Unit 2: Understanding and Using Forging Techniques for Blacksmithing and Metalworking

Unit reference number: Y/602/0493
QCF Level 3: BTEC National
Credit value: 10
Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to forging techniques used in blacksmithing and metalworking and how they can be applied in practice. It is designed for learners in centre-based settings looking to progress in the sector or on to further or higher education.

Unit introduction

Forging techniques are essential elements of the blacksmithing and metalworking industries. This unit introduces the underpinning knowledge and forging skills that are the basis of all blacksmithing production in the forge environment. It introduces learners to:

- forging – hammering metal into different shapes and sections on the anvil
- forming – the skills of bending and twisting metal
- cutting – hot punching and cutting
- joining of hot worked steel using forge welding and riveted joints.

Learners will look at techniques which are demonstrated and practised in the workshop forge to produce easily repeatable artefacts or products. They will cover the management of the forge fire and forge workshop safety. Efficient fire control is essential for the quality forging of metal, and learners will be shown how to recognise, service and maintain the forge hearth and fire safely during the working process. Recognition and safe use of the common forgework tools are important aspects of the work process and learners are expected to inspect, report faults and demonstrate the safe use of tools for set tasks.

Working within the capabilities of the forged material is an important component of the blacksmith's craft and learners will explore the effects of forgework and heat on steel.

Learning outcomes

On completion of this unit a learner should:

1 Be able to demonstrate commonly used forgework techniques

2 Be able to demonstrate solid fuel forge hearth control

3 Be able to maintain common forge tooling

4 Understand the effects of forgework and heat on steel.

Unit content

1 Be able to demonstrate commonly used forgework techniques

Forging by hand: upsetting; drawing down; spreading; sets; transitions

Forming techniques by hand: bending; twisting; spot heat techniques

Cutting techniques by hand: punching; cutting

Joining techniques by hand: riveting; forge-welded joint (lap); flux types

Health and safety: safe working practices in the forge eg tong set up; personal protective equipment (PPE); relevant current legislation; risk assessment

2 Be able to demonstrate solid fuel forge hearth control

Maintenance and control of the solid fuel forge hearth: solid fuels eg coke, coal, charcoal; fuel costs; fuel performance; ease of use; fire lighting; use of appropriate working heats; control of air flow eg slide valve, variable resistor

Health and safety: safe working practices eg maintaining water boshes, preheating fuel, PPE; relevant, current legislation; risk assessment

Areas of the fire: oxidising; neutral; reducing/carburising

The forge hearth: parts of the solid fuel forge hearth eg chimney, hood, fire bed, slide valve, tue iron, back bosh, front bosh, air supply; hearth tools eg rake, shovel, poker

3 Be able to maintain common forge tooling

Forge hand tooling and equipment: recognition and maintenance requirements of common hand tools and equipment eg hammers, tongs, punches, chisels, anvil, leg vice, swage block; methods used to maintain and store hand tools; tooling and equipment costs; maintenance costs; health and safety; PPE; relevant current legislation; risk assessment

4 Understand the effects of forgework and heat on steel

Effects of forging: types of commonly used steels; grain compaction and distortion; the effects of bending and twisting on the grain structure of steel

Effects of heating: recrystalisation of metals; effects of oxidation; giant grain growth and its control; normalising; annealing; effects of poor fire control

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	carry out common forging techniques to meet a given specification	**M1**	select and combine common forgework techniques to produce component(s) or artefact(s) that is/are fit for purpose with appropriate anvil finish, demonstrating efficient fire control	**D1**	evaluate the process and tooling used to produce the finished component(s)/ artefact(s) and recommend improvements to meet craft standard, using craft samples where appropriate.
P2	carry out common forming techniques to meet a given specification				
P3	carry out common cutting techniques to meet a given specification				
P4	carry out common joining techniques to meet a given specification				
P5	maintain and control a solid fuel forge hearth safely to meet given objectives				
P6	describe the safe and efficient control and operation of the solid fuel forge with a specified range of fuels				
P7	prepare and use an inspection and maintenance checklist and report on the condition of a range of common forge equipment [TW, EP]				
P8	carry out common heat treatments of normalising and annealing on forged steel and control the effects of oxidation and overheating. [SM]	**M2**	explain the possible effects of heating, oxidation, burning, work hardening, forging, bending and twisting on the grain structure of ferrous metals.		

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 workshop 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 apply forgework techniques and show finish quality, 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 importance of sound environmental management and the need to manage the resource using legal methods.

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

Health and safety issues relating to working in the forge environment must be stressed and reinforced regularly, and risk assessments must be undertaken before practical activities. Adequate 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 outcome 1 covers the principles and practice of commonly used forgework techniques. This is likely to be delivered through formal lectures, discussion, site visits, supervised practicals and independent learner research. At first, the techniques may be delivered largely as separate elements. As learners gain confidence and competence, a more holistic approach can be adopted with the introduction of more complex tasks requiring the use of several techniques in combination.

