Unit 17: Computer Aided Drafting

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

Computer aided drafting (CAD) is fast becoming the primary means of communicating design information in many industry sectors, particularly in engineering and manufacturing. Two dimensional (2D) CAD drawings and three dimensional (3D) CAD data can be shared with computer numerical control (CNC) machines using computer aided manufacturing (CAM) software. Three dimensional (3D) models can be rendered to produce photo-realistic representations, or can be animated to produce moving views of products and components as they would appear in service. Additionally, models can be used to analyse features such as mass, volume and mechanical properties.

This unit will enable learners to produce a variety of CAD drawings, from single-part 2D components to complex 3D models. Advanced techniques, such as using pre-prepared symbols to construct circuit diagrams and assembly drawings, will provide opportunities for learners to develop their skills. Learners will also investigate the use of CAD in industry, the hardware and software required and the links with other software packages. In doing this learners will appreciate the advantages of CAD over more conventional methods of drawing production.

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

The unit as a whole provides an opportunity to carry out practical CAD activities using a full range of commands and drawing environments. In addition, learners will gain an understanding of the use and impact of CAD on the manufacturing industry.

Learning outcomes

On completion of this unit a learner should:

1 Understand the advantages of using CAD in comparison with other methods

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

3 Be able to produce and interpret CAD drawings

4 Be able to use CAD software to produce 3D drawings and views.

Unit content

1 **Understand the advantages of using CAD in comparison with other methods**

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

Other methods: manual drafting; model making

2 **Know about the software and hardware required to produce CAD drawings**

Software: operating systems; CAD software packages eg AutoCAD, AutoCAD/Inventor, Microstation, Catia, Pro/ENGINEER, Solidworks; 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 produce and interpret CAD drawings**

CAD drawings: orthographic projections; circuit diagrams eg hydraulic, pneumatic, electronic; exploded/assembly drawing; standards eg BS8888, BS3939, BS2917

Commands: absolute/relative/polar coordinates; features eg linetypes, grids, snaps, circle, text, hatching, dimensioning, layers/levels, colour; viewing eg zoom, pan; inserting other drawings eg symbols, blocks; modifying eg copy, rotate, move, erase, scale, chamfer, fillet

Interpret: determine properties of drawn objects eg list, distance, area, volume

4 **Be able to use CAD software to produce 3D drawings and views**

3D environment: 3D views eg top, front, side, isometric

3D models: 3D techniques eg addition and subtraction of material, extrude, revolve, sweep, 3D coordinate entry (x, y, z), wire frame drawing, 2D to 3D (thickness, extrusion); surface models; solid models

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 describe the advantages, compared to other methods, of producing drawings electronically using a CAD package	M1 explain the relationship between CAD and other software/hardware used in manufacturing	D1 justify the use of CAD in a manufacturing company
P2 describe the software and hardware required to produce CAD drawings	M2 explain how the range of commands used to produce CAD drawings can impact drawing production	D2 evaluate the impact of the use of 2D and 3D CAD models on final design requirements.
P3 using appropriate commands, produce 2D CAD detail drawings of five components that make up an assembly or sub-assembly to given standards	M3 explain how 3D CAD models can be used in the design process.	
P4 using appropriate commands, produce a circuit diagram containing at least five components to appropriate standards		
P5 using appropriate commands, produce an assembly drawing and exploded view of an assembly or sub-assembly containing at least five parts		

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:**
P6 interpret the properties of an engineering component or circuit from a given CAD drawing P7 within a 3D environment construct a 3D CAD drawing as a surface and solid model.		

Essential guidance for tutors

Delivery

The delivery strategy used should emphasise the strong links between the learning outcomes.

Learners need to understand the impact of CAD within business and the advantages and uses of CAD information within industry. A practical approach is required to emphasise the ease and speed of drawing production.

It is anticipated that learners will develop their CAD skills through learning activities which involve use of the full breadth of commands outlined in the unit content. These formative activities will enable tutors to give practical support and guidance as well as prepare learners for assessment activities. Throughout this process it is important to emphasise the impact CAD has on the communication of information within organisations and on manufacturing, as well as the links with other software packages.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

Assessment

It is likely that the assessment evidence for P1 and P2 will be produced through a case study or through studying the company in which learners may be employed. Typically, it would take the form of a written report or presentation.

To achieve P1, learners must demonstrate an understanding of how CAD is used in comparison with more traditional drawing methods, stating its advantages and explaining how CAD systems can be linked with other software. A description of basic hardware and software requirements to operate a CAD system will be required to achieve P2.

The remaining pass criteria could be evidenced through a series of competence based practical activities. Evidence could be in the form of witness statements, tutor observation records or a portfolio, although it is likely that electronic files will be used for the majority of the assessment. Screen dumps can often be a good source of evidence to show the range of commands used during the development of the drawings.

