

Unit 29: Undertaking Land-based Technology Engineering Drawing

Unit code:	J/601/4284
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit aims to introduce learners to the skills and knowledge in the creation of three-dimensional objects accurately through the drawing of two-dimensional views. They will consider orthographic projection, the design process and methods of presenting engineering design ideas and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

The land-based sector requires the use of technology been designed to high standards. This technology is often required to meet rigorous demands and, as such, needs to be designed and engineered appropriately. Designs must be understood and developed to meet internationally recognised standards.

In this unit learners will develop their communication skills in and knowledge of the techniques required to produce and interpret engineering drawings and circuit/system diagrams in accordance with British Standards (BS) and accepted practice and conventions.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to produce and interpret engineering drawings in isometric and orthographic projection
- 2 Be able to produce geometrical constructions
- 3 Understand the overall concept of the design process and the role of the engineering drawing office
- 4 Be able to produce presentation drawings.

Unit content

1 Be able to produce and interpret engineering drawings in isometric and orthographic projection

Engineering drawings: first and third angle projections; electrical/electronic circuit layouts; hydraulic layouts; common drawing conventions (drawing layout and presentation, line types, hidden detail and sectioning, dimensions and tolerances, surface finish, limits, symbols)

2 Be able to produce geometrical constructions

Geometric construction: bisection of an angle; division of a straight line (into two and more than three divisions); tangents (normal to radius of a circle, common to two circles)

Moving parts: cams; loci of a point (robot arm movements, slider crank, quick-return mechanism)

3 Understand the overall concept of the design process and the role of the engineering drawing office

Design process: using a customer's design brief; developing ideas; producing design solutions; development techniques (brainstorming, free-hand sketching, research); production restrictions; presenting design solutions (manual or computer-based methods)

Role of the drawing office: role and responsibilities of drawing/design office within a manufacturing company

4 Be able to produce presentation drawings

Presentation drawings: isometric including circles and curves; oblique; 3D; computer-aided design (CAD)

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 produce and interpret engineering working drawings in isometric and orthographic projection to meet given objectives [IE, CT, RL, SM, EP]	M1 produce hydraulic/electronic circuit layout and a wiring diagram for electrical circuits	D1 produce a detailed drawing of an engineering assembly to BS 8888
P2 produce geometrical constructions from working drawings [IE, CT, RL, SM, EP]	M2 draw a cam profile and plot the loci of a point using correct geometric construction techniques	
P3 explain the design process [IE, CT, RL, SM, EP]	M3 explain how production restrictions can influence the design process	D2 analyse the design process with specific reference to the presentation of ideas and evaluate manual and CAD presentation drawings
P4 discuss the role of the engineering drawing office [IE, CT, RL, SM, EP]		
P5 produce manual presentation drawings of a selected product or design to meet given objectives [IE, CT, RL, SM, EP]	M4 produce isometric, oblique and 3D drawings of selected products using CAD	

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to industrial experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. 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 would all be suitable. Delivery should stimulate, motivate, educate and enthuse learners.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities, so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to design and draw an item for a particular implement, and they should be encouraged to ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Whichever delivery methods are used, it is essential that tutors stress the impact of engineering drawing on the design process in the land-based vehicle industry.

Health and safety issues relating to the work area must be stressed and reinforced regularly, and risk assessments must be undertaken before practical activities and before learners visit any industrial premises. Adequate personal protective equipment (PPE) must be provided and used following the production of suitable risk assessments.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

Learning outcomes 1, 2 and 4 are directly linked and could be delivered in the classroom, drawing studio or computer suite and can be reinforced with discussion, site visits and independent learner research. Learners will be aware of the association of geometrical construction and moving parts with the generation of orthographic projection drawings. Visiting expert speakers could add to the relevance of the subject for learners. For example, land-based machinery designers could talk about their work, the situations they face and the methods they use.

Learning outcome 3 is likely to be delivered through formal lectures, discussion, site visits and independent learner research. Learners will be aware of the methods and associated activities commonly used in the design process. Visiting expert speakers could add to the relevance of the subject for learners. For example, land-based machinery design engineers or production managers could talk about their work, the situations they face and the methods they use.

