transport Systems in Buildings
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.
Unit 44: Maintenance & Operations

Level: 5
Credits: 15
Ofqual Code: D/618/8121

Introduction

The aim of this unit is to give students background knowledge and understanding of the maintenance and operations required in relation to the safe and efficient use of buildings, in both specific contexts and in the wider environment.

Students will examine the different maintenance elements and materials available, the varied approaches to managing the processes of maintenance, the impact of planning and scheduling, how maintenance operations integrate with the wider environment and how these impact on core business activities.

Students will also explore the relationship of maintenance and operations as an integral part of the building lifecycle (‘from cradle to grave’) and how the wider external business environment impacts on the way in which maintenance and operations are managed.

On successful completion of this unit, students will have the knowledge to be able to make informed decisions as to how to manage the maintenance of a building from design stage through construction phase and into the stage of facilities management, taking into consideration the health and safety of the building and its occupants at all stages of the lifecycle.

Learning Outcomes

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

LO1 Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities

LO2 Compare different types of building maintenance and the management approaches that support them

LO3 Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently

LO4 Assess how maintenance and operations are managed as part of a wider business management strategy.
Essential Content

LO1 Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities

*Design team*
- Architects
- Planners
- Surveyors

*Construction team*
- Contractors
- Subcontractors
- Suppliers

*Consultants*
- Engineers (e.g., structural, building services)
- Project managers
- Health and safety managers
- Cost consultants

*Operational team*
- Facilities managers
- Building maintenance operatives

*Stakeholders*
- Client
- Developer
- Tenants
- Leaseholders
- Investors
LO2 Compare different types of building maintenance and the management approaches that support them

*Types of maintenance*
- Reactive maintenance
- Planned maintenance
- Cyclical maintenance
- Routine maintenance
- Proactive maintenance

*Maintenance and cost*
- Maintenance cost vs replacement cost
- Maintenance and asset value

*Materials and systems*
- Structural maintenance
- Cosmetic maintenance
- Material requirements
- Services maintenance
- Statutory and legal requirements (e.g., health and safety, fire protection)
- Frequency of maintenance
- Maintenance and building lifecycle

LO3 Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently

*Building Information Modelling and Building Asset Modelling*
- Project Information Requirements (PIR) and Asset Information Requirements (AIR)
- Project Information Model (PIM) and Asset Information Model (AIM)
- Common Data Environment (CDE) and data management
- Event triggers and response
Sustainable maintenance
Finance and management of budgets
Resources (hard and soft)
Health and safety compliance and best practice
Introduction to lifecycle management for maintenance

LO4 Assess how maintenance and operations are managed as part of a wider business management strategy

Core business management
Impact of core business and maintenance operations on one another
Impact of expected lifecycle of core business on maintenance management

Facilities management
Contract parameters for hard/soft facilities management
Integrating management systems to ensure that efficiency and sustainability are achievable

People management
Recruiting staff
Developing staff
Managing teams
Managing staff conflict
### Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Discuss the different parties involved in building maintenance and operations activities, their roles and responsibilities</td>
<td><strong>M1</strong> Evaluate the relationship between the design and construction team and the operational team in ensuring effective maintenance and operations.</td>
<td><strong>D1</strong> Critically analyse how maintenance may be undertaken over a period of time while ensuring compliance with statutory regulations and legislation.</td>
</tr>
<tr>
<td><strong>P1</strong> Illustrate the different parties involved in building maintenance and operations.</td>
<td><strong>P2</strong> Discuss the roles and responsibilities that are required for building maintenance and operations.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Compare different types of building maintenance and the management approaches that support them</td>
<td><strong>P3</strong> Compare the key principles of different types of maintenance and management, with reference to how these may work together for different materials and systems within a building.</td>
<td><strong>M2</strong> Evaluate the advantages and disadvantages of each of the maintenance management approaches.</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss the relationship between building management strategy and building maintenance cost.</td>
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</tr>
<tr>
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</tr>
<tr>
<td><strong>LO3</strong> Demonstrate how Building Information Modelling (BIM) assists in managing maintenance and operations effectively and efficiently</td>
<td><strong>P5</strong> Explain the concepts of project information and asset information in BIM and how management of this data enables building maintenance. <strong>P6</strong> Use building information data to illustrate how maintenance responds to different types of event triggers.</td>
<td><strong>D2</strong> Critically evaluate the role of BIM in supporting sustainable practice in maintenance and operations, relating it to broader business practices and strategies.</td>
</tr>
<tr>
<td><strong>LO4</strong> Assess how maintenance and operations are managed as part of a wider business management strategy</td>
<td><strong>M3</strong> Explore the benefits and constraints of using an asset model for planning maintenance and operations programmes.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Discuss the impacts of core business and facilities/maintenance management on one another on a day-to-day basis. <strong>P8</strong> Assess the role of managers in supporting staff and avoiding conflict as a part of effective maintenance operations.</td>
<td><strong>M4</strong> Reflect on the contract parameters for facilities management and explain the implications on core business.</td>
<td></td>
</tr>
</tbody>
</table>
**Recommended Resources**

**Print resources**

WIGGINS, J. (2010), *Facilities Manager’s Desk Reference*, John Wiley & Sons
WOOD, B. (2009), *Building Maintenance*, John Wiley & Sons

**Web resources**

https://bit.ly/3ib3ZJg  
British Institute of Facilities Management  
(Professional Body)

Facilities Management Journal  
(General Reference)

**Links**

This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 5: Legal and Statutory Requirements in Construction
- Unit 6: Digital Applications for Construction Information
- Unit 11: Financial Management & Business Practices in Construction
- Unit 13: Building Information Modelling
- Unit 14: Principles of Refurbishment
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling.
Introduction

Technological advancements have allowed us to develop material composites with optimum strength performance. Advanced composites allow lightweight materials to perform like metal components, with the necessary strength and stability. ‘Smart’ materials, that can alter their properties in response to external stimuli, are increasingly being found in ever more innovative design solutions. This progress in material technology and processing techniques is essential for the efficient delivery of contemporary buildings and infrastructure.

The aim of this unit is to enable students to make decisions based on the application of knowledge and concepts related to advanced materials. As ever more innovative structural solutions are sought, so the need for greater understanding of material performance and behaviour is required. This encapsulates an understanding of the relationship between material microstructure, composition and mechanical properties in use, and also a knowledge of ‘smart’ materials that are at the heart of innovative material technology development.

On successful completion of this unit, students will be able to make decisions based on an analytical approach to understanding material performance. They will also be able to make an appraisal of the feasibility of innovative and smart materials in construction projects.

Learning Outcomes

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

LO1 Evaluate the characteristic properties that contribute to the mechanical functionality of materials

LO2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods

LO3 Present a case study exploring innovative and smart materials and their role in sustainable construction

LO4 Analyse material selection and design strategies in either a structural or civil engineering environment.
Essential Content

LO1 Evaluate the characteristic properties that contribute to the mechanical functionality of materials

Properties of materials
Drivers for material characterisation and testing
Relationship of microstructure and manufacture/processing to the properties
Mechanical properties and deformation of materials

Underpinning principles of materials characterisation
Destructive and non-destructive testing
Characterisation testing techniques
Equipment and practices of material characterisation (e.g., microscopy, chemical, physical and structural analysis, thermal techniques)
Competencies and limitations of testing methods

Material processing techniques
Heat treatment
Coating processes
Surface treatments
Manufacturing techniques

LO2 Examine failure mechanisms of different materials through intrinsic and extrinsic methods

Modes of failure
Deflection
Fatigue
Creep
Distortion
Corrosion
Fracture
Impact
Thermal cycling
Extrinsic failure (environmental)
Environmental interactions (e.g., erosion, freeze/thaw, factors leading to the failure of materials)
Human interactions (e.g., vandalism, wear, biological transfer)

Intrinsic failure (material)
Crystallography and fracture mechanics
Design faults
Assembly error
Material defects

Failure prevention mechanisms
Preventing or impeding environmentally induced failure of materials
Materials selection
Engineering design
Materials monitoring
Inspection strategies

LO3 Present a case study exploring innovative and smart materials and their role in sustainable construction

Innovative and smart materials
Composite materials (e.g., matrix composition, glass reinforced plastic (GRP), fibre-reinforced polymers (FRP), concretes, metals)
Innovative materials (e.g., aerogels, smart concrete, aluminium oxynitride glass)
Nanotechnology (e.g., photocatalytic concrete, nano-silica, carbon nanofibers, nano-calcite particles)
Property and energy change materials (e.g., reversible energy exchanging, energy exchanging, property changing materials)

Smart materials and sustainability

Use of innovation and smart materials
Creation of energy efficient structures
Adaptive and intelligent behaviours
LO4 Analyse material selection and design strategies in either a structural or civil engineering environment

Design intent
Design for strength
Design for failure avoidance
Design for energy efficiency

Project factors
Structural engineering (e.g., building type, building use, building scale, construction method, loading conditions)
Civil engineering (e.g., infrastructure type, scale, loading conditions, construction method)

Material factors
Material type (e.g., steel, concrete, timber, masonry, composites)
Testing evidence (e.g., strength in compression, strength in tension, impact resistance, expansion, heat/cold resistance)

