

Unit 18: ICT and CAD in Construction and the Built Environment

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

In the past, the majority of design and communication processes used in the industry were performed manually, using techniques that were relatively slow and inflexible. Today, however, the use of Information and Communication Technology (ICT) and Computer Assisted Design (CAD) techniques has revolutionised design and construction processes within the industry. These techniques are becoming an integrated part of the global on-line internet community, where the use of electronic-based communication (e-Communication) and design processes are a major factor leading the pace of change within the industry.

Learners will develop an understanding of how the industry now relies on the production, manipulation, management and distribution of information in electronic form, such as text documents, spreadsheets and drawings, and makes use of the many product and technical information websites that are available on a free or subscription basis.

Learners will be able to form word-processed documents, write basic spreadsheets and produce simple computer-aided drawings. They will also know how these are sent, securely stored, managed and accessed. They will be able to use the internet to find appropriate information, and will be aware of the specialist, industry-related web based resources in common use.

Learning outcomes

On completion of this unit a learner should:

- 1 Know how to use system controls and web-based communication to send, receive and securely manage data files
- 2 Understand the types, uses and safeguards for specialist information sources located on web-based and other e-formats
- 3 Be able to process and manipulate data in word-processing and spreadsheet applications
- 4 Be able to use CAD software to produce 2-dimensional industry-related drawings and details
- 5 Be able to use CAD software to produce 3-dimensional industry-related virtual models.

Unit content

1 Know how to use system controls and web-based communication to send, receive and securely manage data files

System controls: boot up routines; accessing and closing standard email/word processing/spreadsheet software programs; printing routines; standard commands; back-up routines; simple file systems

Web based communication: ISPs; search engines; emails; firewalls; virus-checkers; download formats such as pdf; use of Intranets and project extranets

Managing data files: types of file eg DWG/DXF/DWF; specialist management software; workflow tracking and reporting; real time mark-up and reviews; sharing/security and back-up issues; server security

2 Understand the types, uses and safeguards for specialist information sources located on web-based and other e-formats

Specialist information sources: eg product websites/CDs/DVDs; information portal websites; commercially available online technical libraries; specialist regional and national government websites; local authority weblinks to planning, building control and transport information; research/academic websites

Safeguards: correct search engine techniques and methods; checking the validity of information eg reliance of source, cross-referencing, publication dates; quality of information eg graphics, content, fitness for purpose

3 Be able to process and manipulate data in word-processing and spreadsheet applications

Word-processing manipulation: page set up; font; formatting; use of headers and footers; editing text; toolbars eg drawing, picture and table; spelling and grammar checking

Spreadsheet manipulation: cell referencing; worksheets; entry eg text, number and formula; formatting cells; editing; use of formulae; presentation of data

4 Be able to use CAD software to produce 2-dimensional industry-related drawings and details

2D CAD: set up 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; dealing with different scales on the same drawing; plotting routines; producing hardcopies

5 Be able to use CAD software to produce 3-dimensional industry related virtual models

3D CAD: use of proprietary 3D CAD software programs eg in an architectural, mechanical, electrical or civil engineering context depending on vocational pathway or generic 3D CAD programs to construct manual wire frame, extruded or surface developments; production of elevations and sections eg 3D views, plan views, perspective views and walk-throughs with rendered or textured surfaces; use of component libraries; model space; paper space; dealing with different scales on the same drawing; plotting routines; producing hard copies

Grading grid

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

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 recognise and use basic system operations, routines, controls, emails and web-based search engines P2 describe the types and formats of specialist ICT information sources used in industry	M1 explain the issues which affect the safe management and control of CAD and other electronic data used in the design/construction of a medium-sized project	D1 appraise how current ICT systems are used to monitor, manage and control information in complex design and construction projects.
P3 demonstrate the use of basic word-processing and spreadsheet techniques	M2 produce two complex documents, a word-processed one and a spreadsheet one, to a commercial standard	

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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:
<p>P4 demonstrate the use of basic 2D CAD routines and commands</p> <p>P5 produce a simple graphical drawing using 2D CAD techniques showing a plan, section and elevation at different scales</p> <p>P6 produce a simple virtual 3D model and plot out various views that are fit for purpose.</p>	<p>M3 produce and plot out a set of linked drawings and details featuring a range of schedules, views, sections, plans and elevations</p> <p>M4 explain the benefits of using CAD to produce 3D virtual models.</p>	<p>D2 demonstrate a professional ability in the production and presentation of 2D and 3D CAD drawings.</p>

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 the 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.

This unit should be taught at an early stage in the course programme so that the learner can develop their ICT/CAD skills to inform and assist the remainder of their studies.

