

National 4 Practical Metalworking Course Support Notes



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Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

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Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the National 4 Practical Metalworking Course. They are intended for teachers and lecturers who are delivering the Course and its Units. They should be read in conjunction with the *Course Specification*, the *Added Value Unit Specification*, and the *Unit Specifications* for the Units in the Course.

General guidance on the Course

Aims

As stated in the *Course Specification*, the aims of the Course are to enable learners to develop:

- ◆ skills in metalworking techniques
- ◆ skills in measuring out and marking metal sections and sheet materials
- ◆ safe working practices in workshop environments
- ◆ practical creativity and problem-solving skills
- ◆ knowledge of sustainability issues in a practical metalworking context

This Course will also give learners the opportunity to develop thinking skills and skills in numeracy, employability, enterprise and citizenship.

Progression into this Course

Entry to this Course is at the discretion of the centre. However, learners would normally be expected to have attained some relevant skills and knowledge through prior experience.

Skills and knowledge developed through any of the following, while not mandatory, are likely to be helpful as a basis for further learning for this Course.

Other SQA qualifications

- ◆ National 3 Practical Craft Skills Course or relevant component Units
- ◆ National 3 Design & Technology Course or relevant Units

Experiences and outcomes

National Courses have been designed to draw on and build on the curriculum experiences and outcomes as appropriate. Qualifications developed for the senior phase of secondary education are benchmarked against SCQF levels. SCQF level 4 and the curriculum level 4 are broadly equivalent in terms of level of demand although qualifications at SCQF level 4 will be more specific to allow for more specialist study of subjects.

Learners who have completed Curriculum for Excellence experiences and outcomes will find these an appropriate basis for doing the Course.

In this Course, any of the following may be relevant:

- ◆ I can confidently apply preparation techniques and processes to manufacture items using specialist skills, materials, tools and software in my place of learning, at home or in the world of work. (TCH 4-13a)
- ◆ Showing creativity and innovation, I can design plan, and produce increasingly complex items which satisfy the user at home or in the world of work. (TCH 4-14a)
- ◆ I can explore the properties and functionality of materials, tools, software or control technology to establish their suitability for a task at home or in the world of work. (TCH 4-14c)

- ◆ By examining and discussing the features of everyday products, I am gaining an awareness of the factors influencing design and can evaluate how these products meet the needs of users. (TCH 4-14d)

Other experience

Learners may have also gained relevant skills and knowledge through other prior learning, life and work experiences.

Skills, knowledge and understanding covered in this Course

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the Course.

Note: teachers and lecturers should refer to the *Added Value Unit Specification* for mandatory information about the skills, knowledge and understanding to be covered in this Course.

The mandatory skills may be developed throughout the Course. The table below shows where there are significant opportunities to develop these in the individual Units.

| Mandatory skills and knowledge | Bench Skills | Machine Processes | Fabrication and Thermal Joining | Added Value |
|---|---------------------|--------------------------|--|--------------------|
| Using, with guidance, a range of metalworking tools, equipment and materials safely and correctly for straightforward and familiar metalworking tasks | ✓ | ✓ | ✓ | ✓ |
| Reading and interpreting simple drawings and diagrams in familiar contexts | ✓ | ✓ | ✓ | ✓ |
| Measuring and marking out metal sections and sheet materials in readiness for straightforward cutting and forming tasks | ✓ | ✓ | | ✓ |
| Practical creativity in the context of simple and familiar metalworking tasks | | | ✓ | ✓ |
| Following, with guidance, given stages of a practical problem-solving approach to metalworking tasks | ✓ | ✓ | ✓ | ✓ |
| Applying knowledge and understanding of safe working practices in a workshop environment as they relate to simple and familiar tasks | ✓ | ✓ | ✓ | ✓ |
| Knowledge of the basic properties and uses of common metals and metalworking materials | ✓ | ✓ | ✓ | |
| Knowledge of sustainability issues in a practical metalworking context | ✓ | ✓ | ✓ | |

Progression from this Course

This Course or its Units may provide progression to:

- ◆ National 5 Practical Metalworking Course or relevant Units
- ◆ National Certificate Group Awards (NCGAs)
- ◆ Skills for Work and sector-specific SQA Courses
- ◆ a range of other practical technology Courses at National 4

For some, this Course may also provide progression to employment, apprenticeships and/or training in practical technology and related fields including:

- ◆ crafts
- ◆ construction
- ◆ manufacturing
- ◆ engineering
- ◆ theatre
- ◆ visual arts

Hierarchies

Hierarchy is the term used to describe Courses and Units which form a structured progression involving two or more SCQF levels.