Environmental factors
Exposure (e.g., temperature, freeze/thaw cycles, direct sunlight, wind, humidity, subsurface water)
Pollution (e.g., airborne chemicals, acid rain, CO2, CO)
Erosion (e.g., moving water, airborne grit/sand)
# Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Evaluate the characteristic properties that contribute to the mechanical functionality of materials</td>
<td><strong>P1</strong> Determine the properties and characteristics of materials based on data from testing.</td>
<td><strong>M1</strong> Assess the effects of different manufacturing methods in relation to material properties.</td>
</tr>
<tr>
<td><strong>P2</strong> Evaluate how material characteristics are influenced by the forms in which materials are commonly available.</td>
<td><strong>D1</strong> Critically analyse data from material characterisation techniques and how this informs material selection.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong> Examine failure mechanisms of different materials through intrinsic and extrinsic methods</td>
<td><strong>P3</strong> Explore cause and effect of different modes of failure</td>
<td><strong>M2</strong> Discuss methods of remedial or preventative action to enhance service life of different materials.</td>
</tr>
<tr>
<td><strong>P4</strong> Discuss the differences between intrinsic and extrinsic failure in different materials.</td>
<td><strong>LO3</strong> Present a case study exploring innovative and smart materials and their role in sustainable construction</td>
<td><strong>M2</strong> Discuss methods of remedial or preventative action to enhance service life of different materials.</td>
</tr>
<tr>
<td><strong>P5</strong> Discuss the role of innovative and smart materials in developing sustainable solutions.</td>
<td><strong>LO4</strong> Analyse material selection and design strategies in either a structural or civil engineering environment</td>
<td><strong>D2</strong> Evaluate the effectiveness of using a smart or innovative material as an alternative to a given structural element for a given project.</td>
</tr>
<tr>
<td><strong>P6</strong> Produce a case study of innovative materials currently available or in use in the construction industry.</td>
<td><strong>P7</strong> Specify a range of smart or innovative materials for the structural or design elements of a given project.</td>
<td><strong>M4</strong> Assess the use of advanced materials or techniques to prevent structural failure and create energy efficient structures.</td>
</tr>
<tr>
<td><strong>LO5</strong></td>
<td><strong>P8</strong> Analyse the suitability of materials selected for a given design problem or structural element.</td>
<td><strong>D3</strong> Justify the selection of smart or innovative materials based on their suitability for the project, addressing material and environmental factors.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
GANCHY, S. (2009), *Islam and Science, Medicine, and Technology*, The Rosen Publishing Group, Inc
MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 14: Principles of Refurbishment
- Unit 17: Civil Engineering Technology
- Unit 19: Principles of Structural Design
- Unit 22: Scientific Principles for Building Services
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 34: Further Mathematics for Construction
- Unit 41: Highway Engineering
- Unit 42: Hydraulics.
Unit 46: Transport Systems in Buildings

Level: 5
Credits: 15
Ofqual Code: K/618/8123

Introduction

The success of today's modern high-rise buildings is owed to their ability to transport their occupants vertically and horizontally in a safe and efficient manner. This unit covers these systems in detail, along with their integration into the overall elements of the buildings that support them.

The overall aim of this unit is to give project managers in building services a working knowledge of lifts, escalators and other forms of access arrangements within a building. The principal person responsible for these access arrangements is often the building services engineer and it is their responsibility to ensure that these systems operate efficiently and safely for all stakeholders.

On successful completion of this unit, students will be in a position to understand the requirements for the installation of a transport system in a building that would be installed by a specialist sub-contractor. Students will have the fundamental knowledge and skills needed to progress to a higher level of study in building services engineering.

Learning Outcomes

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

LO1 Discuss the functional requirements for circulation in a proposed building design
LO2 Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design
LO3 Develop a design and installation strategy for escalators and moving walkways into a given building design
LO4 Present a design and installation strategy for lifts to support a given building design.
Essential Content

LO1 Discuss the functional requirements for circulation in a proposed building design

Clients’ requirements
- Private and public access arrangements
- Goods deliveries
- Desired circulation (e.g., capacity, access limits, circulation flows)
- Disability access arrangement requirements (e.g., inclusive design, non-discrimination)
- Sustainable design (e.g., energy use, materials)
- Future expansion planning
- Emergency evacuation policies (e.g., statutory requirements, health and safety)

Human factors
- Volume and timing of circulation
- Circulation zones
- Alarm response (e.g., human reaction, time required for evacuation, speed of access, disabled access)
- Occupancy (e.g., weight of occupancy, body sway)
- Pedestrian access (e.g., speed of pedestrians, age and frailty)
- Safety (e.g., slips, trips and falls, even flooring)
- Wayfinding (e.g., signage locations, signage readability)
- Cultural and religious influence (e.g., separation of sexes)
- Personal influence (e.g., personal space, intimacy, social distancing)
- Health and safety influence (e.g., social distancing, density of occupation)

LO2 Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design

Planning and design
- Building occupancy (e.g., hours of operation, peak congestion times)
- Traffic patterns (e.g., vertical and horizontal traffic, circulation efficiency)
- Building signage
Capacity (e.g., size of lift/escalator/walkway, number of users during peak times, speed of operation)
Waiting times (e.g., peak access wait, access and egress wait, round trip calculations)
Quality of service required (e.g., aesthetics, crowding limits, maximum heights, speeds)
Statutory requirements (e.g., building regulations, health and safety)
Escalators (e.g., inclination distance, stair width, speed)
Lifts (e.g., size of car, vertical travel distance, use, control)
Moving walkway (e.g., length of travel, speed, width, access/egress transition)
Fire and safety considerations (e.g., use during fire, emergency stop, materials)
Traffic simulation systems

*Equipment selection*
Design (e.g., pre-engineered off-the-shelf applications or custom designed)
Costs (e.g., capital expenditure, lifetime maintenance, statutory compliance)
Inspection and testing certification
Specialist considerations (e.g., hospital uses, heavy goods lifting, high-traffic environments)
Context considerations (e.g., lift shaft construction, overall building structure)
Aesthetic requirements (e.g., finishes, fixtures, handrails, bumpers, doors, frames)
Drive systems (e.g., energy requirements, emergency stop procedures, safety devices, single direction or reversible)
Maintenance access (e.g., service ‘down-time’, redundancy, disruption)

**LO3 Develop a design and installation strategy for escalators and moving walkways into a given building design**

*Design factors*
Building type (e.g., public, private, residential, commercial, industrial)
Building scale (e.g., horizontal travel distances, floor-to-floor heights)
Building occupancy (e.g., hours of operation, peak congestion times)
Moving walkway (e.g., length of travel, speed, width, access/egress transition)
Escalators (e.g., inclination distance, stair width, speed)
Aesthetics (e.g., materials, finishes, quality)
Structural support requirements

Building structure
Installation structure (e.g., interface between escalator/walkway and building structure)
Structural connections

Building services
Energy requirements (e.g., electrical load, motor type, drive system, emergency shutdown, safety devices)
HVAC requirements (e.g., heating load, ventilation requirements)
Acoustic requirements (e.g., equipment noise, dampening, vibration)
Signage

Health and safety
Safe installation (e.g., manual lifting, working at height, electrical safety)
Fire precaution measures (e.g., emergency use, emergency stop)
Testing and commissioning

LO4 Present a design and installation strategy for lifts to support a given building design

Design factors
Building type (e.g., public, private, residential, commercial, industrial)
Building scale (e.g., horizontal travel distances, floor-to-floor heights)
Building occupancy (e.g., hours of operation, peak congestion times)
Lift type (e.g., passenger lift, goods and passenger lifts, permanent or construction lift, goods only lift, observation lift in tall structures, service lift, motor vehicle lifts)
Drive system (e.g., hydraulic, electric traction, counterweight driven, suspension and roping, braking systems, speed control)
Car design (e.g., single or double-decker, single point of entry or dual door, materials, finishes)
Signage
Structural support requirements
Building structure
Installation structure (e.g., lift shaft, interface with building structure, prefabricated or in situ)
Structural connections

Building services
Electrical (e.g., mains cable installation, electrical load, isolation, lighting, ventilation, DC and AC drive systems, emergency lighting, standby power)
Sustainability
Access and maintenance
Plant rooms
CCTV requirements

Lift controls
Control type (e.g., single lift, multiple lift, group traffic)
Controller technology for call systems
Door operation controls

Health and safety
Remote alarms
Emergency phone systems
Fire and evacuation control by authorities
Statutory requirements
## Learning Outcomes and Assessment Criteria

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<tr>
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<tr>
<td><strong>LO1</strong> Discuss the functional requirements for circulation in a proposed building design</td>
<td><strong>M1</strong> Compare stakeholders’ needs with statutory requirements for circulation systems in buildings.</td>
<td><strong>D1</strong> Critically analyse the impact of health and safety on the selection for transport systems within buildings.</td>
</tr>
<tr>
<td><strong>P1</strong> Assess stakeholder requirements for movement within a building. <strong>P2</strong> Explain the factors that affect the selection of a transportation system.</td>
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</tr>
<tr>
<td><strong>LO2</strong> Determine traffic planning and equipment selection criteria for lifts, escalators and moving walkways for a given building design</td>
<td><strong>M2</strong> Evaluate selected equipment in meeting the requirements of client and functional needs.</td>
<td></td>
</tr>
<tr>
<td><strong>P3</strong> Assess the client and functional requirements for building transport in a given design. <strong>P4</strong> Review equipment for lifts, escalators and moving walkways to determine their suitability.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Develop a design and installation strategy for escalators and moving walkways into a given building design</td>
<td><strong>M3</strong> Integrate mechanical and electrical systems for escalators and moving walkways with building services installations for a given building.</td>
<td><strong>D2</strong> Justify a design and installation strategy for lifts, escalators and moving walkways within a given building, highlighting how these meet client needs and statutory requirements.</td>
</tr>
<tr>
<td><strong>P5</strong> Prepare design drawings to support the installation of escalators and moving walkways. <strong>P6</strong> Design structural details to support the installation of escalators and moving walkways within a given building.</td>
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</tr>
<tr>
<td><strong>LO4</strong> Present a design and installation strategy for lifts to support a given building design</td>
<td><strong>M4</strong> Analyse the structural and mechanical requirements to support the installation of lifts within a given building.</td>
<td></td>
</tr>
<tr>
<td><strong>P7</strong> Develop design and technical drawings to support the installation of lifts within a given building. <strong>P8</strong> Present a lift design and installation strategy for a given building.</td>
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</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
https://bit.ly/3xbOxB5 *Chartered Institution of Building Services Engineers* (Professional Body)

Links
This unit links to the following related units:
- Unit 2: Construction Technology
- Unit 17: Civil Engineering Technology
- Unit 18: Principles of Electrical Design & Installation
- Unit 19: Principles of Structural Design
- Unit 31: Advanced Structural Design
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 49: Advanced Electrical Design & Installation
- Unit 50: Building Management Systems.
Unit 47: Advanced Building Information Modelling

Level: 5
Credits: 15
Ofqual Code: M/618/8124

Introduction

The aim of this unit is to give students an understanding of the detailed processes that support and guide construction professionals in the context of Building Information Modelling (BIM). Students will explore the relevance of BIM in the construction industry and understand how the standards and processes that support BIM will enable better information management across the life of a project.

Students will also explore in detail the relevant changes to existing documentation and information in a project, and how this information is developed across the various stages of a project. There is a series of standards that support BIM and students will begin to determine their relevance and utilise them in a BIM process.

