

Unit 18: Computer-aided Drafting and Design for Construction

Unit code:	H/600/0232
QCF Level 3:	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit aims to give learners the opportunity to gain knowledge of how CADD is used to produce drawings, including the software and hardware components, and skills in using CADD software to produce 2D drawings and 3D models.

● Unit introduction

The use of computer aided draughting and design (CADD) techniques has revolutionised design and construction processes within the construction industry. This unit will enable learners to produce a variety of CADD drawings, from 2D plans to complex 3D models. 3D CADD models can be rendered to produce photo-realistic representations, or animated to illustrate the construction process. Advanced techniques, such as using pre-prepared symbols to construct drawings, will provide opportunities for learners to expand and develop their CADD skills. Learners will also investigate the use of CADD in industry and the required hardware and software. In doing this, learners will appreciate the advantages of CADD over more conventional methods of drawing production.

Finally, learners will generate 3D models, make comparisons with 2D CADD drawings and evaluate the impact of this technology on construction companies and their customers.

This unit as a whole provides an opportunity to carry out practical CADD activities using a full range of commands and drawing environment. Learners will also gain an understanding of the use and impact of CADD on the construction industry.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the advantages of using CADD in comparison with other methods of producing drawings
- 2 Know about the software and hardware required to produce CADD drawings
- 3 Be able to use CADD software to produce 2D construction drawings and details
- 4 Be able to use CADD software to produce 3D construction virtual models.

Unit content

1 Know the advantages of using CADD in comparison with other methods of producing drawings

Advantages of CADD: quality; accuracy; time; cost; electronic transfer of information; links with other software eg rendering software, animation software, finite element analysis (FEA)

Other methods: manual drafting; model-making

2 Know about the software and hardware required to produce CADD drawings

Software: operating systems; CADD software packages eg AutoCAD; minimum system requirements eg hard disk space, memory required, processor, video card

Hardware: keyboard; mouse; other input devices eg light pen, digitiser, joystick, thumbwheel; monitor; printer; other output devices eg plotter, rapid prototyping; storage eg floppy disk, hard disk, memory stick, CD, network

3 Be able to use CADD software to produce 2D construction drawings and details

2D CADD features: set up of drawing; drawing aids; drawing and editing commands; line-weights and widths; layer convention and controls; text and dimensioning commands; changing properties; layouts; model space; paper space; different scales on the same drawing; plotting routines

4 Be able to use CADD software to produce 3D construction virtual models

3D CADD features: component libraries; model space; paper space; different scales on the same drawing; plotting routines

Model: wire frame, extruded and surface developments; elevations and sections eg 3D views, plan views, perspective views including walk-throughs with rendered and textured surfaces

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 describe the advantages, compared to other methods, of producing drawings electronically using a CADD package [IE1, IE2, IE3, CT2,]	M1 explain the relationship between CADD and other software/hardware used in construction	D1 justify the use of CADD for a construction project
P2 describe the software and hardware required to produce CADD drawings [IE1, IE2]	M2 evaluate how commands used to produce CADD drawings can impact on drawing production	D2 evaluate the impact of using 2D and 3D CADD models on design requirements.
P3 prepare a template drawing using a CADD system, saving it to a file [CT1]	M3 explain the benefits of using CADD to produce 3D virtual models.	
P4 use 2D CADD features to produce a hard copy of a graphical drawing showing a plan, section and elevation at different scales [CT1]		
P5 use 3D CADD features to produce a simple virtual model, plotting out various views that are fit for purpose. [CT1]		

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 CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, 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. Visiting expert speakers could add to the relevance of the subject.

The unit is practical with most learner evidence generated via simulated industry-based exercises, projects and scenarios. Where learners are new to a particular CADD software program they should be taken through the basic routines by following them through a series of graded examples. For large groups, an interactive whiteboard can make it easier to follow, although the use of hard copy learning packs and one-to-one tutorials may be preferable for smaller groups or more focused individuals.

