Unit 50: Construction Design Technology

Unit code: K/600/0460

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit gives learners an understanding of how specifications are used to realise design solutions and of the importance of 'buildability' and 'sustainability'. Learners will gain knowledge of how construction materials fail in use and to prevent these failures, and develop effective drawing skills.

Unit introduction

This unit explores the specification of materials, systems and methods in terms of the requirements of the Building Regulations, British Standard Codes of Practice, Agrément Certificates and the Code for Sustainable Housing (CSH). It then investigates the application of appropriate procedures to guarantee quality control in these areas. The unit will help learners to recognise poor quality materials and poor workmanship, and stresses the importance of effective supervision of work in progress and on completion.

Learners will investigate essential design aspects that must be provided for in the construction process. They will also develop the technical knowledge needed to realise design solutions.

A major part of a design professional's work is the inspection of property to determine its condition and to analyse defects such as the failure of the materials used in the building. Learners will explore both the reasons for these defects and failures and the methods that are typically used to remedy them and prevent them from happening in the first place. The important aspect of cost and cost effectiveness when considering remedial works will be considered.

Learners will be introduced to the concepts of buildability and sustainability and will learn to link these concepts to the design and production of the built environment. They will develop an appreciation of the benefits of using these concepts.

Good architectural detailing, using both manual and CAD techniques, is stressed throughout. This important process will be highlighted at the various project stages from initial sketch details to design details and working drawings.

Learning outcomes

On completion of this unit a learner should:

1 Understand how specifications are used to realise design solutions

2 Know how construction materials fail in use and how such failures can be prevented

3 Understand the importance of 'buildability' and 'sustainability' in the modern built environment

4 Be able to demonstrate effective drawing skills.

Unit content

1 Understand how specifications are used to realise design solutions

Specification of materials, methods and systems: specification techniques; preparation of specification documents; items referenced in Building Regulations, British Standard Codes of Practice, Agrément Certificates, Code for Sustainable Housing (CSH) and trade associations; criteria used for inspecting quality of materials and workmanship; quality control onsite and offsite; reference sources (British Standards Codes of Practice, Building Regulations, Agrément Certificates, Code for Sustainable Housing)

2 Know how construction materials fail in use and how such failures can be prevented

Failures of materials: causes of failure (natural deterioration, human factors, poor design and detailing of the building, human traffic, vandalism); reasons for failures; types of failure

Preventative and remedial measures: techniques used to address material failures; planned maintenance and repair programmes; lifespan and cost-in-use issues, legal and design aspects; associated health and safety issues; cost effectiveness of preventative and remedial work and ongoing maintenance; defects schedules; programmes of planned and emergency maintenance

3 Understand the importance of 'buildability' and 'sustainability' in the modern built environment

Buildability: provision of construction details and materials to simplify construction process; consideration at every stage of the construction process (design, construction, maintenance, alteration, demolition); benefits (lower construction costs, fewer claims, compliance with CDM Regulations) addresses issues raised in the Egan Report

Sustainability: meeting the needs of the present without compromising the ability of future generations to meet their own needs; issues confronting construction design; good practice; impact on Building Regulations; eco-towns

Technical design: planning for buildability before construction; accurate lifelong costings; principles (constructability, maintainability, simplicity in alteration); compliance with Building Regulations and the Egan Report; health and safety requirements

4 Be able to demonstrate effective drawing skills

Drawing techniques: sketching (conceptual and technical); measured drawing; manual drawing techniques; CAD documentation, filing and library retrieval systems; working up initial ideas from sketches to working drawings.