Learning outcomes 2 and 3 are directly linked. They cover the principles and practice of solid fuel forge hearth control and the safe use of common forge tooling and equipment. Learners will be encouraged to gain an understanding of proper fire/forge control using industrially relevant forge equipment. Learners must be introduced to the forge, the anvil and to the hand tools appropriate to the skills they are practising. Actual tools and equipment should be used where possible to illustrate maintenance and health and safety issues.

Learning outcome 4 looks at the effects of forgework and heat on steel. Differing sections and sizes of mild steel should be used during practical work.

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 and overview of the unit.
Assignment 1: Fire Control and Common Forgework and Heat Treatment Techniques (P1, P2, P3, P4, P5, P8, M1, D1) Tutor introduces the assignment. Following the introduction of tutor-set components/artefacts including specifications, the learner produces fit for purpose component(s)/artefacts(s) using the required fire control and forging techniques. Learners should be given the opportunity to select and combine techniques.
Tutor demonstrations of the safe use and operation of the solid fuel hearth and common forging and heat treatment processes as appropriate during the project.
Learners practise techniques and production of components/artefacts.
Learner research and production of workshop records.
Learner assessment/feedback.
Assignment 2: Maintenance of Common Forge Equipment (P7, D1) Tutor introduces the assignment. Learners are asked to produce checklists covering the condition and maintenance of at least six different blacksmith's tools. Learners could include forge tooling that they have worked with during Assignment 1. Learners should prepare a presentation demonstrating an evaluative approach to the making process and tooling used in Assignment 1, recommending improvements.
Learner presentation of assignment.
Learner research and assignment preparation/writing. An evaluation should be included of what was learned during the making process and recommendations for improvement if the task was to be repeated.
Learner assessment/feedback.
Assignment 3: The Solid Fuel Forge Hearth (P6, M2) Tutor introduces the assignment. Learners are asked to produce an assignment or presentation outlining the use of the solid fuel hearth, its fuels and the effects of heating and forging. Learners should, where appropriate, refer to their own forging experience during Assignment 1.
Learner presentation of assignment.
Learner research and assignment preparation/writing.
Learner assessment/feedback.
Visiting lecturer, workshop/site visit or blacksmithing event.
Unit review.

Assessment

For P1, P2, P3 and P4, learners must carry out common forgework techniques of forging, forming, cutting and joining to meet given objectives. Tutors should identify the objectives 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 assessment is fair, the size and complexity of the tasks should be the same for all learners.

P1, P2, P3 and 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, accompanied by appropriate worklogs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P5, learners must maintain, control and describe the safe and efficient use of a solid fuel forge hearth to meet given objectives. Tutors should identify the objectives 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 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 P1, P2, P3 and P4.

For P6, learners should describe the safe operation of the solid fuel forge hearth and discuss the advantages and disadvantages of selected solid fuels (coke, coal, charcoal). Evidence for P6 could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector) or a written assignment.

For P7, learners must inspect and report on the maintenance requirements of selected common hand tools. Tutors should identify the hand tools or agree them in discussion with learners. The hand tools may be the same as those 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. Learners are expected to provide evidence for at least six types of hand tools.

For P8, learners must carry out the common heat treatments of normalising and annealing on three types of forged steel and control the effects of oxidation and overheating. Learners are expected to provide evidence for at least three types of steel and cover the range of techniques listed in the unit content.

For M1, learners must select and apply forgework techniques to a set task which requires the use of techniques to meet given objectives. Tutors should identify the objectives 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 assessment is fair, the size and complexity of the tasks should be the same for all learners.

M1 requires the use of at least two techniques. The objectives should cover normal factors found in industry, for example design criteria, measurements, materials, finish tolerances and any relevant standards. Evidence could be in the same form as for P1, P2, P3 and P4.

M1 requires learners to demonstrate the efficient fire control of a solid fuel forge hearth. Evidence could be in the same form as for P1, P2, P3 and P4.

For M2, learners are required to explain the effects that forgework techniques and heating have on the grain structure of selected types of steel. Learners should include the possible effects of poor fire control and forgework technique on the structure of steel. Tutors should identify the types of steel or agree them through discussion with learners. The types of steel may be the same as those 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.

Learners could include in their evidence examples of situations that they have been involved with or seen during the delivery of this unit. Evidence for M2 could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector) or a written assignment.

For D1, learners must evaluate a finished product and recommend improvements. Learners are expected to evaluate the finished product against the original objectives in terms of specified tolerances of accuracy and finish. Tutors should identify the finished product or agree it through discussion with learners. The finished product may be the same as that used to provide evidence for other grading criteria. Recommendations for improvement must be appropriate and viable—these could be identified during the making process. Where appropriate, improvements to making quality should be demonstrated within the components/artefacts produced. Where possible, to ensure assessment is fair, the size and complexity of the tasks should be the same for all learners.