It is recommended that a diagnostic assessment of the learner's capabilities is undertaken at the start to ensure that they are reasonably IT literate. Some adult learners may not have had exposure to using computers and basic computer software packages, and where this is the case they should work on development exercises to bring them up to the required level of competency.

The learning outcomes essentially cover three basic areas of e-Communication and Design; generic systems, communication and internet software; word-processing and spreadsheet development and manipulation: and the production of computer-aided drawings. These three topic areas should be approached in order, with approximately half the time spent on the CAD work and the two other topic areas equally split.

The unit is very practical with most of the learner's evidence generated via simulated industry-based exercises, projects and scenarios. Where learners are new to a particular software program they should be taken through the basic routines by following the tutor as they go 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 preferred for smaller groups or for more focused individuals.

Where reference is made to company intranets and 'project extranets', input from local employers would be beneficial, however the tutor may have to generate realistic materials to simulate the information needed to meet the unit's requirements.

Learners should be encouraged to problem solve by experimenting with the software programs. Most good industrial programmes are highly intuitive with easy to access 'help' menus and learners should be encouraged to develop their skills in using them. However tutor feedback for learners is very important, this could be generated by short, time-controlled, formative exercises, marked by the tutor at each session. Or alternatively by using centre-generated online multiple choice tests for quick immediate results – see use of the web-based 'Hot Potato' multiple-choice generation program under *Essential resources*.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit will generally be gathered from the production of computer generated files and hard copy.

There are many suitable forms of assessment that could be employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible 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. General guidance on the design of suitable assignments is available on page 19 of this specification.

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. Guidance on their use is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria may be fully addressed by using three assignments.

It is recommended that the unit be split into three assignments to match the delivery strategy. The first of these would explore learners' ability to use a range of basic computer system operations, as well as their ability to access electronic sources of information, use email and internet search engines appropriately. This would cover criteria P1, P2, M1 and D1 and could be in the format of a combined report including the use of witness statements for the practical elements. Alternatively, use of an online multiple-choice test may be appropriate to cover P2 and also help the learners appreciate the variety of uses of ICT itself.

The second assignment would relate to the learner's skills in word processing and using spreadsheets, which encompasses the P3 and M2 criteria. This could be the production of a complex report with each learner given unique statistical data to present, manipulate and comment on, such as a costing exercise or a project planning scenario.

The third assignment would cover P4, P5, P6, M3, M4 and D2. The content of this assignment is based around the development and production of a portfolio of work made up from 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 the work being assessed is the quality of the CAD work and not necessarily the technical correctness of the details being drawn, although this is important. The assessor needs to make an appropriate judgment based on the learner's expected technical knowledge at the time of undertaking this particular assessment.

It is important that the ability of individual learners is verified. The submission of written reports – particularly for IT-based work can be open to plagiarism – hence the need for tailored, practical assessments that can be validated by appropriate witness statements.

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

For P1, learners should be able to recognise and use basic system operations, routines, controls, emails and web-based search engines. They should log on to the computer and be able to use its basic operating systems to open up, amend and save electronic files. Learners should also be able to set up directories and organise the management of their files; demonstrate their ability to attach documents and use email ‘netiquette’ appropriately; and be aware of the methods involved in efficient use of internet search engines such as Boolean searching functions.

For P2, learners should be able to describe the types and formats of specialist ICT information sources used in industry. They should have knowledge of common and useful vocational websites, such as government, professional institutions, product and research department sites. Learners should also know of the existence of specialist portal sites for their vocational area, which may or may not be by subscription. Learners should be able to access and extract information such as details, specifications and drawings from manufacturers’ websites, CDs or DVDs.

For P3, learners should demonstrate the use of basic word-processing and spreadsheet techniques. They should produce simple relevant word-processed and spreadsheet documents to fulfill a range of given vocational situations. The purpose of the documents is to communicate written and numerical information in the appropriate format, such as memos, letters, numerical tables and charts, and to perform simple repetitive calculations.

For P4, learners should demonstrate the use of basic 2D CAD routines and commands. They should demonstrate the ability to access a CAD program and use the basic set-up, tools, drawing, editing and viewing commands to produce simple 2D virtual details.

For P5, learners should be able to produce a simple graphical drawing using 2D CAD techniques showing a plan, section and elevation at different scales. They should show different views and use standard conventions and scales. The drawings should include text blocks, simple dimensions, labelled title block and borders extracted from a provided template. Learners should also be able to carry out simple plotting routines to produce a hard copy at a minimum of A2 size.

For P6, 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 be able to produce drawings of a simple 3D model wire frame with 3D faces, and plot out various views in hardcopy. The drawings should include text blocks, simple dimensions and title block/borders extracted from a provided template. They should also be able to carry out simple plotting routines to produce correctly scaled hard copies at a minimum of A2 size.