The knowledge and skills that students gain in this unit will give them an understanding of the context of BIM in the construction industry and they will be able to relate this to further study or to the realities of today's workplace. Students will be able to effectively determine the relevance of BIM within the construction industry today and how this may affect future processes.

Learning Outcomes

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

LO1 Explain the importance of information management in construction projects and how different parties are involved in the BIM process

LO2 Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project

LO3 Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project

LO4 Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project.
Essential Content

LO1 **Explain the importance of information management in construction projects and how different parties are involved in the BIM process**

*BIM and information management*

ISO 19650

Definitions (e.g., information management, asset, project delivery, asset operation)

*Roles & responsibilities*

Appointing party (e.g., client, asset owner)

Lead appointed party (e.g., main consultant, project manager, information exchange accountability)

Appointed party (e.g., information ‘generators’ – contractor, subcontractor, supplier, consultant)

Project team (e.g., everyone involved in the project)

Delivery team (e.g., lead appointed party and task teams)

Task team(s) (e.g., person or group performing a specific task – design team, curtain wall consultant, steel fabricator)

*Information requirements cycle*

Define

Appoint

Plan

Deliver

Check

Use

Learn (leading back to define)

LO2 **Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project**

*Organisational Information Requirements (OIR)*

High-level business-related requirements

Appointing party organisational objectives (e.g., statement of need)

Pre-contract BIM Execution Plan (BEP)
Post-contract BIM Execution Plan (BEP)

*Exchange Information Requirements (EIR)*

Technical information (e.g., software, data exchange formats, level of detail, training requirements)

Managerial information (e.g., standards, stakeholders and responsibilities, security, coordination and clash detection, collaboration process, compliance plan, model review, health and safety, data segregation and model management, asset information delivery strategy)

Commercial information (e.g., timing of ‘data drops’, client strategic purpose, BIM project deliverables, BIM competence assessment)

*Common Data Environment (CDE)*

Relationship to Exchange Information Requirements

Information states (e.g., work in progress, shared, published, archived)

Metadata (e.g., revision code, status, code, classification)

Classification systems (e.g., Uniclass, Omniclass, CI/SfB)

Software (e.g., vendors, cloud-based, on-premises)

Process (e.g., information sharing, managing revisions, metadata and process management)

Role of the information manager

**LO3** Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project

*Project Information Requirements (PIR)*

High-level project-related requirements

Project delivery phase

Project scope and business case

Strategic brief

Key stakeholders

Project tasks

Key decision points (e.g., project milestones)

Decisions required from appointing party at key decision points

Information required to enable appointing party to make decisions
**Project Information Model (PIM)**

Project delivery phase

Management within the CDE

Relationship to EIR and PIR

Federated building information models (e.g., graphical data and formats, non-graphical data, documentation)

Structured data (e.g., COBie files, schedules)

Reports and other documentation

**LO4** Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project

**Asset Information Requirements (AIR)**

Information required for the lifecycle of the asset (e.g., to operate the asset, to maintain the asset)

Managerial information (e.g., type of asset, identification information, location, floor area, warranties, maintenance and inspection schedules, hazardous materials or waste, end of life process, emergency plans)

Commercial information (e.g., description, function, supplier details, lead time, condition, KPIs, spares)

Technical information (e.g., engineering data, design parameters, commissioning dates and data, operational data, finishes, service requirements, outputs)

**Asset Information Model (AIM)**

Operational phase

Operating costs (e.g., energy use, replacement, repair, maintenance)

Management within CDE

Relationship to Asset Information Requirements

From PIM to AIM

The single source of ‘truth’ about a built asset

AIM content (e.g., graphical data, non-graphical data, ownership information, rights and restrictions, surveys, work carried out, operational performance information, condition information)

Changes to AIM (e.g., event triggers, updating AIM)
# Learning Outcomes and Assessment Criteria

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<thead>
<tr>
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<tr>
<td><strong>LO1</strong></td>
<td>Explain the importance of information management in construction projects and how different parties are involved in the BIM process</td>
<td></td>
<td>D1 Critically evaluate the ways in which a clear information management system enables effective project delivery and asset operations.</td>
</tr>
<tr>
<td><strong>P1</strong></td>
<td>Discuss the key features of ISO 19650 and information management for construction projects.</td>
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<tr>
<td><strong>P2</strong></td>
<td>Illustrate the relationships between different parties and teams for a BIM-enabled project.</td>
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<tr>
<td><strong>M1</strong></td>
<td>Analyse the responsibilities of different teams and parties through the information requirements cycle.</td>
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<tr>
<td><strong>D1</strong></td>
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<tr>
<td><strong>LO2</strong></td>
<td>Assess the Organisational Information Requirements (OIR) and prepare the Exchange Information Requirements (EIR) for a given project</td>
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<tr>
<td><strong>P3</strong></td>
<td>Develop Organisational Information Requirements for a given construction project.</td>
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<tr>
<td><strong>P4</strong></td>
<td>Produce the Exchange Information Requirements for a given construction project to support Organisational Information Requirements.</td>
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<tr>
<td><strong>M2</strong></td>
<td>Specify the Common Data Environment to support the Exchange Information Requirements for a given construction project.</td>
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<tr>
<td><strong>D1</strong></td>
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<tr>
<td>LO3 Analyse the relationship between Project Information Requirements (PIR) and the Project Information Model (PIM) for a given construction project.</td>
<td>P5 Define the Project Information Requirements to support the delivery phase of a given construction project.</td>
<td>D2 Critically analyse the use of BIM data to support the entire lifecycle of a construction project through delivery and operation.</td>
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<tr>
<td>P6 Analyse the way that Project Information Requirements inform the development of the Project Information Model for a given construction project.</td>
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<tr>
<td>LO4 Use available data and information to prepare the Asset Information Model (AIM) based on the Asset Information Requirements for a given construction project.</td>
<td>M3 Evaluate the different types of information that must be developed for the Project Information Model and how they support the delivery phase of the project.</td>
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</tr>
<tr>
<td>P7 Discuss the role of BIM data in supporting the operational phase and the potential cost benefits of an accurate Asset Information Model.</td>
<td>M4 Evaluate the process of updating an Asset Information Model in response to different event triggers.</td>
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<tr>
<td>P8 Compile the materials required for an Asset Information Model of a completed construction project, based on the Asset Information Requirements.</td>
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<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources
BALLAST, D. (2009), Architect's Handbook of Construction Detailing, John Wiley & Sons
FAIRHEAD, R. (2014), Information Exchanges, Riba Publications Limited
MCMULLAN, R. (1998), Environmental Science in Building, Macmillan International Higher Education
SAXON, R. (2016), Bim for Construction Clients, NBS

Web resources
(General Reference)
(General Reference)
(General Reference)
(Training)
(Training)
(General Reference)
(Training)
Links

This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects.
Unit 48: Thermofluids & Acoustics

Level: 5
Credits: 15
Ofqual Code: T/618/8125

Introduction

The study of thermofluids is critical to the design, specification and operation of building services engineering systems. In this unit, students will explore the key features of thermofluids, heat transfer, thermodynamics, fluid mechanics and combustion, and their calculation and application. Understanding how to calculate and manage heat transfer will give students key knowledge that will enable them to work on a range of different systems for heating and refrigeration.

Students will also develop an understanding of the issues associated with acoustics and the operation of building services systems. They will explore the causes of noise and vibration, learn how to calculate noise levels and develop strategies to manage the acoustic environment.

By the end of this unit, students will have an advanced knowledge of the formulae required to undertake calculations related to thermofluids and acoustics, applying the results to the design and specification of equipment, plant and environments.

Learning Outcomes

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

LO1 Use dimensional analysis to determine units in building services systems
LO2 Discuss the principles of heat and vapour transfer in building services systems
LO3 Evaluate the performance of refrigeration plants and heat exchangers
LO4 Design acoustic environments through the control of noise.
Essential Content

LO1 **Use dimensional analysis to determine units in building services systems**

*Dimensional analysis*

Units and dimensions
Dimensional analysis
Fundamental and empirical

*Units and dimensions*

Identification of units and dimensions (e.g., force, energy, mass flow, volume flow, acceleration, density, viscosity, specific heat capacity, specific enthalpy, cubical expansion, thermal conductivity, heat flux, rotation, heat transfer coefficient, velocity and area)

Checking formation of rational formulae
Identification of dimensions of constants
Rational formulae used in building services applications

*Application of dimensional analysis*

Geometric and dynamical similarity

Derivation of appropriate rational and empirical formulae from known variables (e.g., pump/fan laws, Darcy's equation for turbulent flow, equations for heat transfer by free convection and forced convection)

Application of dimensional analysis to the solution of problems in building services applications (e.g., Reynolds number, Grashof number, Nusselt number, Prandtl number)

LO2 **Discuss the principles of heat and vapour transfer in building services systems**

*Heat transfer*

Kinetic theory

Modes of heat transfer

Conduction (e.g., flat surfaces, cylindrical surfaces)

Free and forced convection and boundary layer

Temperature parameters (e.g., mean, bulk, Arithmetic mean temperature difference (AMTD), Log Mean Temperature Difference (LMTD))
Application of dimensionless groups
Heat transfer coefficients
Heat flux
Radiation
Surface characteristics (e.g., reflectivity, transmissivity, absorptivity, emissivity)
Electromagnetic radiation (e.g., waveform, amplitude, frequency, wavelength)
Black body emissions
Emission from black, grey and selective surfaces
Use of form factors to determine radiant heat exchange
Heat transfer equipment
Human comfort (e.g., asymmetric radiation, plane radiant temperature, vector radiant temperature)
Solar radiation (e.g., solar constant, solar intensity on surfaces)

Vapour transfer
Diffusion
Permeability
Vapour resistivity
Moisture transfer
Formation and modes of condensation (e.g., film-wise, drop-wise, direct contact, homogeneous)
Vapour and mass transfer
Interstitial condensation

LO3 Evaluate the performance of refrigeration plants and heat exchangers

Heat exchangers
Types
Classification
Design
Construction
Applications
**Principles of heat exchange**
Fluid flow paths and flow geometries (e.g., counter flow, parallel flow)
Heat exchange calculations (e.g., LMTD, number of transfer units (NTU), capacity ration and effectiveness, heat balance equation, fouling factors)

**Refrigerant plant**
Types
Classification
Design
Construction
Vapour, gas and power cycles
Compression devices
Expansion devices
Performance characteristics