Construction drawings: floor plans; elevations; sections; details; landscape layouts; block diagrams

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 explain how materials, systems and methods are specified for construction projects [IE2, IE4, CT6, SM3]	**M1** evaluate the quality control measures used for materials and workmanship onsite and offsite	**D1** justify specifications and quality control measures in terms of relevant reference sources
P2 describe how common building materials fail in use [IE2, IE4, SM3]	**M2** prepare a defects schedule for a given case study	
P3 describe preventative and remedial measures used to reduce or eliminate the failure of building materials [IE2, IE4, SM3]		
P4 explain the terms buildability and sustainability [IE2, IE4, SM3]	**M3** justify the buildability and of a given construction project in terms of compliance with the Building Regulations.	**D2** evaluate the impact of sustainability issues on the Building Regulations.
P5 analyse the technical design of a given construction project in terms of buildability and sustainability [IE2, IE4, CT6, SM3]		
P6 use drawing techniques to produce construction drawings to support design proposals. [IE2, IE4, SM3]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key			
	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, use of manual and CAD drawings, research using the internet and/or library resources and use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Case studies, documentation and projects should be used to assist and enhance understanding and learning. Wherever practical, site visits to successful projects should be incorporated. Visiting expert speakers could add to the relevance of the subject.

Study of this unit depends on prior knowledge and understanding of construction technology. An overview of the role of the design process, and the wider context within which it fits, needs to be addressed at an early stage in the delivery. Learners must be made aware of how and why materials and methods are specified. Specifications, appropriate techniques for the preparation of specification documents and specifying items with reference to the Building Regulations, British Standard Codes of Practice, Agrément Certificates, Code for Sustainable Housing (CSH) and trade associations are all applicable. Applying the criteria used for inspecting the quality of materials and workmanship will provide a good basis for case study material to enhance and contextualise the learning experience.

Delivery should emphasise the need for sensible planning before construction commences. This should be accurately costed (including lifelong costs-in-use as well as construction costs), intelligently designed and detailed and based on constructability, maintainability and simplicity in alteration. The cost effectiveness of the process is part of creative design and leads to major cost benefits for designers and builders. Understanding the major points of the Egan Report is paramount. Developing an awareness of safety requirements, how accidents occur and how they can be avoided is also important. Consideration should be given to prioritising actions, practical construction methods, improving buildability, lifespan and improving methods, materials, and timescales. Learners must be made aware of sustainability and how to address the important issues confronting the construction industry, including government legislation, codes of practice, building regulations, housing shortages and eco-towns.

A key element of delivery is the production of sketch designs, plans, drawings and/or sketches of construction details using standard conventions and symbols. Learners should be encouraged to develop their ability to draw plans and details for buildings that are functional, but also to express themselves within a design context.

Learners will need to understand the necessity of accurate scale drawings showing salient and important information for construction teams. The ability to translate information contained in drawings into meaningful, written technical terminology is essential.

Wherever possible, links should be made with design practices and 'live buildings' with visits arranged to enable learning to be contextualised. Seeking specialised input from current practitioners could enhance the learning process further.

Overall delivery of the unit should be supported by the use of case studies and visual media, where appropriate, including photographs, videos, DVDs and drawings. Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction Whole-class teaching – selection of materials and methods of use Specifications: appropriate techniques for the preparation of specification documents, specifying items with reference to The Building Regulations, British Standard Codes of Practice, Agrément Certificates, Code for Sustainable Housing (CSH) and trade associations Class exercises in specification writing followed by tutorial/class discussion: sample model specifications to meet requirements of client, building control and production team. Class split to cover different elements and types Whole-class teaching – examine and apply the criteria used for inspecting the quality of materials and workmanship
Introduction to material failure, preventative and remedial measures Whole-class teaching – methods of observing the building, analysing and resolving defects, the cause of deterioration in buildings, and an understanding that some defects have a number of differing causes and remedies and that these must be identified before they can be properly resolved Common building defects, definition of what constitutes a defect. Causes of failure such as natural deterioration, human factors, poor design and detailing of the building, human traffic, and vandalism Group work – common building defects, natural deterioration, human factors, poor design and detailing of the building, human traffic and vandalism Tutorial/class discussion on above Whole-class teaching, followed by class exercise – preventative techniques used to address defects, principles of defect analysis and application of analytical methods to observe defects and compile a report on findings and recommendations Whole-class teaching – preparation of reports and specifications for remedial works. Remedial techniques used to address defects, planned maintenance and repair programmes in terms of lifespan and cost-in-use issues, legal and design aspects and associated health and safety issues Whole-class teaching, followed by group work – important economic constraints, both in terms of cost effectiveness of the work and the ongoing maintenance. Details of specific ongoing maintenance liability including an assessment of planned maintenance programmes and emergency maintenance
Assignment 1: Specification, Quality Control, Failures of Material and Preventative and Remedial Measures

