Unit 24: Engineering Drawing for Technicians

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

It is important that when a product has been designed it is manufactured correctly and to specification. To achieve this it is crucial that the people making the product in a workshop are provided with well-presented engineering drawings, produced to international standards and conventions. This avoids errors of interpretation which can lead to the scrapping of expensive parts.

An understanding of how graphical methods can be used to communicate information about engineering products is an important step for anyone thinking of taking up a career in engineering. This unit gives learners an introduction to the principles of technical drawings and their applications using hand drawing and computer aided drafting (CAD) techniques.

Learners will start by carrying out freehand sketching of simple engineering products using pictorial methods that generate three dimensional images. A range of standard components, such as fixing devices, will be sketched together with other solid and hollow items. Learners are then introduced to a more formalised drawing technique that conforms to British Standards and will put this into practice through a number of drawing exercises. A consistent presentation style will be used as learners draw single part components and simple engineering assemblies.

These drawings will contain all the information needed to manufacture or assemble the product, including information such as dimensions, manufacturing notes and parts lists. The use of conventions to represent standard items will be investigated, such as screw threads and springs in mechanical type drawings or circuit symbols such as solenoids and resistors in electrical/electronic type drawings.

Having learned the principles of engineering drawing, learners will then move on to using a two dimensional (2D) CAD system for the production of drawings using basic set-up, drawing and editing commands. The first task is to produce a drawing template which can be saved to file, as this reinforces the concept of standardisation and consistency of presentation. This is followed by drawing exercises of single-part components, a simple multi-part assembly and circuit diagrams.

Overall, the unit will develop learners' ability to create technical drawings and allow them to compare the use of manual and computer aided methods of producing engineering drawings.

Learning outcomes

On completion of this unit a learner should:

1 Be able to sketch engineering components

2 Understand how engineering components are represented using graphical techniques that comply with drawing standards

3 Be able to produce engineering drawings

4 Be able to produce engineering drawings using a computer aided drafting (CAD) system.

Unit content

1 Be able to sketch engineering components

Sketches: regular solids eg cube, rectangular block, 90^0 angle bracket; hollow objects eg circular tube, square section tube; standard components eg nuts, bolts, screws, pulleys; engineering components eg pulley support bracket, machine vice

Sketching techniques: sketching equipment eg paper (plain, squared, isometric), pencil, eraser; pictorial eg oblique drawing (cavalier and cabinet), isometric; orthographic eg single and linked views; sketching in good proportion; dimensions eg overall sizes, detail

Benefits and limitations of using pictorial techniques: benefits eg speed of production, visual impact; limitations eg lengths and shapes not true, not produced to a recognised standard, dimensions difficult to read; consequences of interpretation errors eg incorrect manufacture, incorrect assembly, cost to scrap

2 Understand how engineering components are represented using graphical techniques that comply with drawing standards

Interpret: obtaining information from engineering drawings eg component features, dimensions and tolerances, surface finish, manufacturing detail, assembly instructions, parts list, circuit operation

Drawing standards: British Standards eg BS8888, BS3939, BS2917, PP7307; company-standardised layouts eg drawing number, title and issue number, projection symbols (first angle, third angle), scale, units, general tolerances, name of person responsible for producing drawing; line types eg centre, construction, outline, hidden, leader, dimension; lettering eg titles, notes; orthographic projection eg first angle, third angle; views eg elevation, plan, end, section, auxiliary; representation of common features eg screw threads, springs, splines, repeated items; section views eg hatching style, webs, nuts, bolts and pins, solid shafts; symbols and abbreviations eg A/F, CHAM, Φ, R, PCD, M; circuit symbols eg electrical, electronic, hydraulic, pneumatic

3 Be able to produce engineering drawings

Detail drawings of single-piece engineering components: projection method, scale, title block, line work, views, sections, dimensions, tolerances, surface finish, notes

Assembly drawings: line work eg centre lines, construction, outline, cutting plane, sectional view, hatching; representation of standard components eg nuts, bolts, screws, keys; parts referencing eg number referencing, parts list; notes eg assembly instructions, installation features, operating instructions

Circuit diagrams: circuits eg electrical, electronic, hydraulic, pneumatic; components eg transformers, rectifiers, solenoids, resistors, capacitors, diodes, valves, pumps, actuators, cylinders, receivers, compressors