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

For M1, learners should be able to explain the issues which affect the safe management and control of CAD and other electronic data used in the design/construction of a medium-sized project. They should understand the main 'workflow' benefits and issues involved in the use of an organisation's intranet management systems for monitoring and controlling documents, such as, server security and backup, tracking and reporting work, revising and approving documents, and email and web publishing documents. Issues regarding technical networking and cost comparisons are not required.

For M2, learners should produce two complex documents, a word-processed one and a spreadsheet one, to a commercial standard. They should produce a cross-referenced complex document featuring a spreadsheet, with worksheets and lookup cells, together with a word-processed report with a table of contents, pagination and variety of images and embedded diagrams.

For M3, learners should produce and plot out a set of linked drawings and details featuring a range of schedules, views, sections, plans and elevations. They should be able to produce this using standard conventions as in P5, but with at least three linked complex 2D drawing, all with differing views and scales. Layer conventions need to be demonstrated, together with the use of blocks, line-type and weight variations, external referencing, drawing aids, and dimension styles. Learners should also be able to carry out more complex plotting routines to produce a variety of correctly scaled hard copies at a minimum of A3 size.

For M4, learners should be able to explain the benefits of using CAD 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 walkthroughs. Learners are not expected to produce such types of graphical information, but is required to describe and appraise examples from industry literature and sources.

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

For D1, learners should appraise how current ICT systems are used to monitor, manage and control information in complex design and construction projects. They should understand the concepts of knowledge management for large, complex projects. This will involve examining the benefits and issues of 'project extranets' in the design, communication and construction of projects. Learners should be able to appraise an existing project extranet or propose one for a given development project involving various partnering organisations. Issues regarding technical networking and internet protocols are not required.

For D2, learners should demonstrate a professional ability in the production and presentation of 2D and 3D CAD drawings. They should possess a high level of understanding, knowledge and skills in the use of CAD. They should be able to demonstrate efficiency and competence in their use the programme, using effective drawing aids and shortcuts to speed up their work and routines. Learners' work should be presented in timely fashion with evidence of appropriate planning and forethought. The presentation methods should use an appropriate variety of styles and formats. They should be able to present accurate and professionally presented hardcopy drawings to any given scale.

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

This unit has 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 CAD. Also, most of the design and technology based units within the National Diploma rely on graphical communication of various types.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The unit provides opportunities to gain Level 3 key skills in communication, information and communication technology and problem solving. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

Essential resources

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

A useful resource for online testing is 'Hot Potato' developed by the Humanities Computing and Media Centre Victoria University, Canada, which can be found at <http://hotpot.uvic.ca/index.htm>.

Indicative reading for learners

There are many textbooks relating to CAD and ICT on the market today. It is important before the learner buys a book to check that it relates to the software that they have. Also, ensure that the learners have access to the appropriate computer manuals related to both the operating systems and specialist programs where 'help' menus within the programs are not provided.

Textbooks

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

Wysack R – *Effective CAD Management: A Manager's Guide* (Elsevier, 1986) ISBN 0444700803

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

Websites

There are many software companies who produce and develop CAD 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 – for Microstation™ CAD software information

www.graphisoft.com/ – for ArchiCAD™ software information

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> producing a complex document with layout and formatting to a required commercial standard appraising how current ICT systems are used to monitor, manage and control information in complex design /construction projects. 	<p>C3.1a Contribute to a group discussion about a complex subject.</p> <p>C3.1b Make a presentation about a complex subject, using at least one image to illustrate complex points.</p> <p>C3.2 Read and synthesise information from two extended documents about a complex subject. One of these documents should include at least one image.</p> <p>C3.3 Write two different types of documents about complex subjects. One piece of writing should be an extended document and include at least one image.</p>

Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> comprehending basic word-processing and spreadsheet techniques undertaking research to find relevant industry based electronic and website information. using email and web-based methods to communicate graphical information producing a complex document with layout and formatting to a required commercial standard demonstrating simple 2D and 3D CAD operations producing, industry-related details. 	<p>IT3.1 Plan and use different sources to search for, and select, information required for two different purposes.</p> <p>IT3.2 Explore, develop, and exchange information and derive new information to meet two different purposes.</p> <p>IT3.3 Present information from different sources for two different purposes and audiences. Your work must include at least one example of text, one example of images and one example of numbers.</p>
Problem solving Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> manipulating word-processing and spreadsheet applications to produce integrated professional-quality illustrated documents designing original presentations of an industry-based project using a full range of complex CAD techniques. 	<p>PS3.1 Explore a complex problem, come up with three options for solving it and justify the option selected for taking forward.</p> <p>PS3.2 Plan and implement at least one option for solving the problem, review progress and revise your approach as necessary.</p> <p>PS3.3 Apply agreed methods to check if the problem has been solved, describe the results and review your approach to problem solving.</p>