It is important that any content in a Course and/or Unit at one particular SCQF level is not repeated if a learner progresses to the next level of the hierarchy. The skills and knowledge should be able to be applied to new content and contexts to enrich the learning experience. This is for centres to manage.

This Course is designed in hierarchy with the corresponding Course at National 5 and has the same structure of three Units with corresponding titles.

There is no direct hierarchy between National 4 Practical Metalworking Course and the National 3 Practical Craft Skills, but there is a fall back arrangement in place. This means that a learner who gains all three Units of the National 4 Practical Metalworking Course, but fails the Added Value Unit, may be awarded the National 3 Practical Craft Skills Course, provided they have been entered for the National 3 Course.

| | | |
|-------------------|------------------------|------------------------|
| National 4 | Practical Woodworking | Practical Metalworking |
| National 3 | Practical Craft Skills | |

Appendix 2 contains a table showing the relationship between the mandatory knowledge and understanding at National 4 and National 5. This may be useful for:

- ◆ designing and planning learning activities for multi-level groups including National 4 and National 5 learners
- ◆ ensuring seamless progression between levels
- ◆ identifying important prior learning for learners at National 5

Teachers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

Approaches to learning and teaching

Practical Metalworking, like all new and revised National Courses, has been developed to reflect Curriculum for Excellence values, purposes and principles. The approach to learning and teaching developed by individual centres should reflect these principles.

Learning in this Course should be primarily practical, hands-on and experiential in nature.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the three Units. Learning should be focused on appropriate practical activities so that practical skills are developed simultaneously with knowledge and understanding and to allow evidence for assessment to be naturally occurring.

Teaching is likely to involve a range of strategies including demonstration, discussion, problem-solving, exploration and perhaps simple experimentation (particularly with materials) in building learner competence and confidence. Where possible, visits to relevant local industrial/workshop environments should be undertaken. The use of video and online resources may also provide valuable resources.

Co-operative and collaborative learning approaches support and encourage learners to achieve their full potential. Unlike individual learning, learners engaged in these strategies capitalise on one another's resources and skills — asking one another for information, evaluating one another's ideas and monitoring the group's work. While working in a group is not specifically identified as one of the skills for life, learning and work for this Course, and therefore not assessed, it is a fundamental aspect of working in practical technologies and so should be encouraged and developed by teachers.

When delivering the Units, reference should be made to the appropriate content statements within the 'Further mandatory information on Course coverage' section of the *Added Value Unit Specification* to ensure the required breadth of knowledge is covered. A range of approaches to learning and teaching appropriate to the delivery of the Course have been further described at individual Unit level.

Assessment activities, used to support learning, may usefully be blended with learning activities throughout the Course.

For example by:

- ◆ sharing learning intentions/success criteria
- ◆ using assessment information to set learning targets and next steps
- ◆ adapting teaching and learning activities based on assessment information
- ◆ boosting learners' confidence by providing supportive feedback

Self- and peer-assessment techniques should be encouraged wherever appropriate.

Working towards Units and Course

Learning and teaching activities should be designed to develop both:

- ◆ skills and knowledge to the standard required by **each Unit** and to the level defined by the associated Outcomes and Assessment Standards
- ◆ ability to apply the breadth of knowledge, understanding and skills required to complete the **Added Value Unit** successfully

Meeting the needs of all learners

Within any class, each learner has individual strengths and areas for improvement. For example, within a National 4 class, there may be learners capable of achieving National 5 standards in some aspects of the Course. Where possible, they should be given the opportunity to do so.