4 **Be able to produce engineering drawings using a computer aided drafting (CAD) system**

Prepare a template: standardised drawing sheet eg border, title block, company logo; save to file

CAD systems: computer systems eg personal computer, networks; output devices eg printer, plotter; storage eg server, hard disc, CD, pen drive; 2D CAD software packages eg AutoCAD, Microstation, Cattia, Pro/Engineer, Pro/Desktop

Produce engineering drawings: set-up commands eg extents, grid, snap, layer; drawing commands eg coordinate entry, line, arc, circle, snap, polygon, hatch, text, dimension; editing commands eg copy, move, erase, rotate, mirror, trim, extend, chamfer, fillet

Store and present engineering drawings: save work as an electronic file eg hard drive, server, pen drive, CD; produce paper copies eg print, plot, scale to fit

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 create sketches of engineering components using a range of techniques P2 explain the benefits and limitations of using pictorial techniques to represent a given engineering component P3 identify and interpret the main features of a given engineering drawing which complies with drawing standards P4 produce detail drawings of three given single-piece components P5 produce an assembly drawing of a product containing three parts P6 produce a circuit diagram with at least five different components which uses standard symbols P7 prepare a template drawing of a standardised A3 sheet using a CAD system and save to file	M1 explain the importance of working to recognised standards when producing engineering drawings M2 explain how a given engineering drawing would be used and the reasons it is suitable for its intended audience.	D1 evaluate the use of different methods of producing engineering drawings including manual and computer aided methods.

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:**
P8 produce, store and present 2D CAD drawings of a given single-piece component and an assembly drawing of a product containing three parts.		

Essential guidance for tutors

Delivery

All four learning outcomes of this unit are strongly linked and the delivery strategy should ensure that these links are emphasised. The method of delivery should be activity based with learners being shown examples of engineering drawings sourced from actual companies.

Learners need to understand that if products are to be manufactured correctly it is crucial that the people cutting metal or assembling components are given accurate and unambiguous information to work from. Whilst it is not intended that learners become expert draftspersons, it is expected that they will gain the necessary skills in manual and computer aided drafting to be able to communicate effectively using graphics. Delivery of this unit will need to develop practical skills in graphical communication and knowledge of drawing standards.

The starting point for delivering this unit is pictorial freehand sketching using pencil and paper. Very simple items such as a cube of wood can be used to get learners thinking about size and proportion and how to fit the drawing onto a piece of paper. It is useful, even at this introductory level, to introduce the idea of standardisation and to encourage learners to put a border and simple title block onto their work. During the course of studying the unit learners will produce a portfolio of sketches and drawings and it is good practice to develop the concept of a corporate presentation, as would happen in industry.

Some learners will have no knowledge of engineering components and delivery needs to be supported with actual examples that they can hold, look at and sketch. This brings in the idea of pictorial sketching in good proportion. There is no need to use colour or shading effects; just produce outline shapes which can be looked at and used as the basis for development into orthographic form. For example, a simple bracket with a single hole could be sketched using isometric projection and a few leading dimensions added. Then, discuss the problem of drawing the hole so that it appears to be circular (time need not be wasted using the geometrical construction method) and lead on to the idea that, if the component is drawn out using a set of linked 2D views, circles can be easily drawn and lengths become true.

Care should be taken when delivering learning outcome 2 because there is a huge amount of information relating to drawing standards and learners will need to be given a structure to work to when being asked to interpret drawings.

Learning outcome 3 is practical and should be achieved by carrying out a number of developmental drawing exercises, starting with a very simple component. Some centres may wish to start learners on CAD at this point and there is nothing in the unit content to prevent this happening. However, care should be taken to ensure that learners do not get sidetracked by the technicalities of the CAD system and lose sight of what they should really be learning (ie the principles of engineering drawing). When deciding on a method of projection to use, either first or third angle can be chosen but there should be an understanding of the principles of both.

In learning outcome 4 learners are required to produce a standard drawing template. This is a straightforward task and some learners may want to do this early on in the unit so that they can print off their own personalised drawing paper. When delivering this part of the unit, thought needs to be given to authentication of learners' work.

