Unit 14: Undertake Fabrication Drawing for Blacksmithing and Metalworking

Unit reference number: K/602/0711

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 for fabrication drawing for blacksmithing and metalworking, and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or on to further or higher education.

Unit introduction

The ability to interpret and create artefacts using detailed working drawings and diagrams is a valuable skill within the blacksmithing and metalworking industries.

This unit gives the metalworker an in-depth knowledge of the methods used to construct detailed working drawings. It will also enable them to develop a mastery of template construction in order to produce patterns/templates for complex forms such as those encountered in transition components.

Learning outcome 1 covers the use of standard conventions in the production of detailed technical drawings and the methods used to produce these drawings. Learners will cover the use of computer-aided design (CAD).

Learning outcomes 2, 3 and 4 look at the production of working patterns and detailed technical drawings using respectively the parallel line method, the radial line method and triangulation. Learners need to use these methods when producing working patterns and detailed technical drawings.

Learning outcomes

On completion of this unit a learner should:

1 Know the standard conventions used in the production of detailed technical working drawings

2 Be able to use the parallel line method of surface development to produce a working pattern

3 Be able to use the radial line method of surface development to produce a working pattern

4 Be able to use the triangulation method of surface development to produce a working pattern.

Unit content

1 Know the standard conventions used in the production of detailed technical working drawings

Standard conventions: methods used to produce detailed technical drawings by hand; CAD eg advantages disadvantages, 2D and 3D systems; equipment; materials; costs; views eg using change of scale, sectioning, enlarged detail, line type, relevant symbols; advantages and limitations of using pictorial views and orthographic projections; health and safety; relevant current legislation eg health and safety at work legislation; risk assessment

2 Be able to use the parallel line method of surface development to produce a working pattern

Parallel line method: uses; equipment; materials; method; calculations; advantages and limitations; hollow form pattern and template production eg oblique and right cylinders, square, rectangles and regular polygon prisms; mean-line; lines of intersection between shapes of equal/unequal diameters both on- and off-centre

3 Be able to use the radial line method of surface development to produce a working pattern

Radial line method: uses; equipment; materials; method; calculations; advantages and limitations; hollow form pattern and template production eg oblique cones, right cones, pyramids, their frustums and truncated forms

4 Be able to use the triangulation method of surface development to produce a working pattern

Triangulation: uses; equipment; materials; method; calculations; advantages and limitations; on centre and off centre transformers between parallel planes; factors affecting location of join; hollow form pattern and template production eg rectangle to rectangle transition, rectangle to round transition

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 describe the basic standard conventions used to produce detailed technical working drawings [IE, RL, SM]		
P2 apply the use of different types of line in the production of a technical working drawing [IE, RL, SM]		
P3 apply the use of sectioning to aid clarity in a technical working drawing [IE, RL, SM]		
P4 use the parallel line method to produce a simple working pattern to meet a given specification [IE, RL, SM]	**M1** produce patterns combining the use of parallel and radial line development to meet a given multiple component specification	
P5 use the radial line method to produce a simple working pattern to meet a given specification [IE, RL, SM]		**D1** discuss the relative merits of producing a complex working pattern for an oblique cone using both the radial line and triangulation methods of surface development, with illustrations of methods, observations on the likely accuracy against a given specification.

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:**	
P6	use the triangulation method to produce a simple working pattern to meet a given specification [IE, RL, SM]	**M2**	interpret locations and/or dimensions of points from a detailed working technical drawing by triangulation and create a complex working pattern.		
P7	recognise and select an appropriate method of surface development for a range of hollow forms. [IE, RL, SM]				

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. 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 work 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 pattern and technical drawing production 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 are undertaken so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to use the triangulation method to produce patterns, and they should 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 Pearson website.

Whichever delivery methods are used, it is essential that tutors stress the importance of operator welfare, sound environmental management and the need to manage the resource using legal methods.

Health and safety issues relating to working with drawing and fabrication equipment must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities. 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.

Visiting expert speakers could add to the relevance of the subject for learners. For example, experienced metalworking designers could talk about their work, the situations they face and the methods they use.

Learning outcome 1 covers the standard conventions used in the production of detailed technical working drawings. This is likely to be delivered through formal lectures, discussion, site visits, supervised practicals and independent learner research. The drawing office or studio will probably be the main delivery site, but there should be directed and personal opportunities for research, for example via information and learning technologies supported by formal classroom activity.

Learning outcomes 2, 3 and 4 look at the use of the parallel line, radial line and triangulation methods of surface development to produce working patterns and detailed technical drawings. These are likely to be delivered through formal lectures, discussion, site visits, supervised practicals and independent learner research. The drawing office or studio will probably be the main delivery site but there should be directed and personal opportunities for research, for example via information and learning technologies supported by formal classroom activity.

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 learners 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 and overview of the unit.
Assignment 1: Standard Drawing Conventions (P1) Tutor introduces the assignment brief.
Theory session: standard drawing conventions used in the production of orthographic viewing and surface development.
Assignment 2: Sectioning and Lines (P2, P3) Tutor introduces the assignment brief.
Introduce types of line and sectional views.
Practical application of types of line and sectional views in orthographic viewing.
Assignment 3: Multiple Pattern Transformer (P4, P5, P6, M1) Tutor introduces the assignment.
Introduce the principles of parallel line development.
Practical application of parallel line development.
Introduce the principles of radial line development.
Practical application of radial line development.
Introduce the principles of surface development using triangulation.
Practical application of surface development using triangulation.
Discuss factors affecting choice of surface development techniques and make recommendations.
Assignment 4: Methods of Surface Development for Hollow Forms (P7) Tutor introduces the assignment.
Principles and practical application of surface development for hollow forms.
Assignment 5: Oblique Cones: Radial Line Versus Triangulation (M2, D1) Tutor introduces the assignment.
Discuss factors affecting choice of radial line versus triangulation regarding oblique cones, and make recommendations.
Unit review.