**Principles of refrigeration**
Vapour compression diagrams
T-S diagrams
p-H diagrams
p-V diagrams
Thermodynamic processes in refrigeration cycles
Heat pumps and heat engines
Carnot cycle
Performance and analysis of refrigeration/heat pumps in cooling/heating modes (e.g., formulae, tables, charts)
Mass flow rates
Input power
Capacity
Efficiency
Coefficient of performance
Theoretical/actual cycle arrangements
Ideal/actual pressure-volume diagrams (e.g., reciprocating compression devices, roto-dynamic compression devices)
Compression and expansion curves (e.g., isothermal, adiabatic, polytropic, open and closed systems)
First Law of Thermodynamics (e.g., convention of energy transfer, non-flow energy equation (NFEE), specific heat of gases, steady flow energy equation (SFEE), heat engine)

**LO4 Design acoustic environments through the control of noise**

*Acoustic environments*

Human hearing (e.g., unit of loudness (Phon), frequency weightings, reverberation, absorption coefficients)

Noise ratings
Noise criteria curves
Application in acoustic design
Privacy criteria
Concept of speech intelligibility
Statutory and local regulations and criteria (e.g., internal and external environments)
Evaluation of sound and vibration effects on the environment in a building
Transmission paths
Design criteria in a building environment
Design solutions for acceptable acoustic environments (e.g., sound reduction index, insulation principles)

*Control of noise*

Attenuation characteristics of materials
Components and systems
Acoustic enclosures
Noise control design solutions (e.g., pipework, ductwork, grilles, diffusers, prime movers)
Compressors
## Learning Outcomes and Assessment Criteria

<table>
<thead>
<tr>
<th>Pass</th>
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<th>Distinction</th>
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</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Use dimensional analysis to determine units in building services systems</td>
<td><strong>M1</strong> Apply the outcomes of dimensional analysis to the design and specification of building services systems.</td>
<td><strong>D1</strong> Critically analyse the different outcomes of calculations using dimensionless parameters, highlighting their use in building services.</td>
</tr>
<tr>
<td><strong>P1</strong> Use dimensional analysis to determine units, dimensions and dimensionless groups.</td>
<td><strong>P2</strong> Identify dimensions, units and constants necessary to complete calculations for building services.</td>
<td><strong>M2</strong> Assess a building services installation to determine the mechanism and performance of heat transfer through measurement and calculation.</td>
</tr>
<tr>
<td><strong>LO2</strong> Discuss the principles of heat and vapour transfer in building services systems</td>
<td><strong>P3</strong> Discuss the principles of conductive, convective and radiant heat transfer through building services equipment and structures.</td>
<td><strong>D2</strong> Evaluate the modes of condensation used in building services equipment and the impact of heat and vapour transfer on human comfort in buildings.</td>
</tr>
<tr>
<td><strong>P4</strong> Explain the process of vapour transfer through building structures and the efficiency of building services equipment.</td>
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</tr>
<tr>
<td><strong>LO3</strong> Evaluate the performance of refrigeration plants and heat exchangers</td>
<td><strong>P5</strong> Evaluate the performance of refrigeration plant and heat pumps through the application of scientific principles. <strong>M3</strong> Compare the efficiency and performance of different forms of refrigeration plant, heat pumps and heat exchangers through measurement and calculation.</td>
<td><strong>D3</strong> Critically analyse the relationship between the performance and efficiency of heating or refrigeration plant and the acoustic environment.</td>
</tr>
<tr>
<td><strong>P6</strong> Analyse the performance of heat exchangers used in building services.</td>
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</tr>
<tr>
<td><strong>LO4</strong> Design acoustic environments through the control of noise</td>
<td><strong>P7</strong> Explain the design criteria for acoustic environments. <strong>M4</strong> Evaluate, through measurement and calculation, the relative benefit of different forms of sound attenuation, dampening and absorption on reducing noise from building services installations.</td>
<td></td>
</tr>
<tr>
<td><strong>P8</strong> Design effective acoustic environments for building services installations.</td>
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</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
https://bit.ly/3rEECD0 The Building Regulations Approved Documents (UK)
(General Reference)

https://bit.ly/3xirWTC Building Services Research and Information Association
(Professional Body)

https://bit.ly/3xbOxB5 Chartered Institution of Building Services Engineers
(Professional Body)

(General Reference)

Links
This unit links to the following related units:

- Unit 3: Science & Materials
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 22: Scientific Principles for Building Services
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics.
Unit 49: Advanced Electrical Design & Installation

Level: 5
Credits: 15
Ofqual Code: A/618/8126

Introduction

Across the world, people rely on the ability to use electrical devices to facilitate work, education and entertainment. The provision of sufficient electrical power relies on the design of systems that are suitable to the application but which are also safe and sustainable. The overall aim of this unit is to support students in developing an understanding of the principles that underpin the design and installation of electrical systems for complex buildings.

Topics covered in this unit include: electrical distribution systems, cabling, lighting systems, electromagnetic compatibility, applying protective measures, equipment installation, building services automation, building system engineering, statutory regulations and health and safety.

On successful completion of this unit, students will be in a position to be able to assist senior colleagues with electrical systems design and installation. Students will also have the advanced knowledge and skills needed to progress to a higher level of study.

Learning Outcomes

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

LO1 Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services

LO2 Discuss the protective measures necessary for the safe installation and operation of electrical systems

LO3 Design an electrical distribution plan for a complex non-domestic building

LO4 Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types.
Essential Content

LO1  Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services

Electrical distribution
Substations and transformers
Distribution and branch panels
High voltage switch gear
Vertical supply system (e.g., rising main)
Horizontal supply (e.g., branch circuits, distribution at floor level)
Power cables and their application
Grounding systems
Use of renewable sources

Electromagnetic compatibility (EMC)
Causes of electromagnetic interference
System protection
Compliance with EMC installation rules

Electrical equipment and fixtures
Electrical wiring
Switchgear (e.g., manual switches, automatic switching)
Data and communications (e.g., network cabling, computers, telephones)
HVAC systems
Building management systems (BMS)
Building energy management system (BEMS)
Specialist equipment (e.g., factory equipment, medical equipment, servers)
Energy efficiency of equipment and fixtures
LO2 Discuss the protective measures necessary for the safe installation and operation of electrical systems

*Contact protection*
Direct contact
Indirect contact

*Electrical shock protection*
Normal conditions
Fault conditions

*Overvoltage protection*
Atmospheric overvoltage
Switching overvoltage

LO3 Design an electrical distribution plan for a complex non-domestic building

*Building type/use*
Residential (e.g., multi-occupancy, apartments, flats)
Commercial (e.g., office buildings, shopping centres)
Cultural (e.g., museums, theatres, stadiums, exhibition halls)
Industrial (e.g., factories, warehouses, garages)
Medical/scientific (e.g., hospitals, clinics, laboratories)

*Power requirements*
Single phase vs three phase
Loads (e.g., individual loads, emergency loads, area loads, activity loads)
Power source (e.g., primary, standby, emergency)

*Equipment requirements*
Lighting
Mechanical equipment (e.g., HVAC, lift motors, automatic doors)
Data and communication equipment
Specialist equipment (e.g., medical devices, factory machinery, theatre lighting)

*Planning for future demand*
LO4 **Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types**

*Standards*
- International standards (e.g., ISO, IEC)
- National, regional and local standards
- Professional standards and codes of practice
- Sustainability standards (e.g., greenhouse gas emissions from generation, use of materials)

*Legislation*
- Building regulations
- Health and safety regulations
- Electrical equipment (safety) regulations

*Commissioning*
- Lighting levels
- Electrical supply, generators, uninterruptible supply equipment
- Distribution board, metering, switchgear
- Earthing and bonding
- Protective devices
- Circuits, fuses, breakers, isolation
- Communications/data equipment, wiring
- Appropriate signage, protection
## Learning Outcomes and Assessment Criteria

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<tbody>
<tr>
<td><strong>LO1</strong></td>
<td>Explain the principles and equipment associated with power and distribution systems, electromagnetic compatibility and electrical services</td>
<td>P1 Discuss the principles and equipment used in electrical distribution for buildings.</td>
<td>D1 Analyse the potential for electrical shock and overvoltage related to the different elements of electrical supply, distribution and use of equipment in buildings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2 Explain the causes of, and possible protection against, electromagnetic interference.</td>
<td></td>
</tr>
<tr>
<td><strong>LO2</strong></td>
<td>Discuss the protective measures necessary for the safe installation and operation of electrical systems</td>
<td>P3 Explain the different forms of electrical shock and overvoltage.</td>
<td>M2 Illustrate the protective measures necessary for normal and fault conditions in specific systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P4 Describe the methods of protection available to ensure safe installation and operation of electrical systems.</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td>M1 Analyse the relationship between electrical equipment and fixtures, and electromagnetic interference.</td>
</tr>
<tr>
<td>Pass</td>
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</tr>
<tr>
<td><strong>LO3</strong> Design an electrical distribution plan for a complex non-domestic building</td>
<td><strong>P5</strong> Evaluate building use, power requirements and equipment to inform a design for electrical distribution. <strong>P6</strong> Calculate electrical loads and suitable cabling sizes for an electrical distribution plan. <strong>M3</strong> Specify correctly sized distribution equipment for an electrical distribution plan.</td>
<td><strong>D2</strong> Justify the design of an electrical power distribution system and the specification of equipment in relation to statutory regulations and health and safety.</td>
<td></td>
</tr>
<tr>
<td><strong>LO4</strong> Present a report on the national, regional and local standards for sustainability, technical and health and safety regulations that apply to specific building types</td>
<td><strong>P7</strong> Review the different types of standards associated with the design and installation of electrical systems that promote sustainability. <strong>P8</strong> Explain the role of regulations in ensuring the safe installation, commissioning and operation of electrical systems. <strong>M4</strong> Evaluate the relationship between local, regional and national standards related to electrical system design and installation.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

AL-SHEMMERI, T., PACKER, N. (2021), *Building Services Engineering*, John Wiley & Sons

Links

This unit links to the following related units:

- Unit 8: Mathematics for Construction
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 48: Thermofluids & Acoustics
- Unit 50: Building Management Systems.
Introduction

The earliest examples of building management systems (BMS) are found in large public and commercial premises. For the most part, these were used for automatic control of heating, cooling and, in some instances, security. However, BMS applications have broadened in scope and are becoming common in the domestic market, such as extra-low-voltage, intelligent lighting, which is already becoming the norm for many new homes (not exclusively those at the higher end of the market).