Topic and suggested assignments/activities and/assessment
Introduction to buildability and sustainability
Whole-class teaching, followed by class exercise – propose and evaluate the ways in which the concept of 'buildability' impacts on design and construction
Whole-class teaching on Egan Report, safety requirements, how accidents occur (statistics), accident avoidance measures, prioritising actions, practical construction methods, lifespan considerations, improving methods, materials, and timescales
Whole-class teaching – sustainability issues confronting the construction industry Government legislation including codes for building regulations and good practice
Group work on eco-towns
Assignment 2: Buildability and Sustainability
Whole-class teaching – sketching, both conceptual and technical, measured drawing, manual drawing techniques, CAD documentation
Class exercise – sketching, both conceptual and technical, measured drawing, using both manual and CAD drawing techniques
Whole-class teaching, followed by class exercises – working up of initial ideas, from sketches to design to working drawings. Floor plans and elavations, landscape layouts, block diagrams, filing and library retrieval systems
Assignment 3: Graphical Communication
Unit review and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or live projects.

There are many suitable forms of assessment that could be used. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. Some criteria could be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements.

The structure of the unit suggests that the grading criteria could be addressed fully by using three assignments. The first of these would cover P1, P2, P3, M1, M2 and D1, the second would cover P4, P5, M3 and D2, the third P6. Case studies could provide a suitable vehicle for assessments. Staged submissions should be considered and regular, interim feedback from the tutor would be essential.

To achieve a pass grade learners must meet the six pass criteria.

For P1, learners must explain how sample specifications for various materials and construction processes are produced to provide suitable instructions for the construction team. This could be completed by using various elements of a given building or ongoing construction project. Learners will need to be provided with suitable materials that can be used to draft specifications. Examples include detailed working drawings, photographs and manufacturer literature.

For P2, learners must describe how common building materials fail in use. They should be able to recognise each failure as the consequence of natural deterioration, human factors, poor design/detailing of the building, human traffic or vandalism.

For P3, learners must describe the preventative and remedial measures used to reduce and/or minimise defects and material failures. This should build on the evidence provided for P2.

For P4, learners must explain the terms buildability and sustainability in terms of how each impacts on the natural and built environment.

For P5, learners must analyse the effectiveness of the technical design of a successful construction project and explain how the technical design works in terms of buildability and sustainability. Evidence should refer to effectiveness, compliance with legislation and guidance, and cost economies that have been made.

For P6, learners must produce sketch designs, plans, drawings and/or sketches of construction details using standard conventions and symbols. Learners are required to communicate construction information through carefully constructed drawings using both manual and/or CAD techniques. The latter is not mandatory but is acceptable where learners have the required skills.

To achieve merit grade learners must meet all of the pass criteria and the three merit grade criteria.

For M1, learners must evaluate the procedures for the quality control of various materials/items on and off site. This should build on the evidence for P1.

For M2, learners must complete a defects schedule from a tutor-provided case study. This could perhaps be completed using a 'live building' and could relate to the evidence provided for P3.

For M3, learners must justify the buildability of a given construction project. They should explain the importance of sensible planning before construction commences, accurate costing, lifelong costs as well as construction costs, intelligent design and detailed information. Evidence should be based on constructability, maintainability and simplicity in alteration. The cost effectiveness of the project should feature in the evidence but costs need only be approximate and relative.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and both of the distinction grade criteria.