Teachers need to consider both the Outcomes and Assessment Standards, and the content tables in Appendix 2 of these notes, to identify opportunities where learners may achieve National 5 standards.

When delivering this Course to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners. This is particularly appropriate where the National 5 learners have come directly from the broad general education without doing National 4.

However, where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation.

Learning about Scotland and Scottish culture will enrich the learners' learning experience and help them to develop the skills for learning, life and work they will need to prepare them for taking their place in a diverse, inclusive and participative Scotland and beyond. Where there are opportunities to contextualise approaches to learning and teaching to Scottish contexts, teachers and lecturers should consider this.

Sequence of delivery of Units

The sequence of delivery of the Units within the Course is a matter of professional judgement and is at the discretion of the centre. The decision may well be influenced by local factors such as resource or staffing allocation, staff expertise and timetable structure.

Whether the decision is taken to deliver the Units sequentially or in parallel, it is recommended that where possible the initial part of the *Bench Skills* Unit should be delivered before commencing other Units so that learners can develop their initial skills in reading drawings and basic marking out.

It would be good practice to complete all Units before attempting the Added Value practical activity: *Making a Finished Product from Metal*. This approach will give learners the opportunity to develop the skills and knowledge to enable them to successfully attempt the practical activity for Course assessment.

Fitting the Added Value Unit into a Course plan

As the Added Value Unit is intended to build on knowledge, understanding and skills developed through the other Units, it will normally be delivered at the end of the Course. However, it may be possible to begin work on the Added Value Unit at an earlier stage, but only where it is clear that learners have already gained the required skills and knowledge.

Advice on distribution of time

The distribution of time between the various Units is a matter for professional judgement and is entirely at the discretion the centre. Each Unit is likely to require an approximately equal time allocation, although this may depend on the learners' prior learning in the different topic areas.

Within the time allocated for the Added Value Unit (practical activity), time will be required for:

- ◆ preparation for the practical activity, which could include considering exemplars and practising the application and integration of skills
- ◆ carrying out the stages of the practical activity with teacher guidance and support
- ◆ maintaining a progress diary

Resources

Centres may find that existing equipment workshop and classroom resources provide all that is required to deliver the Course. In addition, where knowledge is being consolidated, centres may use digital resources to support learning.

Teaching and learning materials

Centres may also be able to adapt existing activities and resources to support and consolidate learning such as online interactive quizzes and activities currently well utilised in centres.

Developing skills for learning, skills for life and skills for work

Guidance on the development of skills for life, skills for learning and skills for work is to be found in the support notes for each of the component Units.

Approaches to assessment

See the *Unit Support Notes* for guidance on approaches to assessment of the Units of the Course.

Added value

Courses from National 4 to Advanced Higher include assessment of added value. At National 4, the added value will be assessed in the *Added Value Unit*.

Information given in the *Course Specification* and the *Added Value Unit Specification* about the assessment of added value is mandatory.

Full details of assessment of the practical activity are included in the *Added Value Unit Specification*.

The *Added Value Unit* will assess the application of skills and knowledge which learners will have developed through the other Units. Evidence for this Unit will be generated through a practical activity in which learners will be required to make a finished product in metal.

Combining assessment across Units

A holistic approach to assessment will enrich the assessment process for the learner, avoid duplication of assessment, provide more time for learning and teaching and allow centres to manage the assessment process more efficiently.

Each of the Units in the National 4 Practical Metalworking Course is focused on delivering different, but interrelated, skills, knowledge and understanding. When Units are taken as part of the Course, there will be opportunities to combine assessment across the Units. This has been outlined, where possible, in individual *Unit Support Notes*. If assessment across Units is combined, then it must be clear where such evidence has been taken from and which Assessment Standards it evidences.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies. This is for both learners and centres to consider.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Course Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Course.