Assessment

For P1, learners must describe the basic standard conventions used to produce detailed technical working drawings. Learners could include examples of work that they have carried out for learning outcome 1 as part of their evidence. Evidence could take the form of a pictorial presentation with notes either as hard copy or electronically or a written assignment.

For P2, learners must use different types of line in the production of technical working drawings. Learners could include examples of the work that they have carried out for learning outcome 1 as part of their evidence. Evidence could take the form of a pictorial presentation with notes either as hard copy or electronically or a written assignment.

For P3, learners must use sectioning to aid clarity in the production of technical working drawings. Learners could include examples of the work that they have carried out for learning outcome 1 as part of their evidence. Evidence could take the form of a pictorial presentation with notes either as hard copy or electronically or a written assignment.

For P4, learners must use the parallel line method to produce a working pattern to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners.

P4 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor and accompanied by appropriate work logs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

P5 requires learners to use the radial line method to produce a working pattern to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P4.

For P6, learners must use the triangulation method to produce a simple working pattern to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P4.

For P7, learners need to recognise and select an appropriate method of surface development for a range of hollow forms and, in each case, produce a simple working pattern to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners. Evidence could be in the same form as for P4. Learners are expected to provide evidence of using at least three different methods.

M1 requires learners to produce a detailed working technical drawing combining the use of the parallel line and radial line methods of surface development to meet a given specification. Tutors should identify the specification or agree it through discussion with learners. The specification should cover the usual factors that would be found in industry, such as design criteria, measurements, materials, finish tolerances and any relevant standards, and may be the same as that used to provide evidence for other grading criteria. Where possible, to ensure assessment is fair, the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P4.

For M2, learners must interpret locations and/or dimensions of points from a detailed working technical drawing using triangulation and create a complex working pattern. Tutors should identify the detailed working technical drawing or agree it through discussion with learners. The drawing may be the same as that used to provide evidence for other grading criteria. Evidence could be in the same form as for P4.

For D1, learners must discuss the relative merits of producing a complex working pattern for an oblique cone using both the radial line and triangulation methods of surface development, with illustrations of methods and observations on the likely accuracy against a given specification. Tutors should identify the technical drawing and specification or agree them through discussion with learners. The technical drawing and specification may be the same as those used to provide evidence for other grading criteria. Learners could include examples of the work that they have carried out for learning outcomes 3 and 4 as part of their evidence.

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 Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1	Standard Drawing Conventions	A trainee blacksmith needs to understand technical working drawings. Describe the basic standard conventions that they would need to be familiar with when producing or reading detailed technical working drawings.	Written evidence.
P2, P3	Sectioning and Lines	A trainee blacksmith needs to understand how to produce technical working drawings which include the use of sectioning and various types of line. You are to produce an orthographic drawing illustrating these features.	Practical observation and assessment of practical work.
P4, P5, P6, M1	Multiple Pattern Transformer	A three-stage transition is needed between a square duct and a circular pipe, incorporating a circular reducer. You are to produce appropriate patterns.	Observation and assessment of practical work.
P7	Methods of Surface Development for Hollow Forms	A trainee blacksmith needs to understand technical working drawings. Identify an appropriate method of surface development the blacksmith would need to select when producing a pattern for a range of hollow forms.	Practical observation and written evidence.
M2, D1	Oblique Cones: Radial line versus triangulation	A blacksmith is undecided about which method to use in the production of a working pattern for an oblique cone. You are to argue the case (with illustrations) for the use of radial line and the use of triangulation for this task.	Observation and assessment of practical work. Written evidence.

Links to other BTEC units

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

Level 2	Level 3
	Undertake Drawing Practice for Blacksmithing and Metalworking
	Understanding and Using Fabrication Skills for Blacksmithing and Metalworking
	Understanding and Using Fabrication Techniques for Blacksmithing and Metalworking
	Understanding Principles and Methods of Design for Blacksmithing and Metalworking
	Undertake Small-scale Design for Blacksmithing and Metalworking

Essential resources

Learners will require supervised access to appropriately resourced drawing office/studio/classroom facilities. The equipment required will include drawing boards, compasses, set squares and measuring equipment, plus consumables.

Library and IT facilities should be available with access to unit-specific examples of drawing practice and for learners to research techniques, materials, equipment and examples of existing work.

Employer engagement and vocational contexts

This unit focuses on developing the practical skills and underpinning knowledge associated with the successful production of patterns to produce hollow forms from a technical drawing source. Tutors are encouraged to make links with local blacksmiths, architects and fabrication drawing offices. A visit to a successful sheet metalworking company is advised so that learners can appreciate the conversion process within an industrial context.

Delivery of personal, learning and thinking skills (PLTS)

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit:

Skill	When learners are …
Independent enquirers	interpreting details from drawings
Reflective learners	producing drawings and patterns
Self-managers	producing drawings and patterns.

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 …
Creative thinkers	selecting methods to use in the production of working patterns
Team workers	discussing methods to use in the production of working patterns
Effective participators	discussing methods to use in the production of working patterns.

Functional Skills – Level 2

Skill	When learners are …
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching standard conventions for technical working drawings
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching standard conventions for technical working drawings
Mathematics	
Use appropriate checking procedures and evaluate their effectiveness at each stage	ensuring that pattern drawings are free from errors
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching standard conventions for technical working drawings.