Learners should be encouraged to problem solve by experimenting with the CADD packages. Most good industrial programs are highly intuitive with easy to access 'help' menus and learners should be encouraged to develop their skills in using these. 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 to unit content
Assignment 1: CADD Report Introduction to CADD system Class exercise on using the operating system to identify and activate CADD software, including the system requirements for running CADD software and the relationship between CADD and associated software packages Individual practical activities introducing learners to the system configuration and setting up the drawing environment including the use of relevant toolbars and menus Class exercise on the individual hardware elements of a CADD system and an exercise comparing the use of CADD with other methods Whole-class exercise on the use of appropriate standards in creating drawings Production of a report on CADD

Topic and suggested assignments/activities and/assessment

Assignment 2: A 2D CADD Drawing

Use CADD to produce conceptual drawings – tutor explanation and demonstrations

Produce conceptual drawings – individual exercises

Use CADD to produce project drawings – tutor explanation and demonstrations

Produce project drawings – individual exercises

Production of a 2D CADD drawing

Assignment 3: A 3D CADD Model

Wire-framed drawings – tutor explanation and demonstrations

Produce wire-framed drawings – individual exercises

Walk-through models – tutor explanation and demonstrations

Produce walk-through models – individual exercises

Production of a 3D CADD model

Review of unit and assignment feedback

Assessment

There are many suitable forms of assessment that could be used and tutors are encouraged to consider and adopt these where appropriate. 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 can be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements.

The unit is structured so that the grading criteria can be addressed fully by using three assignments.

The first assignment would relate to learner knowledge of the advantages of using CADD, as opposed to other methods of drawing, and of the software and hardware needed for CADD. This would cover P1, P2, M1, M2, M3, D1 and D2.

The second assignment would relate to learner skills in using CADD software to produce 2D drawings. This would cover P3 and P4.

The third assignment relates to the learner's skills in using CADD software to produce 3D models. This would cover P5.

The content of the second and third assignments is based on the development and production of a portfolio of work, consisting of a variety of computer-aided details and drawings, using industry software. This work should be based around a realistic industrial scenario with sufficient information in the form of a written brief, specifications and sketches. However, it should be noted that what is being assessed is the quality of the CADD work and not necessarily the technical correctness of the details being drawn, although this is important. The tutor needs to make an appropriate judgement based on the learner's expected technical knowledge at the time of undertaking this particular assessment.

To achieve a pass grade learners must meet the five pass criteria listed in the grading grid.

To achieve P1, learners must describe the advantages, compared to other methods, of producing drawings electronically using a CADD package. This should include how CADD systems can be linked with other software. A description of the basic hardware and software requirements needed to produce CADD drawings will be required to achieve P2.

For P3, learners should prepare a template drawing using a CADD system and save the template to a file. This template could then be used for P4.

For P4, learners should be able to produce a simple graphical drawing using 2D CADD techniques showing a plan, section and elevation at different scales. They should show different views and use standard conventions and scales. Drawings should include text blocks, simple dimensions, labelled title block and borders extracted from a given template. Learners should also be able to carry out simple plotting routines to produce a hard copy of a minimum of A2 size.

For P5, learners should be able to produce a simple virtual 3D model and plot out various views that are fit for purpose. Using standard conventions, they should produce drawings of a simple 3D model wire frame, with 3D faces, and plot out various views in hard copy. Drawings should include text blocks, simple dimensions, title block and borders extracted from a given template. They should also be able to carry out simple plotting routines to produce correctly scaled hard copies of a minimum of A2 size. The CADD diagrams should relate to an architectural, mechanical, electrical or civil engineering context depending on the vocational pathway.

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

For M1, learners will need to explain the relationship between CADD and other software/hardware used in construction.

For M2, learners will need to evaluate how commands used to produce CADD drawings can impact on drawing production in terms of efficiency (for example speed, accuracy, repeatability).

For M3, learners should be able to explain the benefits of using CADD to produce 3D virtual models. They should be able to qualitatively describe the applications and benefits of 3D virtual modelling, such as the use of rendering, shading/colouring, photo-realisation, and the production of walk-throughs. Learners are not expected to produce these types of graphical information, but are required to refer to them, using examples from industry literature and similar sources.

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

To achieve D1, learners should justify the use of CADD and analyse other factors (for example disadvantages, costs, training requirements). This links with P1 and P2 as well as the M1 and M2 criteria. Learners should be able to evaluate the relative merits of using CADD software. This could be as part of the case study outlined as possible evidence for P1.