It is important that centres are aware of and understand SQA's assessment arrangements for disabled learners, and those with additional support needs, when making requests for adjustments to published assessment arrangements. Centres will find more guidance on this in the series of publications on Assessment Arrangements on SQA's website: www.sqa.org.uk/sqa/14977.html.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- ◆ Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications are available on SQA’s website at: www.sqa.org.uk/sqa//14977.html
- ◆ [*Building the Curriculum 4: Skills for learning, skills for life and skills for work*](#)
- ◆ [*Building the Curriculum 5: A framework for assessment*](#)
- ◆ [*Course Specifications*](#)
- ◆ [*Design Principles for National Courses*](#)
- ◆ [*Guide to Assessment \(June 2008\)*](#)
- ◆ Principles and practice papers for curriculum areas
- ◆ [*SCQF Handbook: User Guide*](#) (published 2009) and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- ◆ [*SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*](#)

Appendix 2: Comparison between National 4 and National 5

The table below shows the relationship between the mandatory National 4 and National 5 knowledge, understanding and skills.

Teachers should also refer to the Outcomes and Assessment Standards for each level when planning delivery.

NB: Where similar topics, tools, equipment, materials and processes are used at both levels, the Outcomes, Assessment Standards and Evidence Requirements distinguish the level of treatment.

| Identification and use of the following tools and processes: | | |
|---|--|--|
| Topic | National 4 | National 5 |
| Measuring and marking out | <p>Tools and equipment:</p> <ul style="list-style-type: none"> ◆ scribe and scribing block ◆ steel rule ◆ engineer's square ◆ spring dividers ◆ calipers (odd-leg, inside, outside, and Vernier or digital) ◆ centre punch ◆ witness marks ◆ surface table <p>Basic knowledge and understanding of:</p> <ul style="list-style-type: none"> ◆ units of measurement, datum, functional dimensions ◆ Engineer's blue | <p>As at National 4, plus:</p> <p>Tools and equipment:</p> <ul style="list-style-type: none"> ◆ combination set ◆ micrometer (analogue or digital) ◆ angle block ◆ v-block <p>Knowledge and understanding of:</p> <ul style="list-style-type: none"> ◆ allowances for expansion, bending, stretching, forming, trimming, welding, brazing and soldering |
| Reading and interpreting drawings and documents | <p>Working drawings, pictorial drawings, diagrams, cutting lists</p> <p>Knowledge and understanding of orthographic projection, scale, dimensioning (linear, radial and diameter) and basic drawing conventions including: line types, centre lines and hidden detail</p> | |
| Materials | <p>Knowledge (basic knowledge at National 4) of variety of common metalworking materials:</p> <ul style="list-style-type: none"> ◆ ferrous metals (steel, high carbon steel, iron) ◆ non-ferrous metals (aluminum, copper, nickel) ◆ alloys (bronze, brass, stainless steel) ◆ common sections (square bar, round bar, hexagonal bar, angle iron, tube) ◆ sheet materials (tin plate, copper, brass, steel, aluminum) <p>Common metals associated with different fabrication and joining techniques</p> | |

| | | |
|---------------------------------------|--|---|
| Bench work | Common bench tools, including: <ul style="list-style-type: none"> ◆ hammers (ball-pein) ◆ cold chisels ◆ files ◆ saws (hacksaw, junior hacksaw) ◆ taps, dies tap wrench and die stock for tapping and threading and awareness of twist drill size ◆ rivet set and snap | |
| Sheet-metal tools and machines | <ul style="list-style-type: none"> ◆ bending equipment including folding bars ◆ notchers ◆ hide or rubber mallets ◆ tin snips ◆ pop riveter ◆ spot welder ◆ formers and jigs (as appropriate) | |
| Machine processes | Centre lathe: parallel turning, facing, chamfering, centre drilling and drilling generally, knurling, parting off Pedestal drill for drilling and counter-sinking Knowledge (basic knowledge at National 4) of: <ul style="list-style-type: none"> ◆ bench grinders ◆ centering of cutting tools ◆ milling machines (vertical, horizontal and CNC) ◆ industrial cutting processes (including laser and plasma cutters) | As at National 4, plus: <ul style="list-style-type: none"> ◆ centre lathe: taper turning (using a compound slide) ◆ use of a 4-jaw chuck (if appropriate) |
| Machine tools | <ul style="list-style-type: none"> ◆ lathe cutting tools ◆ knurling tool ◆ parting tool ◆ 3-jaw chuck and Jacob's chuck ◆ chuck keys ◆ revolving centres ◆ machine vices Appropriate holding devices Safety equipment | As at National 4, plus: <ul style="list-style-type: none"> ◆ 4-jaw chuck |
| Finishing | <ul style="list-style-type: none"> ◆ Preparation of surfaces ◆ Planishing, polishing, bluing ◆ Machine finishing (ground, milled) Knowledge (but not use) of preparation and application of painting and powder-dip coating | |