For D1, learners must justify specifications and quality control measures in terms of appropriate information from major British Standard Specifications and Codes of Practice, the Building Regulations, Agrément Certificates, the Code for Sustainable Housing (CSH) and trade associations.

For D2, learners must evaluate the impact of sustainability issues on the Building Regulations. Evidence should include environmental factors and conditions that influence design for sustainable construction.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, M2, D1	Specification, Quality Control, Failures of Material and Preventative and Remedial Measures	Working for a company that refurbishes buildings, you have been asked to produce specifications refurbishing a building after identification of a range of building defects and material failures, and selection of appropriate remedial or preventative techniques.	A report containing sample specifications for various materials and construction processes, a defects schedule and selection of planned or emergency remedial and preventative techniques.

Criteria covered	Assignment title	Scenario	Assessment method
P4, P5, M3, D2.	Buildability and Sustainability	The company asks you to do an analysis of the effectiveness of the technical design of a successful construction project in terms of buildability and sustainability.	A report to include text, drawings and costs as appropriate.
P6	Graphical Communication	The company asks you to prepare s portfolio of sketch designs, plans, drawings and construction details to support the technical design of a refurbishment project.	Drawings showing sketch designs, and fully annotated plans showing construction details using manual and CAD techniques. These should include correct technical terminology and any modifications.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Health, Safety and Welfare in Construction and the Built Environment
		Sustainable Construction
		Construction Technology and Design in Construction and Civil Engineering
		Building Technology in Construction
		Graphical Detailing in Construction and the Built Environment
		Economics and Finance in Construction and Civil Engineering
		Building Surveying in Construction
		Building Regulations and Control in Construction
		Computer Aided Drafting and Design for Construction
		Project in Construction and the Built Environment
		Design Procedures in Construction

This unit links to the Edexcel Level 3 NVQ in Technical Design (Construction Environment) and the Edexcel Level 4 NVQ in Site Inspection. It also links to the following National Occupational Standards at Level 3:

- BE Design
- BE Development and Control
- Construction Contraction Operations
- Spatial Data Management.

Essential resources

Learners should have access to a wide range of manual and ICT/CAD facilities, documentation and library resources, including textbooks and journals, government and industry wide publications, British Standard Specifications, Codes of Practice, BRE Digests, professional journals, the internet and other research materials, and other associated documents. Access to authentic general and detailed working drawings and specifications to show their format, use and application is advisable. Where possible, real examples of buildings and building technology will improve learning. Appreciation of the characteristics of building materials and components would be enhanced by the availability of selected samples.

Employer engagement and vocational contexts

The use of vocational contexts is essential in the delivery and assessment of this unit. Much of the work can be set in the context of learners' work placements or be based on case studies of local employers or employer related projects in construction and the built environment.

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- The Royal Institution of Chartered Surveyors – www.rics.org
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Brett P – *An Illustrated Dictionary of Building* (Elsevier, 2007) ISBN 9780750636841

Chanter B and Swallow P – *Building Maintenance Management, 2nd Edition* (Wiley-Blackwell, 2007) ISBN 9781405135061

Chudley R and Greeno R – *Building Construction Handbook* (Butterworth-Heinemann, 2008) ISBN 0750686227

Emmitt S and Gorse C – *Barry's Introduction to Construction of Buildings* (Blackwell, 2005) ISBN 1405110554

Emmitt S and Yeomans D – *Specifying Buildings: a Design Management Perspective, 2nd Edition* (Butterworth-Heinemann, 2008) ISBN 9780750684507

Emmitt S – *Design Management for Architects* (Blackwell, 2007) ISBN 9781405131476

Mitchells – *Introduction to Buildings* (Pearson Education Ltd, 2007) ISBN 9780132325714

Mitchells – *Structure and Fabric Part 1* (Pearson Education Ltd, 2008) ISBN 9780131970946

Riley M and Cotgrave C – *Construction Technology 1 House Construction* (Palgrave, 2008) ISBN 9780230624

Riley M and Cotgrave C – *Construction Technology 2 House Construction* (Palgrave, 2008) ISBN 9781403940957