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 gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction to the unit.
Assignment 1: Produce and Interpret Engineering Drawings in Isometric and Orthographic Projection (P1, P2, M1, D1) Introduction to the assignment and learner-centred research.
Produce drawings in isometric and orthographic projections.
Communicate information using isometric and orthographic drawings.
Assignment 2: Be Able To Produce Geometrical Constructions (P3, M2) Introduction to the assignment and learner-centred research.
Produce isometric, oblique and 3D drawings of selected products using CAD.
Assignment 3: Understand The Overall Concept Of The Design Process And The Role Of The Engineering Drawing Office (P4, M3, D2) Introduction to the assignment and learner-centred research.
Assignment 4: Be Able To Produce Presentation Drawings (P5, M4) Introduction to the assignment and learner-centred research.
Unit review.

Assessment

For P1 and P2, learners must produce and interpret engineering working drawings in isometric and orthographic projection. Learners need to interpret isometric and oblique drawings and produce a selection of manual drawings in orthographic project (1st and 3rd). Learners are expected to give evidence for at least four drawings. Tutors should identify the objectives or agree them through discussion with learners. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor. Alternatively, evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a written assignment.

For P3, learners must produce geometrical constructions from working drawings. These can be linked to the content of drawings produced in P1 and P2 as long as they include bisection of an angle, division of a straight line and tangents. Evidence could be in the same form as for P1 and P2.

P4 requires learners to explain the design process and the role of the engineering drawing office. They should explain the design process from the inception of an idea to the presentation of the final design, including the role of the engineering drawing office in this process. Evidence could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a written assignment.

P5 requires learners to produce manual presentation drawings of a selected product or design to meet given objectives. Tutors should identify the objectives or agree them through discussion with learners. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

For M1, learners must produce a hydraulic circuit layout and a wiring diagram for electrical circuits. Tutors should identify the circuits or agree them through discussion with learners. The circuits should be of a type associated with land-based vehicles. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. The drawings can be produced manually or with the use of a computer program but must relate to the appropriate BS. Evidence could be in the same form as for P1.

M2 requires learners to draw a cam profile and plot the loci of a point using correct geometric construction techniques. They should create a cam profile for an operating component found on land-based vehicles and plot the loci of a point of a mechanism associated with the land-based industry sector or engineering. Evidence could be in the same form as for P1.

M3 requires learners to explain how production restrictions can influence the design process. Learners could include evidence of situations that they have seen during delivery of this unit. They should restrict their evidence to situations faced within land-based engineering. Evidence could be in the same form as for P4 and P5.

M4 requires learners to produce isometric, oblique and 3D drawings of selected products using CAD. Tutors should identify the products or agree them through discussion with learners. The objectives may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Learners are expected to give evidence for three drawings, one in each category. Evidence could be in the same form as for P1.

For D1, learners must produce a detailed drawing of an engineering assembly to BS 8888. The assembly should include at least five components. The drawing can be produced manually or using CAD. Evidence could be in the same form as for P3. The drawing must include abbreviations for components, hidden detail, sectioning, dimensions and tolerances.

D2 requires learners to analyse the design process with specific reference to the presentation of ideas and to evaluate manual and CAD presentation drawings. Evidence should be related to land-based engineering and include, for example, the management of the design office and quality systems. Evidence could be in the same form as for P4 and P5.

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, D1	Produce and Interpret Engineering Drawings in Isometric and Orthographic Projection	To assist your work as an engineer in the land-based sector there is a need to be able to produce and interpret isometric and orthographic drawings.	Practical assessment. Report. Presentation.
P3, M2	Be able to Produce Geometrical Constructions	As an engineer in the land-based sector you will need to communicate information through the use of drawings and you will need to understand of how to produce circuit diagrams.	Practical assessment Report. Presentation.
P4, P5, M3, D2	Understand the Overall Concept of the Design Process and the Role of the Engineering Drawing Office	As a design engineer in the land-based sector you need to understand the design process and the role of the drawing office.	Assignment. Report. Presentation.
P6, M4	Be able to Produce Presentation Drawings	As a design engineer in the land-based sector you need to present ideas to a team using drawings.	Practical assessment. Report. Presentation.