| | | |
|--|---|---|
| Care and maintenance of tools and equipment | Knowledge and understanding (basic at National 4) of: <ul style="list-style-type: none"> ◆ reporting faults and fault reporting systems ◆ general condition before, during and after use ◆ position and condition of guards ◆ position and security of cutting tools on machine tools ◆ secure holding techniques | |
| Fabrication and thermal joining | Hot-forming techniques including twisting, drawing down and flattening Hot-bending techniques including metal bar bending, metal strip bending (including on edge) Thermal joining techniques including welding, soldering or brazing Mechanical fixing techniques including screw-fixing and proprietary fixings Proprietary metalwork adhesives | As at National 4, plus: Heat-treatment methods of annealing, hardening and tempering Knowledge and understanding of metals associated with different fabrication and joining techniques |
| Safe working practices | Good practices and safe systems for general workshop and individual activities as appropriate Personal protective equipment | |
| Recycling and sustainability | Best practice in selecting materials appropriate for use Understanding and following workshop recycling practices and processes | |

Administrative information

Published: June 2014 (version 1.2)

History of changes to Course Support Notes

| Course details | Version | Description of change | Authorised by | Date |
|----------------|---------|--|------------------------------------|-----------|
| | 1.1 | Changes to comparison table in Course Support Notes; minor changes to learning and teaching information in Unit Support Notes. | Qualifications Development Manager | July 2013 |
| | 1.2 | Appendix 2: Comparison between National 4 and National 5 page 13 — deletion of 'senior', and 'blue-dip' changed to 'powder-dip'. | Qualifications Manager | June 2014 |
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Unit Support Notes — Practical Metalworking: Bench Skills (National 4)



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Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Practical Metalworking: Bench Skills (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- ◆ the *Unit Specification*
- ◆ the *Course Specification*
- ◆ the *Added Value Unit Specification*
- ◆ the *Course Support Notes*
- ◆ appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to help learners develop a range of metalworking hand tool skills including simple bench-fitting work, basic sheet-metal work and simple measuring and marking-out work. The ability to read and interpret simple drawings and diagrams is also developed in this Unit. Learners will also develop their knowledge and understanding of metalworking materials, recycling and sustainability issues, as well as an appreciation of safe working practices in a workshop environment.

This Unit will also give learners the opportunity to develop thinking skills and skills in numeracy, employability, enterprise and citizenship.

This Unit can be delivered as:

- ◆ a stand-alone Unit
- ◆ part of the National 4 Practical Metalworking Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained useful skills, knowledge and understanding from prior learning, such as:

- ◆ National 3 Practical Craft Skills Course or relevant Units
- ◆ National 3 Design and Technology Course or relevant Units

Learners may have also gained relevant skills and knowledge through other prior learning, life and work experiences.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the National 4 Practical Metalworking *Course Support Notes*.

If the Unit is being delivered as part of the National 4 Practical Metalworking Course, the teacher should refer to the 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If the Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide an appropriate progression pathway for learners:

- ◆ other Practical Metalworking (National 4) Units: *Machine Processes*; and *Fabrication and Thermal Joining*
- ◆ Practical Woodworking (National 4) Units
- ◆ National Certificate Group Awards in a range of practical technology Courses
- ◆ Skills for Work Courses and sector-specific SQA qualifications
- ◆ a range of other stand-alone Units in practical technologies contexts

Approaches to learning and teaching

General guidance

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

The National 4 Practical Metalworking *Course Support Notes* provide broad guidance on approaches to learning and teaching which may apply to all Units of the Course.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards. Learning should be supported by appropriate practical activities, so that skills are developed simultaneously with knowledge and understanding.