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. For example, grading criterion P6 asks for a circuit diagram to be drawn. This may depend on the learner's chosen workplace experience or area of expertise — they could choose an electrical, electronic, hydraulic or pneumatic system provided that the correct components are picked and represented properly.

Assessment

Assessment of this could be through the use unit as six assignments. To achieve a pass learners are expected to show competence in a number of graphical techniques and to be able to apply these to the production of engineering drawings which meet recognised standards.

The first assignment, to cover P1 and P2, could consist of a small portfolio of sketches and written explanations. Items drawn must include regular solids and hollow objects, standard and engineering components. The techniques used must involve sketching equipment, pictorial and orthographic representation and sketching in good proportion with the addition of some dimensions (all as specified in the unit content).

The second assignment, to cover P3 and M1, will need to be carefully structured and should be based on a drawing of a component or assembly rather than a circuit diagram so that the unit content can be properly covered.

The third assignment could cover P4 and P5, with the three single-piece components being used for the assembly drawing. This would then make the assignment more realistic in terms of what happens in industry.

The fourth assignment could cover P6, with learners being given a choice of the type of circuit they produce depending on their interest (ie from electrical, electronic, hydraulic and pneumatic). The circuit can be drawn by hand but using CAD may be the preferred method if a library of components is available.

P7 and P8 can be covered by a fifth assignment, which could ask for increased competence in the application of standards when producing drawings. To help authenticate learner's work, additional evidence could be in the form of witness statements, tutor observation records and 'screen dumps' which show the range of commands used during the development of the drawings.

As mentioned above, M1 builds upon the evidence presented for P3 and these two criteria could be assessed using a single assignment. The wider issues of standardisation and manufacturing for the global market place should be addressed with learners supporting their explanations with case study evidence. There are links here to *Unit 21: Engineering Finishing/Secondary Processes and Techniques* from which some supporting evidence could be drawn.

The sixth assignment could cover M2 and would be based on knowledge gained to achieve P6, P7 and P8, together with a wider understanding of the use of engineering drawings to communicate information effectively. It will be a piece of explanative writing and can be extended to include D1. As there is only the one distinction criterion in this unit, learners must produce some high-level reflective writing, using fully supported argument, if they are to achieve it. The assignment brief should ask for an evaluation of the various drawing techniques used by the learner and link directly with the criteria P1, P5, P6 and P8. To add depth to their evidence, learners could be asked to look more widely at what is used in industry — particularly the use of 3D CAD systems which generate solid models. This would then bring them full circle back to the start of the unit, where they were producing pictorial sketches.

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

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

- Unit 2: Using and Interpreting Engineering Drawings and Documents
- Unit 3: Produce Detailed Drawings
- Unit 4: Producing Mechanical Engineering Drawings using Computer Aided Techniques
- Unit 6: Producing Electrical Engineering Drawings using Computer Aided Techniques
- Unit 7: Producing Electronic Engineering Drawings using Computer Aided Techniques
- Unit 9: Producing Fluid Power Engineering Drawings using Computer Aided Techniques.

Essential resources

To meet the needs of this unit it is essential that centres have, or have access to, manual drawing equipment and a CAD system which uses a 2D commercial engineering software package. Centres will also need extracts and illustrations from appropriate drawing standards and conventions.

Indicative reading for learners

Textbooks

Cheng R — *Using Pro/Desktop 8* (Delmar Publishing, 2003) ISBN 1401860249

Conforti F — *Inside Microstation* (Onward Press, 2005) ISBN 1418020842

Mawdsley I — *AutoCAD 2000i An Introductory Course* (Newnes, 2001) ISBN 0750647221

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

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

Simmons C and Maguire D — *Manual of Engineering Drawing* (Butterworth-Heinemann, 2004) ISBN 0750651202

Tooley M and Dingle L — *BTEC National Engineering* (Newnes, 2002) ISBN 0750651660

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.

Information and communication technology Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• producing engineering drawings of components and assemblies using a CAD system.	ICT3.3 Present combined information such as text with image, text with number, image with number.
Problem solving Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• producing assembly drawings • planning the layout of an engineering drawing.	PS3.1 Explore a problem and identify different ways of tackling it. PS3.2 Plan and implement at least one way of solving the problem.