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

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Undertake Work Related Experience in the Land-based Industries	Undertake and Review Work Related Experience in the Land-based industries

Essential resources

Learners will need access to a suitably equipped room containing engineering drawing boards, computers and appropriate software.

Learners should also have access to a copy of the manual of British Standards in engineering drawing.

Tutors delivering this unit should be familiar with British Standards and be able to operate a suitable CAD programme

Employer engagement and vocational contexts

Learners could be introduced to a variety of professionals from different companies and organisations to broaden their knowledge and make the learning experience interesting and contextualised. This could be through guest lectures, work placements or off-site visits to different establishments.

Indicative reading for learners

Textbooks

British Standards Institution – *British Standard Pp 8888-1:2001 Engineering Drawings: Engineering Drawing Practice for Schools and Colleges* (BSI Standards, 2001) ISBN 0580379531

British Standards Institution – *BS 3939-1:1986 Graphical Symbols for Electrical Power, Telecommunications and Electronics Diagrams: General Information, General Index* (BSI Standards, 1986) ISBN 0580153975

British Standards Institution – *Drawing practice: a guide for schools and colleges to BS 8888:2004. Technical product specification* (BSI Standards, 2005) ISBN 0580454002

British Standards Institution – *Manual of British Standards in Engineering Drawing and Design* (Nelson Thornes, 1991) ISBN 0748710310

McFarlane R – *Beginning AutoCAD 2000, 2nd Edition* (Butterworth-Heinemann, 2000) ISBN 0340760974

Tooley M and Dingle L – *BTEC National Engineering* (Butterworth-Heinemann, 2002) ISBN 0750651660

Yarwood A – *An Introduction to AutoCAD 2002* (Prentice Hall, 2002) ISBN 0130447714

Websites

www.bagma.com

British Agricultural and Garden Machinery Association

www.defra.gov.uk

Department for Environment, Food and Rural Affairs

www.howstuffworks.com

HowStuffWorks

www.hse.gov.uk

Health and Safety Executive

www.iagre.org

Institution of Agricultural Engineers

www.lantra.co.uk

Lantra Sector Skills Council

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	planning and implementing at least one way of solving a problem reviewing work with others and agreeing ways of improving collaborative work in the future
Creative thinkers	exploring a problem and identifying different ways of tackling it reviewing progress and establishing evidence of achievements.
Reflective learners	checking if the problem has been solved and reviewing approach to problem solving seeking to develop cooperation and checking progress towards agreed objectives
Self-managers	setting targets using information from appropriate people and planning how these will be met taking responsibility for learning, using their plan to help meet targets and improve your performance
Effective participators	reviewing progress and establishing evidence of achievements. reviewing work with others and agreeing ways of improving collaborative work in the future.

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 ...
Independent enquirers	planning and carrying out research activities related to the unit evaluating and carrying out extended thinking
Creative thinkers	asking questions to extend their thinking during lectures adapting ideas as circumstances change
Reflective learners	identifying opportunities for their own achievements setting goals for themselves eg time management reviewing progress in coursework
Team workers	working with others reaching clear agreements regarding who is carrying out which tasks working together developing ideas
Self-managers	dealing with pressures in an emergency situation managing time and resources during activities
Effective participators	discussing issues of concern relating to time management and resources during practical activities identifying improvements that could be implemented during practical tasks.

● 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	completing their course work using ICT facilities using interactive materials for teaching and learning, researching subjects on the internet
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
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	
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	planning an activity and getting relevant information from relevant sources
Identify the situation or problem and the mathematical methods needed to tackle it	using this information to carry out multi-stage calculations to do with, amounts or sizes, scales or proportion and using formulae
Select and apply a range of skills to find solutions	interpreting the results of calculations, presenting findings and justifying methods
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	reading material on the subject from a variety of sources for their assignment work
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading around subjects and producing clear and concise documents using correct engineering terminology
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	presenting information to a group of people ideally in a classroom situation with their peers.