An environment controlled by a computer can provide not only the optimum levels of heat, humidity and lighting for a building and its occupants, but it can also monitor energy use and contribute to energy conservation. Incorporating Energy Demand Management (EDM) into the BMS can facilitate automatic conformance with current energy usage regulations. The advent of the smart phone and low-cost apps has opened the door to truly remote control and monitoring of a building’s environment and security. Heating and lighting can be switched on and set by the homeowner long before they reach their front door.

The aim of this unit is for students to explore the rapidly growing range of services provided by BMS technology and to assess its contribution to the renewable energy debate. Students also have the opportunity to apply their research by carrying out the design of a BMS.

On successful completion of this unit, students will be conversant with current and emerging BMS technologies. They will also have developed the skills necessary to evaluate the benefit of a BMS and be able to apply their theoretical knowledge to a real-life installation.
**Learning Outcomes**

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

**LO1** Discuss the technologies and applications used in building management systems

**LO2** Assess how a building energy management system (BEMS) can optimise cost and energy usage

**LO3** Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies

**LO4** Specify a building management system suitable for a small multi-zone, non-residential building.
Essential Content

LO1 Discuss the technologies and applications used in building management systems

General categories
Centralised system (e.g., a single central processing unit (CPU))
Distributed Intelligence Systems (e.g., intelligent ‘outstations’ with communications channels)
SMART buildings (Self-Monitoring Analysysis and Reporting Technology)
Internet of Things (IOT)

Applications
Lighting
HVAC
Fire and smoke detection and alarms
Security
ICT
Lifts
Shading devices
Energy use (e.g., smart meters, adaptive energy management)

System structure
Server (coordinates data received from sensors and issues commands to controllers)
Sensors (measures local conditions and supplies data to server)
Controllers (adjusts local equipment in response to signals from server)
Uninterruptible Power Supplies (UPS)

System integration
Local systems
Cloud and web applications
Mobile apps
Protocols (e.g., SOAP, XML, BACnet, KNX)
LO2 **Assess how a building energy management system (BEMS) can optimise cost and energy usage**

*Building Energy Management Systems (BEMS) vs Building Management System (BMS)*

Specialisation (e.g., BEMS is for energy only, while BMS may cover different systems)

Real-time monitoring and action (e.g., dynamic system)

*Monitoring*

Energy consumption

User behaviour

Energy use patterns

Time of use (e.g., large-scale energy costs fluctuate based on time of day and demand)

Cyclical/seasonal factors (e.g., different energy needs for different times of year)

Humidity

Weather data

*Control*

HVAC control (e.g., system adjustments based on weather, building/room occupancy, ambient temperature)

Lighting (e.g., automatic lights-off for unoccupied areas, light intensity response to ambient light)

Energy storage (e.g., store energy during periods of low-cost and use this to offset use during period of high cost)

LO3 **Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies**

*Legislation, regulation and standards*

Building regulations

Governmental targets

Institutional targets

National and International standards (e.g., ISO 50001, ISO 52000, ISO/TS 50008)
Sustainability

Reduced energy consumption (e.g., automatic control of lighting and heating to avoid use in unoccupied areas)

Reduced reliance on fossil fuels (e.g., integrating renewable energy sources/systems)

Balanced energy use (e.g., limit high-demand conditions through energy storage and management)

Optimise passive systems (e.g., automatic control of passive cooling and ventilation when building demands are lower)

Cost

Installation cost vs return on investment

New build installation or retrofit system

Reduced maintenance cost (e.g., managed use of plant/equipment reduces load and wear)

Reduced time of use costs (e.g., power storage when lower utility cost)

Related expenditure (e.g., insulation upgrade to existing buildings, need to update plant/equipment/fixtures)

LO4 Specify a building management system suitable for a small multi-zone, non-residential building

Project information

Client requirements

Building use (e.g., commercial, industrial, cultural)

Building scale

Building construction (e.g., external wall construction, roof construction, window/glazing types)

Building services (e.g., HVAC systems, electrical supply, water supply)

Regulations and standards

Health and safety

Building regulations

Manufacturing certifications
Design factors

Building zones

Human comfort requirements (e.g., heating/cooling levels, lighting levels, ventilation requirements)

System design/specification

Overall strategy

Components (e.g., sensors, controllers, servers, UPS)

Protocols and compatibility (e.g., ensuring all components are compatible)

Potential savings (e.g., cost, energy consumption)

Commissioning process
## Learning Outcomes and Assessment Criteria

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<tbody>
<tr>
<td><strong>LO1</strong> Discuss the technologies and applications used in building management systems</td>
<td></td>
<td></td>
<td>D1 Evaluate the integration of building management system and building energy management system in providing an overall building management strategy.</td>
</tr>
<tr>
<td><strong>P1</strong> Discuss the principles of building management system.</td>
<td></td>
<td>M1 Compare the use of different protocols and their interoperability in building management systems.</td>
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<tr>
<td><strong>P2</strong> Explain the different components and approaches to system integration in building management systems.</td>
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<tr>
<td><strong>LO2</strong> Assess how a building energy management system (BEMS) can optimise cost and energy usage</td>
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<tr>
<td><strong>P3</strong> Explain the differences between a BEMS and BMS.</td>
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<td>M2 Assess different strategies for the control of energy use and consumption.</td>
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<tr>
<td><strong>P4</strong> Discuss how a BEMS can lead to lower energy usage.</td>
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<tr>
<td><strong>LO3</strong> Evaluate the potential benefits in cost and sustainability through the use of BMS and BEMS technologies</td>
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<td></td>
<td>D2 Justify the design and specification of a BMS/BEMS installation with regard to its impact on sustainability and cost.</td>
</tr>
<tr>
<td><strong>P5</strong> Explain the role of legislation, regulation and standards that support BMS/BEMS.</td>
<td></td>
<td>M3 Illustrate the relationship between cost and return on investment for new-build or retrofit installation of a BMS/BEMS.</td>
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<tr>
<td><strong>P6</strong> Analyse the ways in which a managed building can lead to lower costs and greater sustainability.</td>
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<tr>
<td><strong>LO4</strong> Specify a building management system suitable for a small multi-zone, non-residential building</td>
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<tr>
<td><strong>P7</strong> Examine project information to define requirements for a BMS/BEMS installation.</td>
<td></td>
<td>M4 Compare different strategies for a BMS/BEMS installation to determine optimised performance of components and overall system.</td>
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<tr>
<td><strong>P8</strong> Design and specify a BMS/BEMS installation for a small multi-zone, non-residential building.</td>
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</tbody>
</table>
Recommended Resources

Print resources


Web resources

Centre for Digital Built Britain  
(General Reference)

www.thenbs.com  
The NBS Knowledge  
(General Reference)

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 15: Principles of Alternative Energy
- Unit 16: Principles of Public Health Engineering
- Unit 18: Principles of Electrical Design & Installation
- Unit 22: Scientific Principles for Building Services
- Unit 30: Project Management
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 46: Transport Systems in Buildings
- Unit 49: Advanced Electrical Design & Installation.
Unit 51: Advanced Construction Development & Prototyping

Level: 5
Credits: 30
Ofqual Code: J/618/8128

Introduction

Prototypes, whether full scale, models or components of a system, provide means by which design and manufacturing processes can be tested and evaluated. Through the making of prototypes, design, technical and cost issues can be resolved while at the same time evaluating aesthetic characteristics and market factors.

The rise of Modern Methods of Construction, particularly off-site approaches, has increased the need and value of prototyping in construction. Whether developing a panelised system, a volumetric approach or prefabricated units, the success of a manufactured component relies on its design and production being controlled and predictable. To achieve the necessary level of precision and reliability, prototypes are used to refine the outcome and optimise processes.

This unit supports students in bringing together their design, technical and process knowledge in the development of prototypes for construction using modern methods.

Learning Outcomes

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

LO1 Evaluate a design proposition to identify prototyping opportunities
LO2 Develop prototypes for a manufactured construction solution through iterative testing
LO3 Create a final prototype through the integration of resolved component, assembly and system solutions
LO4 Present an off-site manufacturing solution based on prototype development and evaluation.
**Essential Content**

**LO1** **Evaluate a design proposition to identify prototyping opportunities**

*Design evaluation*
- Typology
- Material
- Method of production
- Design aims
- Stakeholder requirements
- Adaptability/customisation (e.g., deconstructability, long life, 'loose fit')

*Prototypes*
- Scale (e.g., model, full-scale)
- Component prototype
- Assembly prototypes
- System prototypes

**LO2** **Develop prototypes for a manufactured construction solution through iterative testing**

*Testing types*
- Performance testing (e.g., air infiltration, water ingress, weathering, energy efficiency, passive strategies, carbon emissions)
- Safety testing (e.g., fire retardant, flame spread, fire compartmentation, means of escape, structural integrity.)