The process evidence for these remaining pass criteria (P3 to P7) might be obtained from three further assignments. In the first of these learners would be required to produce five separate CAD drawings of the components which make up an assembly or sub-assembly. The full range of commands must be used and the drawings should be dimensioned to an appropriate standard, enabling P3 to be achieved. These drawings could then be used to produce an assembly and exploded view drawing (P5).

The second assignment would require production of a circuit diagram to achieve P4. This might reflect the learner's occupation or area of interest and should be assembled from symbols previously introduced by the tutor and/or externally sourced. This assignment could also ask learners to interpret and provide a summary of the information contained in a given detail drawing or circuit diagram (P6).

The final assignment would require production of a single 3D model using both surface and solid modelling techniques to enable achievement of P7. This might be a 3D version of one of the part drawings used as evidence for the assembly and exploded view drawing.

To achieve a merit grade learners will need to look beyond how drawings are produced and evaluate their use and application. This will typically be through looking more closely at the relationship between CAD and other software. Learners should be able to explain how linking CAD to other software/hardware impacts on an organisation (eg improving production, reducing waste, reducing lead times). This will build upon the evidence generated for P1 and enable the M1 merit criterion to be achieved.

An evaluation of the range of commands for criterion M2 and how they impact on drawing production in terms of efficiency (eg speed, accuracy, repeatability) links with P3, P4 and P5. Similarly, knowledge for the M3 criterion of how 3D models can be used in the design process links with the 3D activity in P7.

To achieve distinction criterion D1, learners should be able to justify the use of CAD and will need to analyse other factors (eg 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 CAD software. This could be as part of the case study outlined as possible evidence for the P1 criterion.

To achieve the D2 criterion learners will need to evaluate 2D and 3D drawings from a customer perspective. This links directly with the P7 and M3 criteria. Learners will need to compare and contrast the impact on customers of producing drawings using 2D and 3D CAD and how customers might use the information produced.

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

This unit takes forward the knowledge and skills gained from similar units at BTEC First Certificate/Diploma level and, whilst no prerequisite units are required, it might be useful if learners had previously studied the BTEC First Diploma Unit 10: Using Computer Aided Drawing Techniques in Engineering.

This unit links to *Unit 2: Communication for Technicians*, *Unit 8: Engineering Design*, *Unit 15: Electro, Pneumatic and Hydraulic Systems and Devices*, *Unit 16: Engineering Drawing for Technicians*, *Unit 26: Computer Numerical Control of Machine Tools* and *Unit 31: Computer Aided Manufacturing*.

This unit covers some of the knowledge and understanding associated with the SEMTA Level 3 National Occupational Standards in Engineering Technical Support, particularly:

- Unit 4: Producing Mechanical Engineering Drawings using Computer Aided Techniques

- Unit 5: Producing Engineering Drawings/models using 3D Computer Aided Techniques
- Unit 6: Producing Electrical Engineering Drawings using Computer Aided Techniques
- Unit 7: Producing Electronic Engineering Drawings using Computer Aided Techniques
- Unit 8: Producing Fabrication/Structural Engineering Drawings using Computer Aided Techniques
- Unit 9: Producing Fluid Power Engineering Drawings using Computer Aided Techniques
- Unit 10: Producing Engineering Systems/Services Drawings using Computer Aided Techniques.

Essential resources

Centres will need to have access to a suitably equipped IT facility with access to a printer/plotter. Access to software with 2D and 3D capabilities, such as AutoCAD and Inventor is also required. Whilst general graphics packages would not be suitable, any CAD software capable of generating the evidence required for this unit would be acceptable.

Indicative reading for learners

Textbooks

Cheng R — *Using Pro/Desktop 8* (Delmar Publishing, 2004) ISBN 1401860249

Conforti F — *Inside Microstation* (Delmar, 2002) ISBN 1401814816

Mawdsley I — *AutoCAD 2000i: An Introductory Course* (Newnes, 2000) ISBN 0750647221

Middlebrook M and Byrnes D — *AutoCAD 2006 for Dummies, First Edition* (John Wiley and Sons, 2005) ISBN 0764589253

Roberts J — *Introduction to AutoCAD 2005, First Edition* (Payne-Gallway, 2005) ISBN 1904467865

Yarwood A — *Introduction to AutoCAD 2005: 2D and 3D Design* (Newnes, 2005) ISBN 0750667214

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. Staff 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.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• preparing data sourced from 2D CAD drawings and 3D CAD models.	N3.1 Plan an activity and get relevant information from relevant sources.
Problem solving Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• presenting the same drawing in both 2D and 3D.	PS3.1 Explore a problem and identify different ways of tackling it.