Unit 12: Engineering Drawing for Technicians

Level: 3
Unit type: Optional
Assessment type: Internal
Guided learning: 60

Unit introduction

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.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Learning outcomes

On completion of this unit a learner should:

1 Be able to sketch engineering components

2 Be able to interpret engineering drawings 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 e.g. cube, rectangular block, 900 angle bracket; hollow objects e.g. circular tube, square section tube; standard components e.g. nuts, bolts, screws, pulleys; engineering components e.g. pulley support bracket, machine vice

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

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

- 2 **Be able to interpret engineering drawings that comply with drawing standards**

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

  Drawing standards: British Standards e.g. BS8888, BS3939, BS2917, PP7307; company-standardised layouts e.g. 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 e.g. centre, construction, outline, hidden, leader, dimension; lettering e.g. titles, notes; orthographic projection e.g. first angle, third angle; views e.g. elevation, plan, end, section, auxiliary; representation of common features e.g. screw threads, springs, splines, repeated items; section views e.g. hatching style, webs, nuts, bolts and pins, solid shafts; symbols and abbreviations e.g. A/F, CHAM, Φ, R, PCD, M; circuit symbols e.g. 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 e.g. centre lines, construction, outline, cutting plane, sectional view, hatching; representation of standard components e.g. nuts, bolts, screws, keys; parts referencing e.g. number referencing, parts list; notes e.g. assembly instructions, installation features, operating instructions

  Circuit diagrams: circuits e.g. electrical, electronic, hydraulic, pneumatic; components e.g. 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 e.g. border, title block, company logo; save to file

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

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

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

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 create sketches of engineering components using a range of techniques	M1 assess the suitability of the different techniques for the sketches	
P2 describe the benefits and limitations of using pictorial techniques to represent a given engineering component		
P3 interpret the main features of a given engineering drawing which complies with drawing standards	M2 explain in the importance of working to recognised standards when producing engineering drawings	
P4 produce detailed drawings of three given single-piece components that comply with drawing standards	M3 explain how the sketches comply with drawing standards	
P5 produce an assembly drawing of a product containing three parts that complies with drawing standards		

P6 produce a circuit diagram that complies with drawing standards, with at least five different components which use standard symbols	M4 explain in 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
P7 prepare a template drawing of a standardised A3 sheet using a CAD system and save to file	M5 explain the hardware components of a typical industry standard CAD system.	D2 evaluate the functionality of a CAD software package.
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

Assessment

Assessment of this unit could be through the use of five 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, P2 and M1, could consist of a small portfolio of sketches and written descriptions. Items drawn must include regular solids and hollow objects, standard and engineering components. The techniques used must be valid and involve sketching equipment, pictorial and orthographic representation and sketching in good proportion with the addition of some dimensions (as specified in the unit content). An assessment of these techniques will meet the requirement for M1.

The second assignment, to cover P3 and M2, 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. M2 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.

The third assignment could cover P4, P5 and M3 with the three single-piece components in P4 being used for the assembly drawing in P5. This would then make the assignment more realistic in terms of what happens in industry. M3 would require an explanation of how the sketches in P4 comply with drawing standards.

The fourth assignment could cover P6, M4 and D1 with learners being given a choice of the type of circuit they produce depending on their interest (i.e. 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. M4 requires an explanation of the use of engineering drawings to communicate information effectively. D1 could be carried out as a separate task, requiring 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.

P7, P8, M5 and D2 can be covered by a fifth assignment, which could ask for increased competence in the application of standards when producing drawings. To help authenticate learners' 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. M5 and D2 could form a separate task as part of this assignment, requiring an explanation of CAD hardware and an evaluation of CAD software functionality.

Programme of suggested assignments

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

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Producing Engineering Sketches	Learners have been asked to produce sketches of a range of different objects.	A practical assignment requiring learners to produce a portfolio of engineering sketches with accompanying written descriptions.
P3, M2	Interpreting and Using Drawing Standards	Learners have to read and interpret an engineering drawing in order to report the key features of the component, circuit or assembly to a colleague.	A written assignment for which learners need to produce a short report detailing the main features of a given engineering drawing that complies with drawing standards. A further task would require them to explain the importance engineering standards.
P4, P5, M3	Producing Engineering Drawings	Learners need to produce an engineering drawing of three components and an assembly drawing for use by the manufacturing department of their company.	A practical assignment in which learners produce component and assembly drawings.
P6, M4, D1	Producing Circuit Drawings	Learners need to produce a circuit diagram for use by the manufacturing	A practical assignment in which learners produce a circuit diagram.

		department of their company.	

Criteria covered	Assignment title	Scenario	Assessment method
P7, P8, M5, D2	Producing Engineering Drawings Using CAD	Learners need to prepare and produce 2D CAD drawings for use by the manufacturing department of their company.	A practical assignment in which learners produce 2D CAD drawings of a component and an assembly.

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, 2004) ISBN 9781401860240

Conforti F – *Inside Microstation* (Delmar, 2005) ISBN 9781418020842

Fane B – *AutoCAD 2014 for Dummies* (John Wiley and Sons, 2013) ISBN 9781118603970

Simmons C, Maguire D and Phelps N – *Manual of Engineering Drawing* (Butterworth-Heinemann, 2009) ISBN 9780750689854

Tooley M and Dingle L – *BTEC National Engineering* (Routledge, 2010) ISBN 9780123822024