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, P3, P4, P5, P8, M1, D1	Fire Control and Common Forgework and Heat Treatment Techniques	You are attending an interview for a job as blacksmith at a forge and have been asked to produce a series of forged samples covering the core forgework skills and demonstrating your control of the solid fuel hearth.	Practical production of samples and components/ artefacts. Observation records completed by learners and the tutor. Work logs or other relevant learner notes and drawings. Witness statements.
P7, D1	Maintenance of Common Forge Equipment	You have taken over an existing workshop. The previous blacksmith has also sold a lot of his tools and you are inspecting them and listing the requirements to bring them back into service. You have also outsourced the making of a series of components from a fellow smith. He has provided samples for you to evaluate against the specification.	Oral questioning. Written assignment or presentation. Maintenance checklist. Tooling and forged examples. Visual records. Research.
P6, M2	The Solid Fuel Forge Hearth	The solid fuel forge is still the core piece of equipment used to heat metal for forging. As a working smith you may have to operate different forge types and use a variety of fuels when forging a range of metals. As such you are asked to research and describe the efficient use of the hearth and link this to the available fuels.	Oral questioning. Written assignment or presentation. Tooling examples. Visual records. Work logs or other relevant learner notes and drawings. Research.

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
Introduction to Forgework Processes	Undertake Forge Practice for Blacksmithing and Metalworking
Introduction to Forgework Construction Techniques	Undertake Blacksmithing Processes
	Understanding and Using Blacksmithing and Construction Skills
	Understanding and Using Blacksmithing Installation Skills

This unit also has links with Level 3 National Occupational Standards in Fabrication and Welding Engineering, and Farriery.

Essential resources

Learners will need supervised access to workshops and classrooms appropriate to their specialist pathways. They should contain a comprehensive range of blacksmithing and forge tools and equipment, including solid fuel forge hearths, anvils and leg vices supported by a range of tongs, hammers, swages, fullers and other ancillary equipment.

Health and safety considerations require that sufficient facilities be provided to allow for one forging station per learner. Health and safety information and support must be provided.

Learners must have access to a sufficiently diverse range of materials and stock sizes/sections to explore this unit fully.

This unit requires vocationally specific craft knowledge and appropriately qualified tutors to deliver it.

Employer engagement and vocational contexts

This unit focuses on introducing the core skills and underpinning knowledge associated with the practical operation of the blacksmith's hearth and related common forging skills. Tutors are encouraged to promote learner/employer links by introducing learners to suppliers of tools, fuels and materials. Visits to or by suppliers should be encouraged. The national and international variation in the use of the various types of solid fuel forge hearth and fuels should be explained.

Indicative reading for learners

Textbooks

Andrews J – *New Edge of the Anvil: A Resource Book for the Blacksmith* (Skipjack Press, 1994) ISBN 9781879535091

Bealer A – *The Art of Blacksmithing* (Castle, 1996) ISBN 9780785803959

Blandford P – *Practical Handbook of Blacksmithing and Metal Work* (Bantam Doubleday Dell Publishing Group, 1998) ISBN 9780318148915

Bray S – *Metalworking: Tools and Techniques* (The Crowood Press, 2003) ISBN 9781861265739

McDaniel R – *Blacksmithing Primer: A Course in Basic and Intermediate Blacksmithing* (Dragonfly Enterprises, 2004) ISBN 9780966258912

Parkinson P – *The Artist Blacksmith: Design and Techniques* (The Crowood Press, 2001) ISBN 9781861264282

Rural Development Commission – *The Blacksmith's Craft 2nd Edition* (Countryside Agency, 1990) ISBN 9781869964146

Rural Development Commission – *Wrought Ironwork: A Manual of Instruction for Craftsmen* (Rural Industries Bureau, 1957) ASIN B0000EEYT5

Journals

Artist Blacksmith

Forge

The Worshipful Company of Blacksmiths newsletter

Websites

www.baba.org.uk	British Artist Blacksmiths Association
www.blacksmithscompany.org.uk	Worshipful Company of Blacksmiths
www.hse.gov.uk	Health and Safety Executive
www.nafbae.org	National Association of Farriers, Blacksmiths and Agricultural Engineers

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	researching the possible effects of heating, oxidation, burning, work hardening, forging, bending and twisting on the grain structure of ferrous metals
Creative thinkers	selecting and combining common forgework techniques to produce component(s) or artefact(s)
Reflective learners	evaluating the process and tooling used to produce the finished component(s)/ artefact(s) and making recommendations for improvement
Team workers	preparing and using an inspection and maintenance checklist and reporting on the condition of a range of common forge equipment
Self-managers	carrying out common heat treatments of normalising and annealing on forged steel and controlling the effects of oxidation and overheating
Effective participators	preparing and using an inspection and maintenance checklist and reporting on the condition of a range of common forge equipment.

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 the effects that forgework techniques and heating have on the grain structure of different types of steel
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching the effects that forgework techniques and heating have on the grain structure of different types of steel
ICT – Develop, present and communicate information	
Bring together information to suit content and purpose	outlining the use of the solid fuel hearth, its fuels and the effects of heating and forging
Present information in ways that are fit for purpose and audience	outlining the use of the solid fuel hearth, its fuels and the effects of heating and forging
Mathematics	
Use appropriate checking procedures and evaluate their effectiveness at each stage	carrying out common forging, forming, cutting and joining techniques
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching the effects that forgework techniques and heating have on the grain structure of different types of steel
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	outlining the use of the solid fuel hearth, its fuels and the effects of heating and forging.