To achieve D2, learners will need to evaluate the impact of using 2D and 3D CADD models on design requirements. This links directly with P4 and P5. Learners will need to compare and contrast the impact on design requirements, considering how customers might use the information produced.

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, M1, M2, M3, D1 and D2	CADD Report	You are employed in a drawing office. You are asked to research and compare the use of CADD with other methods and determine the software and hardware required to produce CADD drawings. In addition an investigation of how CADD links to other software and hardware and a justification of using CADD in manufacturing.	A report containing written responses about the use of CADD and alternative methods. In addition the software and hardware requirements of a CADD system should be listed and described.
P3 and P4	A 2D CADD Drawing	A client asks you to produce CADD drawings of a planned building.	Hard copies of drawings.
P5	A 3D CADD Model	A clients asks you to produce 3D views of a planned building.	Different views of the model.

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 Built Environment sector suite. It links to many other areas within construction, civil engineering, and building services engineering, as at its core is the ability to use modern communication methods such as email, the internet and CADD. Also, most of the design and technology-based units within the BTEC Nationals rely on graphical communication of various types. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Graphical Detailing in Construction and Built Environment
		Construction Technology and Design

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

- BE Design
- BE Development and Control.

This unit will be beneficial for learners progressing on to BTEC Higher. These units will particularly benefit from this unit:

- *Unit 1: Design Principles and Applications*
- *Unit 5: Group Project*
- *Unit 12: Refurbishment and Adaptations*
- *Unit 32: IT Applications – Computer-aided Design.*

Essential resources

A suite of dedicated PCs, including a reasonably powerful CADD package, together with a linked printer plotter that can produce minimum A3 size copies is required for delivery of this unit. It is advisable to try to keep the ICT/CADD provision as up to date as possible so that the centre, employers and learners are in step with the latest developments and with each other.

Employer engagement and vocational contexts

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

There are many textbooks relating to CADD on the market today. Before learners buy a book it is important to check that it relates to the software that they have. Also, ensure that learners have access to the appropriate computer manuals related to both operating system and specialist programs where 'help' menus are not provided within the programs.

Ethier S and Ethier C – *AutoCAD in 3 Dimensions Using AutoCAD 2005* (Pearson, 2005) ISBN 013152562X

Kirkpatrick B and Kirkpatrick J – *AutoCAD Architectural Drawing using AutoCAD 2002* (Prentice Hall, 2002) ISBN 0130971049

McFarlane B – *Beginning AutoCAD 2002* (Butterworth-Heinemann, 2004) ISBN 0750656107

Yarwood A – *AutoCAD Worked Examples* (Pearson, 2000) ISBN 0582424909

Journals

AT Architectural Technology – CIAT publication

AJ The Architect's Journal – RIBA publication

BRE Digest – Building Research Establishment publication

Building Design – United Business Media

Building Magazine – CMP

Contract Journal – Reed Business Publishing

Websites

There are many software companies who produce and develop CADD software, a current list can be obtained from:

- http://en.wikipedia.org/wiki/List_of_CAD_companies#Existing_CAD_software_companies

The most common companies are:

www.autodesk.co.uk	for AutoCAD™ software information
www.bentley.com	Microstation™ CAD software information
www.ciat.org.uk	Chartered Institute of Architectural Technologists
www.graphisoft.com	ArchiCAD™ software information

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	exploring advantages, compared to other methods, of producing drawings electronically using a CADD package exploring the software and hardware required to produce CADD drawings
Creative thinkers	producing lay outs for CADD diagrams exploring advantages, compared to other methods, of producing drawings electronically using a CADD package.

Although PLTS opportunities 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 ...
Reflective learners	converting space diagram to solid elevations
Team workers	practicing 3D project modelling with people and landscaping
Self-managers	organising their time to study this unit
Effective participators	practicing walk through of rendered project evaluating their approach to studying this unit.

● 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 a CADD system to create a variety of construction drawings
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	comparing the production of drawings using CADD with traditional techniques
Manage information storage to enable efficient retrieval	creating a file/folder system for the storage and retrieval of CADD drawings and symbols
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	plotting/printing a variety of CADD construction drawings
Evaluate the selection and use of ICT tools and facilities used to present information	justifying the use of a CADD system in a construction company.
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	