Riley M and Cotgrave C – *Construction Technology 3 The Technology of Refurbishment and Maintenance* (Palgrave, 2005) ISBN 1403940959

Stephenson —*Spon's Building Regulations Explained* (Taylor and Francis, 2009) ISBN 9780415430678

Journals

Architects Journal – Emap

The Builder – Hanley Wood

BRE Digests and publications – CMP

Construction News – Emap

Websites

www.greenspec.co.uk	Green Building
www.palgrave-journals.com/jba/free_articles.html	Journal of Building Appraisal
www.planningportal.gov.uk	The Complete Online Planning and Building Resource
www.thenbs.com	National Building Specification

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	determining the sources of common building defects and applying analytical methods to observe defects
Creative thinkers	creating sample specifications for construction details to provide suitable instructions for the construction team producing sketch designs, plans, drawings and/or sketches of construction details using standard conventions and symbols
Self-managers	organising time and resources, prioritising.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	making an individual input to group work investigating common building defects, natural deterioration, human factors, poor design and detailing of the building, human traffic, and vandalism using 'live buildings' identifying questions to answer and problems to solve during whole-class teaching planning and carrying out research and appreciating the consequences of decisions exploring issues, events or problems from different perspectives when carrying out research and analysing and evaluating information, judging its relevance and value and supporting conclusions, using reasoned arguments and evidence
Creative thinkers	generating ideas when writing specifications asking questions to extend their thinking during whole-class teaching asking questions to extend their thinking during preparation for assignments connecting their own and others' ideas when carrying out group work, and questioning their own and others assumptions adapting ideas as circumstances change
Reflective learners	assessing themselves and others and identifying opportunities and achievements when carrying out research and group work inviting feedback and dealing positively with praise, setbacks and criticism during tutorial/class discussion communicating their learning in different ways for different audiences whilst carrying out building observations
Team workers	collaborating with others to work towards common goals during group work and providing constructive support and feedback to others
Self-managers	working towards goals showing initiative, commitment and perseverance organising time and resources, prioritising actions
Effective participators	discussing issues of concern and seeking resolution where needed during tutorial/class discussions.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using the internet to search for information, eg material failure and to use software applications
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	using software applications to programme activities of work when undertaking assignments
Manage information storage to enable efficient retrieval	managing files and folders in assignment work, eg buildabilty and sustainability to enable efficient information management
Follow and understand the need for safety and security practices	storing and backing up information in an orderly and safe manner
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	selecting and using information from the web and from software applications in their research for assignment tasks, eg buildabilty and sustainability
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	using internet sources of information effectively recognising the intention and authority of the provider, currency of the information, relevance and bias
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	using ICT word-processing and presentation applications in compiling reports to satisfy assignment tasks
Bring together information to suit content and purpose	organising information in different forms or from different sources to achieve various purposes including presentations
Present information in ways that are fit for purpose and audience	working accurately and proofreading, using software facilities where appropriate, ensuring clear meaning seeking views of others, check spelling, check calculations, ensuring consistent layout and previewing printouts
Evaluate the selection and use of ICT tools and facilities used to present information	reviewing and modifying work as it progresses to ensure the results are fit for purpose and audience, and in informing future judgements checking draft reports with professional audiences
ICT – Use ICT systems	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	using email messaging in communicating internally and externally when carrying out study, research and assignment work adapting a vocational style to suit a professional audience

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	presenting information and ideas clearly and persuasively to others adapting contributions in discussions to suit a professional audience, purpose and situation using a professional vocabulary in a responsible and ethical context
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	undertaking research activities by selecting and using different types of texts to obtain relevant information reading and summarising succinctly information from different sources identifying the purpose of texts and commenting on how effectively meaning is conveyed
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	presenting information such as property valuations concisely, clearly, logically and persuasively to a professional audience using a range of different styles of writing for different purposes using a range of sentence structures, including complex sentences, with accurate punctuation, grammar, spelling and meaning.