*Fault-finding*
*Operational testing*

*Test rigs*

*Testing centres*

*Test reporting*
- Parameters
- Process
- Results
- Actions
LO3  **Create a final prototype through the integration of resolved component, assembly and system solutions**

*Final prototype*
- Design modifications
- Manufacturing modifications
- Materials
- Components
- Assemblies
- Systems

*Production model*
- Volume production
- Material management
- Sustainability

LO4  **Present an offsite manufacturing solution based on prototype development and evaluation**

*Solution*
- Final design
- Solution development process (e.g., prototyping process, testing process)
- Manufacturing features
- Profit (e.g., development cost vs return on cost)

*Presenting solution*
- Prototype scale (e.g., model vs full-scale, mock-up vs functional)
- Reports/results (e.g., cost reports, testing reports, etc.)
- Market (e.g., solution to meet market demand, market testing, consumer testing)

*Presentation*
- Audience (e.g., technical, professional, financial, stakeholder)
- Format (e.g., written report, audio-visual, etc.)
- Supporting/defending (e.g., reference material, research, design/testing)
- Feedback/reflection
# Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1 Evaluate a design proposition to identify prototyping opportunities</strong></td>
<td><strong>P1 Evaluate a design proposition to determine areas for manufacturing research.</strong></td>
<td><strong>M1 Analyse the potential benefits of different forms of prototyping in relation to a design proposition.</strong></td>
</tr>
<tr>
<td><strong>P2 Identify prototyping opportunities, related to a design proposition, to test manufacturing potential.</strong></td>
<td><strong>D1 Critically analyse the results of testing different forms of prototype to refine design propositions and technical developments.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO2 Develop prototypes for a manufactured construction solution through iterative testing</strong></td>
<td><strong>P3 Develop different forms of prototype to test specific features of a design and manufacturing solution.</strong></td>
<td><strong>M2 Prepare detailed reports on the results of prototyping and testing to determine actions for iterative development and re-testing.</strong></td>
</tr>
<tr>
<td><strong>P4 Iteratively test different forms of prototype to determine levels of performance, safety and operation.</strong></td>
<td><strong>M3 Analyse the manufacturing modifications required for a final building prototype to be achieved through a specific production model.</strong></td>
<td><strong>D2 Critically evaluate the potential success of a manufacturing solution, based on the data gathered through prototyping and testing components, assemblies and systems.</strong></td>
</tr>
<tr>
<td><strong>LO3 Create a final prototype through the integration of resolved component, assembly and system solutions</strong></td>
<td><strong>P5 Create a final prototype building, based on development prototypes.</strong></td>
<td><strong>M4 Justify a manufacturing solution, based on prototype, research, reporting and data.</strong></td>
</tr>
<tr>
<td><strong>P6 Discuss the design modifications resulting from prototyping and testing.</strong></td>
<td><strong>D3 Critically analyse the potential success of a manufacturing solution, designed through prototyping and testing components, assemblies and systems.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LO4 Present an off-site manufacturing solution based on prototype development and evaluation</strong></td>
<td><strong>P7 Present a detailed solution for the manufacture of a given building, component or system.</strong></td>
<td><strong>M4 Justify a manufacturing solution, based on prototype, research, reporting and data.</strong></td>
</tr>
<tr>
<td><strong>P8 Integrate cost and market information into a manufacturing solution.</strong></td>
<td><strong>M5 Analyse the manufacturing modifications required for a final building prototype to be achieved through a specific production model.</strong></td>
<td><strong>D2 Critically evaluate the potential success of a manufacturing solution, based on the data gathered through prototyping and testing components, assemblies and systems.</strong></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

CIBSE (2006), *Environmental Design*, CIBSE
MCDONOUGH, W., BRAUNGART, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press

Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 47: Advanced Building Information Modelling
- Unit 52: Advanced Housing Design & Specification
- Unit 53: Advanced Off-site Construction.
Unit 52: **Advanced Housing Design & Specification**

**Level:** 5  
**Credits:** 15  
**Ofqual Code:** L/618/8129

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**Introduction**

In this unit, students will explore the role of design and specification in the production of housing. The emphasis in this unit is on expanding the knowledge and awareness of the processes of design, information production and construction, integrating the work of other professionals and consultants, to ensure high-quality design output.

Students will develop strategies and propositions that achieve stakeholder needs by addressing design, technical, environment and cost challenges.

By the end of this unit, students will have a greater awareness of managing their own design process as well as an understanding of how other professionals contribute to design and specification.

**Learning Outcomes**

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

- **LO1** Review a given site and client brief to develop a housing design proposition
- **LO2** Prepare building information modelling data and construction information in support of a housing design proposition
- **LO3** Produce specifications and schedules, based on construction information, for a contract tender
- **LO4** Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants.
**Essential Content**

**LO1** Review a given site and client brief to develop a housing design proposition

*Site considerations*
- Scale
- Location
- Traffic/access
- Zoning/planning

*Design considerations*
- Site/building orientation
- Client/user requirements
- Site density
- Housing type/typology
- Procurement model
- Construction method
- Health and safety
- Building regulations

*Environmental considerations*
- Materials
- Energy supply
- Heating/ventilation
- Material transport
- Construction/manufacturing method

*Consultant integration*
- Information (e.g., structural, mechanical, cost)
- Integration
- Clash detection
- Value engineering
- Design revision
LO2  **Prepare building information modelling data and construction information in support of a housing design proposition**

*Drawings*
- Presentation drawings
- Technical drawings

*Models*
- Physical models
- Digital models
- Building Information Modelling (BIM)

*Consultant information*
- Structural drawings
- Mechanical drawings
- BIM
- Cost information
- Manufacturing information

LO3  **Produce specifications and schedules, based on construction information, for a contract tender**

*Specification types*
- Outline specification
- Performance specification
- Prescriptive specification
- Proprietary specifications

*Schedules*
- Door schedules
- Hardware schedules
- Window schedules
- Schedules of Work
Contracts
Contract type
Standard clauses and conditions
Contract prelims

LO4 **Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants**

Proposal
Feasibility
Design
Engineering
Cost

Audience
Professional
Non-professional
Statutory bodies

Presentation
Format (e.g., written report, audio-visual, etc.)
Feedback and reflection
Learning Outcomes and Assessment Criteria

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<tr>
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<th>Merit</th>
<th>Distinction</th>
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<tbody>
<tr>
<td><strong>LO1</strong> Review a given site and client brief to develop a housing design proposition</td>
<td><strong>P1</strong> Identify issues and considerations of site to inform a design proposition.</td>
<td><strong>M1</strong> Assess the need for different consultants to support the development of a housing proposal.</td>
</tr>
<tr>
<td><strong>P2</strong> Analyse a brief to develop a design proposition, responding to identified issues.</td>
<td><strong>P3</strong> Produce building information data for a housing design proposal.</td>
<td><strong>M2</strong> Use building information modelling systems to coordinate information from consultants.</td>
</tr>
<tr>
<td><strong>LO2</strong> Prepare building information modelling data and construction information in support of a housing design proposition</td>
<td><strong>P4</strong> Prepare construction drawings and details in support of a housing design proposition.</td>
<td><strong>M3</strong> Compile information required for a contract tender package for an appropriate form of contract.</td>
</tr>
<tr>
<td><strong>LO3</strong> Produce specifications and schedules, based on construction information, for a contract tender.</td>
<td><strong>P5</strong> Produce specification information based on building information modelling data and construction information.</td>
<td><strong>M4</strong> Defend a design proposal in response to feedback and comment.</td>
</tr>
<tr>
<td><strong>P6</strong> Prepare relevant schedules for a contract tender.</td>
<td><strong>P7</strong> Present a coherent housing design proposal to a diverse audience.</td>
<td><strong>M5</strong></td>
</tr>
<tr>
<td><strong>LO4</strong> Present a housing design proposal and tender package to a diverse audience, integrating information from other consultants.</td>
<td><strong>P8</strong> Integrate the information from consultants in support of a housing design and tender presentation.</td>
<td><strong>D4</strong></td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

BALLAST, D. (2009), Architect’s Handbook of Construction Detailing, John Wiley & Sons
CHING, F. (2011), Building Construction Illustrated, John Wiley & Sons
CIBSE (2006), Environmental Design, CIBSE
HUTH, M. (2018), Understanding Construction Drawings, Cengage Learning
MCDONOUGH, W., BRAUNGART, M. (2010), Cradle to Cradle: Remaking the Way We Make Things, North Point Press

Web resources

(General Reference)

www.thenbs.com  The NBS Knowledge
(General Reference)

(General Reference)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 13: Building Information Modelling
- Unit 26: Digital Applications for Building Information Modelling
- Unit 28: Group Project (Pearson-set)
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping.
Unit 53: Advanced Off-site Construction

Level: 5
Credits: 15
Ofqual Code: F/618/8130

Introduction
In this unit, students will explore different approaches to off-site construction. Focusing on the technical features of different methods of manufacturing and logistics, they will develop the knowledge and skills to be able to select appropriate forms of manufacture in support of specific design and delivery aims concerning building development and delivery. This includes modular construction, factory construction, automation and robotics, and 3D printing. Students will consider the ways in which off-site processes and technologies may influence building design and delivery.

By the end of this unit, students will be able to evaluate and select strategies for off-site production, to meet the technical and design challenges associated with the construction market.

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

LO1 Explore different production models and their application to building manufacture

LO2 Analyse how the relationship between material selection and technical processes inform design decisions

LO3 Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context

LO4 Present a strategy for high-volume off-site manufacture for a given building type and context.
Essential Content

LO1 Explore different production models and their application to building manufacture

Production model
Lean manufacturing
‘Just-in-time’ (JIT)
Automotive/assembly line
Mobile factory

Production challenges
Material sourcing
Factory/production facility
Logistics
On-site installation
Cost

LO2 Analyse how the relationship between material selection and technical processes inform design decisions

Material
Sustainability
Waste
Aesthetics
Supply
Transport

Technical process
Manufacturing
Manual assembly
Robotics
3D printing
Logistics (e.g., transport, assembly, storage, etc.)
Design impact
Speed of construction/delivery
Cost of construction/delivery
Addressing client/user needs

LO3 Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context

Stakeholders
Client (e.g., private, developer, investors)
Institutions (e.g., government, private sector, housing association)
Users (e.g., building users, general public)
Manufacturer
Supplier

Context
Typology (e.g., building type, building use)
User requirements
Environment/site
Economy/market
Statutory regulations
Design aims

Selection criteria
Volume/demand
Production model
Logistics
Budget
Time/deadline
Market/economy
Sustainability
Procurement
User/stakeholder requirements
**Strategy**
- Contextual features
- Design response
- Material strategy
- Sustainability
- Production model
- Market opportunity
- Manufacturing approach

**Design information**
- Sketches
- Models
- Drawings
- Renderings
- Animations/walk-thrus

**Construction information**
- General Arrangement Drawings (e.g., plans, sections, elevations)
- Details
- Consultant information (e.g., structural, mechanical, cost)
- Schedules (e.g., door, window, finishes)
- Specifications

**LO4 Present a strategy for high-volume off-site manufacture for a given building type and context**

**Design proposition**
- Addressing client requirements
- Meeting statutory requirements

**Manufacturing strategy**
- Materials
- Method of manufacture
- Transport requirements
On-site installation requirements (e.g., equipment, services, health and safety requirements)
Cost information

*Presentation*
Mode (e.g., report, audio-visual, video, etc.)
Audience (e.g., professional, client/stakeholder, technical)
Feedback
Reflection
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<tr>
<td><strong>Pass</strong></td>
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<tr>
<td><strong>LO1</strong> Explore different production models and their application to building manufacture</td>
</tr>
<tr>
<td><strong>P1</strong> Discuss the features of different production models in manufacturing.</td>
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<tr>
<td><strong>P2</strong> Explain the challenges of different production models for building manufacture.</td>
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<tr>
<td><strong>Merit</strong></td>
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<tr>
<td><strong>LO2</strong> Analyse how the relationship between material selection and technical processes inform design decisions</td>
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<tr>
<td><strong>P3</strong> Discuss the issues associated with material supply, sustainability, waste and material use in off-site manufacturing.</td>
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<tr>
<td><strong>P4</strong> Analyse the way in which technical processes inform and influence building design for manufacture.</td>
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<tr>
<td><strong>Distinction</strong></td>
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<tr>
<td><strong>M1</strong> Evaluate the potential benefits that a production model may address specific production challenges.</td>
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<tr>
<td><strong>D1</strong> Critically analyse the way that production model and material selection support a high-volume off-site building manufacturing strategy that addresses sustainability issues.</td>
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<tr>
<td><strong>M2</strong> Assess the design impact of manufacturing and logistics on building delivery.</td>
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<td>Pass</td>
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<tr>
<td><strong>LO3</strong> Develop design and construction information to support a high-volume off-site building manufacture strategy to meet stakeholder requirements for a given building type and context</td>
</tr>
<tr>
<td><strong>P5</strong> Analyse a given context to determine factors that may inform selection of an off-site production model. <strong>P6</strong> Develop a strategy for high-volume off-site manufacture to address identified factors for a given context.</td>
</tr>
<tr>
<td><strong>LO4</strong> Present a strategy for high-volume off-site manufacture for a given building type and context</td>
</tr>
<tr>
<td><strong>P7</strong> Present a coherent strategy for high-volume off-site manufacture that meets client and stakeholder requirements. <strong>P8</strong> Discuss the regulatory and health and safety requirements related to off-site construction.</td>
</tr>
</tbody>
</table>
Recommended Resources

Print resources

Web resources
(General Reference)

(Professional Body)

(General Reference)

(General Reference)

https://bit.ly/3l8DEO0  ICE Virtual Library
(General Reference)
Links

This unit links to the following related units:

- Unit 1: Construction Design Project (Pearson-set)
- Unit 2: Construction Technology
- Unit 3: Science & Materials
- Unit 6: Digital Applications for Construction Information
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 15: Principles of Alternative Energy
- Unit 23: Construction Economics & Sustainability
- Unit 24: Principles of Off-site Construction
- Unit 26: Digital Applications for Building Information Modelling
- Unit 30: Project Management
- Unit 32: Advanced Construction Drawing & Detailing
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 35: Sustainable Methods of Construction
- Unit 45: Advanced Materials
- Unit 47: Advanced Building Information Modelling
- Unit 51: Advanced Construction Development & Prototyping
- Unit 52: Advanced Housing Design & Specification.
Introduction

The function of a quantity surveyor on a large project will take several forms. The professional quantity surveyor (PQS) will support the client in terms of the project's budget and obtaining tenders that are within this budget. Contract selection will be a function to enable legally binding agreements between the client and the main contractor. The PQS will advise a client as to which is the best contract to use for their project. The main contractor’s quantity surveyor’s function on a large project will be to assemble a quantity surveying team that can control the costs of the works in accordance with the tender sum submitted. They will also maximise the revenue potential against any variations, buying or construction processes to maximise the project's return.

The quantity surveyor interacts with many different roles in project teams. They may work alongside the architect or designer, costing project elements and specifying, to arrive at a budget for the client. The main contractor’s quantity surveyor interacts with the estimating and construction teams. They work to establish what the estimator has included in terms of prices from suppliers and subcontractors so that orders can be placed in advance of the work commencing. Once the project has begun, they are involved in ensuring that the costs of the project are controlled to ensure they remain within the agreed contract sum.

In this unit, students will expand their knowledge and understanding of quantity surveying practice, with the emphasis on more complex projects and contract requirements.
Learning Outcomes

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

LO1 Analyse the functions of a quantity surveyor on large complex projects
LO2 Explain the quantity surveyor’s interactions with project teams
LO3 Prepare a contract for a complex project
LO4 Develop preliminary items and specification sections for a building or infrastructure project.
Essential Content

LO1  **Analyse the functions of a quantity surveyor on large complex projects**

*Pre-contract: professional quantity surveyor*
- Costing of client's project into a budget
- Advising client on potential procurement routes
- Advising client on contract types
- Preparation of any nominated or named contractors
- Obtaining quotations for nominated works
- Preparation of bills of quantity (BoQ)
- Preparation of tender documentation

*Specifications*
- Select tender list compiled
- Sending out project enquiries
- Receiving tenders
- Adjudicating tenders
- Awarding project

*Pre-contract: main contractor's quantity surveyor*
- Advising on procurement process and contract
- Read and digest tender documentation
- Analysis of project into packages
- Obtaining quotations for packages of work
- Materials and plant enquiries
- Assembly of tender documentation

*Specifications*
- Costing of preliminary items
- Tender adjudication meeting
- Tender submission
- Negotiation with specialist subcontractors
Construction phase: professional quantity surveyor
Issue and sign contracts
Pre-start meeting
Check valuations
Negotiations with main contractor
Issue certificates
Costing and agreement on variations
Running final account summary
Agree final account
Release retention

Construction phase: main contractor’s quantity surveyor

Legal and regulatory requirements for quantity surveyors
Contract law
Health and safety Regulations
Professional body codes of conduct and codes of practice
Financial regulations and financial regulators

LO2 Explain the quantity surveyor’s interactions with project teams

Main contractor’s quantity surveyor
Interaction with PQS and client regarding signing contract documentation
Pre-start meeting
Liaising with the estimator regarding quotations used in tender
Discussions with contracts manager and site manager regarding programme
Interaction with other quantity surveyors (QS) in the project team
Interaction with buying department for materials and plant requisitions
Interim valuations interactions with site manager and PQS
Interactions with site manager regarding variations
Attendance at site progress meetings
Interactions and negotiations with nominated and domestic subcontractors
Interactions with contracts manager regarding delays and extensions
Handover meetings
**Professional quantity surveyor**

Tender adjudication and interviews with main contractor’s estimating team
Award of contract with client
Award of contract to main contractor
Cost value engineering with main contractor
Issue and obtain contract signatures between client and main contractor
Control client’s budget with main contractors QS
Liaise regarding additional works and final account summary
Attend site progress and budget meetings
Interaction and negotiation with main contractor
Advise client on spending against budget
Attend handover meetings
Interact on final account and retention release

**Dealing with disputes between parties**

Avoiding and managing conflicts
Recording issues and complaints
Legal processes (e.g., adjudication, arbitration)
Financial disputes (e.g., cost overruns, valuation disputes)

**LO3 Prepare a contract for a complex project**

**Contract selection criteria**

Type of construction work
Duration of project
Number of projects
Value of work
Flexibility required
Private or public sector
Size of project
Funding strategy
**Construction contracts**

Joint Contracts Tribunal (JCT) (e.g., standard building contract, intermediate form of building contract, major project construction contract, design and build contract, management building contract, construction management contract, constructing excellence contract, measured term contract, prime cost building contract)

FIDIC (Fédération Internationale des Ingénieurs-Conseils)

NEC (The New Engineering Contract): Engineering and construction contract

CIOB (The Chartered Institute of Building) (e.g., CPC 2013 – CIOB Contract for use with Complex Projects)

Local international contract agreements

Classification of contracts (e.g., lump sum contracts, unit price contracts, cost-plus contracts, target cost contract)

**LO4** Develop preliminary items and specification sections for a building or infrastructure project

**Project information**

Client’s complex brief with working drawings

Specification of elements making up project

Cost estimate for the project

Client’s initial budget

**Specifications**

Types of specification (e.g., performance specifications, prescriptive specifications)

Standard forms (e.g., construction, civil engineering, building services)

Specification sections and classifications

Preliminary items

Specific ‘prelims’ sector requirements (e.g., construction, civil engineering, building services, relation to contract)
<table>
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<tr>
<td><strong>LO1</strong> Analyse the functions of a quantity surveyor on large complex projects</td>
<td><strong>P1</strong> Analyse the pre-construction and construction functions of a professional quantity surveyor and a contractor's quantity surveyor.</td>
<td><strong>M1</strong> Compare the functions of a professional quantity surveyor and a contractor's quantity surveyor during the execution of construction contract for a complex project.</td>
</tr>
<tr>
<td><strong>P2</strong> Discuss the legal and regulatory responsibilities of a quantity surveyor during different phases of a project.</td>
<td><strong>M2</strong> Analyse the financial interactions between the professional quantity surveyor and the contractor's quantity surveyor during the construction phase.</td>
<td><strong>D1</strong> Critically analyse the contractor's quantity surveyor's interactions in maintaining the profitability of a contract.</td>
</tr>
<tr>
<td><strong>LO2</strong> Explain the quantity surveyor's interactions with project teams</td>
<td><strong>P3</strong> Discuss the interaction of a professional quantity surveyor and a contractor's quantity surveyor with different teams during the pre-construction phase of a project.</td>
<td><strong>P4</strong> Describe the process of valuation and release of payments by the quantity surveyor during the construction phase.</td>
</tr>
<tr>
<td><strong>P4</strong> Describe the process of valuation and release of payments by the quantity surveyor during the construction phase.</td>
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</table>
| **LO3** Prepare a contract for a complex project | **P5** Analyse the criteria used for the selection of a contract for a large complex project.  
**P6** Prepare a contract, based on an appropriate standard, for a large complex project. | **M3** Assess the selection of a contract in meeting the requirements for a given project.  
**D2** Justify the selection of a contract, prelims and specification sections in meeting the needs of client and contractor for a large complex project. |
| **LO4** Develop preliminary items and specification sections for a building or infrastructure project | **P7** Prepare preliminary items for a building or infrastructure project specification, based on an appropriate standard.  
**P8** Develop specification sections to define works for building or infrastructure project, based on an appropriate standard. | **M4** Evaluate the relationship between preliminary items and specification sections in clearly defining works. |
Recommended Resources

Print resources
CARTLIDGE, D. (2017), New Aspects of Quantity Surveying Practice, Routledge
COOPER, R. (2017), Target Costing and Value Engineering, Routledge
TOWEY, D. (2017), Construction Quantity Surveying, John Wiley & Sons

Web resources
https://bit.ly/3BVZZ7y Chartered Institution of Civil Engineering Surveyors
(Professional Body)
(General Reference)
(Professional Body)
Links
This unit links to the following related units:

- Unit 2: Construction Technology
- Unit 4: The Construction Environment
- Unit 6: Digital Applications for Construction Information
- Unit 10: Measurement & Estimating
- Unit 12: Tender & Procurement
- Unit 13: Building Information Modelling
- Unit 23: Construction Economics & Sustainability
- Unit 25: Quantity Surveying Practice
- Unit 26: Digital Applications for Building Information Modelling
- Unit 29: Contracts & Management
- Unit 30: Project Management
- Unit 33: Construction Technology for Complex Buildings Projects
- Unit 36: Value Engineering & Cost Control
- Unit 38: Advanced Quantities for Complex Building Projects
- Unit 40: Surveying for Conservation, Renovation & Refurbishment
- Unit 44: Maintenance & Operations
- Unit 47: Advanced Building Information Modelling.
Unit 55: Alternative Sustainable Solutions in Construction

Level: 4
Credits: 30
Ofqual Code: J/650/4844

Introduction

The construction industry seeks to be dynamic and forward thinking but most buildings are still constructed using many of the same materials and processes that have been utilised for centuries.

While there is accumulated knowledge in the use of tried and tested methods they are not always the most efficient or cost effective. This, combined with the fact that the construction industry is one of the largest contributors to emissions, means that it is under increasing pressure and legislative requirements to improve its processes and practices. However, the industry also faces other challenges. As one of the most important sectors of the global economy, it is important that construction is able to meet the demands for housing and institutional and commercial development. Traditional methods of construction will not be sufficient. One of the ways in which the sector is exploring how to address sustainability and increase productivity is through the development and implementation of alternative forms of construction.

Buildings use about 40 per cent of global energy, 25 per cent of global water and 40 per cent of global resources in their construction and operation. Globally, governments have recognised the importance of tackling energy consumption in the built environment and have instituted legislation to address these issues. This has often been supported by financial incentives to implement alternative energy systems and processes. Technologies that harness renewable solutions are now established and are generating power and heat. Along with other innovations, such as heat pumps and biofuel, they are often incorporated into the design for new construction projects.

On successful completion of this unit, students will have examined how the construction industry impacts on the environment, explored alternative construction methods that are fit for purpose and government policy implications, and designed a fit-for-purpose structure using an alternative construction method.
Learning Outcomes

By the end of this unit, a student will be able to:

LO1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies

LO2 Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies

LO3 Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation

LO4 Present the retrofit solution for the given building and evaluate the solution and presentation.
Essential Content

LO1 Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies

Sustainable development:
Meeting current and future demands, e.g., Brundtland definition, global demographics, trends and predictions, population growth, urbanisation, UN sustainability development goals, the balance of urban/rural space.

Environmental protection:
Environmental characteristics, e.g., environment features, global warming, carbon emissions, government and national targets, construction statistics.

Environmental issues:
Impact of environmental issues on alternative sustainable construction, e.g., climate change, planetary energy balance, the Intergovernmental Panel on Climate Change (IPCC), carbon cycle science, the 2°C climate-change obligation, carbon capture, pollution prevention and management.

Social and economic factors:
Socio-economic impact of construction, e.g., government influences, construction statistics, housing statistics, affordable homes, urbanisation, greenfield and brownfield sites.

Government policy:
Local/regional/national planning, policies and regulations, such as approved documents, e.g., Part L, Part F, health and safety legislation, carbon taxes, Bonfield Review, PAS 2035.

Systems thinking and socio-technical systems:
Politics and economics of sustainable construction, e.g., Kyoto Protocol, Montreal Protocol, Paris Agreement, UN Climate Change Conference (COP), European Union Emissions Trading Scheme.

Sustainability protocols:
Sustainable construction of homes protocols, e.g., Passivhaus Trust, Building Research Establishment Environmental Assessment Method (BREEAM), Code for Sustainable Homes, retrofit solutions, 2030 Agenda for Sustainable Development.
LO2 Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies

Energy demand and security of supply:
Energy demand and security of construction design solutions, e.g., energy consumption changes, intensity and trends (domestic, industrial, transport, service sectors), factors affecting changes in energy consumption and demand, future demand planning based on trends and needs analysis, risk analysis for energy supplies for UK and local areas.

Energy reduction and efficiency approaches:
Reducing energy use, during construction and post construction, e.g., energy saving and reduction schemes, energy-saving technologies available, grants and government schemes, effect of such schemes on supply and demand.

Low-carbon transport systems:
Sustainable cities, green building, power storage and distribution, sustainable logistics, waste and recycling, vehicle to grid.

Construction methods:
Timber frame, prefabrication, Insulated Concrete Forms (ICFs), Structural Insulated Panels (SIPs), offsite manufacture, modulisation/componentisation, robotics, autonomous building.

Alternative methods of power generation:
Solar power, passive solar heating, wind energy technology, ocean energy technology, hydroelectric and micro-hydro power turbine geothermal energy, combined heat and power, heat pumps, storage technologies.
LO3  **Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation**

*Selection of alternative sustainable solution techniques:*
Building types and their needs, consumer needs, technical aspects, economical aspects, social aspects, environmental aspects, manufacturer specifications.

*Calculation of the impact of a retrofit design solution and environmental benefits:*
Data analysis and calculations, e.g., review of product specifications, comparison of product, effectiveness of product selection, e.g., price, appearance, longevity, adhering to regulation, U-values, energy-generation values, sustainability, carbon emissions, footprint and neutrality.

*Digital planning and design software:*
Construction planning and design software tools to develop design ideas, e.g., AutoCAD, Revit, SketchUp, Photoshop.

*Construction information:*
Construction design drawings, e.g., floor plans, elevations, sections, details, sketches, models, perspectives, rendered, photo-realisation.

*Financial and environmental implications:*
Cost-benefit analysis, socio-economic factors, financial implications of renewable and conventional energy systems, whole lifecycle costing.

*Presentation and skills:*
Consideration of audience, venue, environment, documentation, resources, time management, clarity, concision, voice.
Present the retrofit solution for the given building and evaluate the solution and presentation

Communicating results:
Types of communication methods, e.g., written, verbal, the medium, e.g., different report formats, online, presentation. Multi-media presentation tools, e.g., PowerPoint, Prezi, Google slides, Microsoft Sway, Adobe Spark.
Video conferencing, e.g., Zoom, Adobe Connect, Google Hangouts, Slack video calls.

Communicating skills:
Verbal and non-verbal communication skills required to meet audience requirements, e.g., eye contact, pitch, pace.
Communicating and persuading internal/external stakeholders, e.g., negotiation and sales skills.

Reflection for learning and practice:
Differences between reflecting on performance and evaluating a project – the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence. The cycle of reflection and using reflection to inform future behaviour.
Reflective practice, including feedback, e.g., self-evaluation, peer and expert.
Reflective writing – writing to avoid generalisation, focusing on personal development and the research journey in a critical and objective way.
### Learning Outcomes and Assessment Criteria

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<tr>
<td><strong>LO1</strong> Explain how socio-economic, legislative and environmental factors impact on the consideration and selection of renewable energy resources and technologies</td>
<td><strong>P1</strong> Describe the principals of modern sustainability theory.</td>
<td><strong>M1</strong> Analyse the impact of socio-economic factors that influence a retrofit project.</td>
</tr>
<tr>
<td><strong>P2</strong> Explain the market forces that dictate energy supply and demand.</td>
<td><strong>M2</strong> Analyse the selection of MMC in terms of alternative methods of power generation.</td>
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</tr>
<tr>
<td><strong>LO2</strong> Investigate alternative construction methods suitable for new build and retrofit that include alternative energy solutions alongside techniques that improve energy efficiency through the design and specification of modern materials and technologies</td>
<td><strong>LO1 and LO2</strong></td>
<td><strong>D1</strong> Evaluate the factors that inform the selection of a retrofit project.</td>
</tr>
<tr>
<td><strong>P3</strong> Compare Modern Methods of Construction (MCC).</td>
<td><strong>P4</strong> Describe the available alternative methods of power generation.</td>
<td><strong>D1</strong> Evaluate the factors that inform the selection of a retrofit project.</td>
</tr>
</tbody>
</table>

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**Unit Descriptors for the Pearson BTEC Higher Nationals Construction Suite**  
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<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO3</strong> Prepare a retrofit design solution for a given building to improve the performance of the building fabric and energy utilisation</td>
<td><strong>M3</strong> Justify solution decisions based on design, funding, sustainability and performance.</td>
<td><strong>LO3</strong> <strong>D2</strong> Evaluate the selection outcomes of a retrofit proposal in relation to a specific installation.</td>
</tr>
<tr>
<td><strong>P5</strong> Select appropriate solutions for a given retrofit project.</td>
<td><strong>P6</strong> Produce data to draw valid and meaningful conclusions and recommendations from data analysis.</td>
<td><strong>P7</strong> Calculate the impact of a retrofit project.</td>
</tr>
<tr>
<td><strong>P8</strong> Present the recommended retrofit solution using an appropriate format.</td>
<td><strong>M4</strong> Reflect on the effectiveness of the chosen communication strategy in presenting the retrofit solution.</td>
<td><strong>LO4</strong> <strong>D3</strong> Appraise own performance in managing the retrofit project, draw conclusions and make recommendations that would improve performance in the future.</td>
</tr>
<tr>
<td><strong>P9</strong> Explain possible communication strategies and presentation methods that could be used to inform the recipient of the recommended retrofit solution.</td>
<td></td>
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<tr>
<td><strong>P10</strong> Review feedback given and own performance.</td>
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</tbody>
</table>
Recommended Resources

Print resources


Web resources
bregroup.com  BREEAM Assessment Methods and Standards  (General Reference)

building.co.uk  Construction articles and papers  (General Reference)

constructionnews.co.uk  Construction News articles and papers  (General Reference)

sdgs.un.org  Global Sustainable Developments  (General Reference)
Links

This unit links to the following related units:

Unit 3: Science & Materials
Unit 4: The Construction Environment
Unit 6: Digital Applications for Construction Information
Unit 9: Principals of Heating, Ventilation and Air Conditioning
Unit 13: Building Information Modelling
Unit 16: Principles of Alternative Energy
Unit 23: Construction Economics & Sustainability
Unit 24 Principles of Off-site Construction
Unit 35: Sustainable Methods of Construction.