When delivering the Unit as part of the National 4 Practical Metalworking Course, reference should be made to the appropriate content statements within the 'Further mandatory information on Course coverage' section of the *Added Value Unit Specification* to ensure the required breadth of knowledge is covered.

Health and safety

Each centre already has its statutory obligations and local advice on health and safety practice. In addition, it is likely that centres will have policies and approaches to learning and teaching which support best practice in the workshop environment.

Learners should be reminded of the importance and expectations of responsible working and the care and welfare of self and others. In addition, most learners will already be aware and have previous experience of workshop and practical environments and there will be opportunities to visit these responsibilities throughout the Unit.

Centres are likely to consider the learners positive attitudes to safety, care and attention, through observation of learners' working procedures, responsible use of tools, conversations, simple question and answer, and other opportunities as providing evidence of this standard.

Proper care of tools and recognition of the dangers of tool defects with regard to quality of work and possible hazards will be a recurrent theme, and the topic should be raised in this Unit.

Delivering the Unit within the Practical Metalworking Course

When delivering this Unit as part of the National 4 Practical Metalworking Course, it is recommended that *Bench Skills* would be the first Unit undertaken by learners; however, the available equipment may dictate that several Units are run at the same time. If this is the case then it would be advisable to use the first part of the *Bench Skills* Unit to develop the learner's initial skills in reading drawings and basic marking out prior to introducing the other Units.

Sequence of delivering learning and teaching activities within the Unit

In developing a sequence for the items to be produced in the Unit, it would be advisable to complete a sheet-metalwork item first; this will establish some of the skills, knowledge, discipline, and working practices associated with the workshop environment. The second item produced could be used to reinforce and further develop these skills in the context of a fitting item. This could also be used to introduce some of the activities from the other Units of the Course, such as the use of the pillar drill or perhaps hot-bending. For some of the activities undertaken, learners may produce a practice piece first to enable them to develop the required skills before undertaking the main item.

For each practical exercise, learners would be shown a completed example of the work to be undertaken, enabling them to see the standard of work they are expected to produce.

As each new operation, process or stage is reached, it will need to be demonstrated or discussed, possibly with reference to video material, on a need-to-know basis. This should enable learners to proceed with some confidence and safety. Teaching inputs should be kept as brief as possible to allow the main activity of 'hands-on' practical work.

Advice specific to delivery of this Unit

Learning and teaching approaches for this Unit will likely take a variety of forms. Teaching will certainly include whole class demonstration and instruction as well as follow up sessions with individual learners or small groups. Learners may demonstrate a range of preferences for learning and these will be teased out over the period of the Course.

Alternative approaches to teaching are suggested in the *Course Support Notes*.

Knowledge and understanding

Knowledge and understanding should not be taught in isolation from other aspects of the Course. Practical examples should be used where possible to help pupils to identify tools, equipment, processes, metals, alloys and their uses. In most workshop environments much of this will be undertaken during conversations and less formal input or directions.

Reading and interpreting workshop drawings

Learners should have practice at reading and interpreting orthographic and pictorial drawings. It is expected that these drawings will use a variety of line types and conventions, eg screw threads. Dimensioning should be for the most part linear, though it will be necessary to also include diameters and radii as appropriate to the item being made. It would assist learners at this level if orthographic and pictorial views were provided together to allow for easier visualisation of the item. Where British Standard conventions are used as part of a drawing, these should be explained to the learner.

Using marking-out tools

Learners should be introduced to the concept of marking out using a datum. On metal, a datum should first be established by filing two adjacent edges straight and at 90°, and using basic marking-out equipment —steel rule, engineer's square, odd-legged calipers, scribe, centre punch, and spring dividers — to achieve the required accuracy.

Using a range of tools to manufacture metalwork products

In this Outcome, learners will be manufacturing metalwork products using sheet-metal and fitting tools. Prior to attempting the product for Outcome 3, learners might carry out some initial practice work, and, for example, create a cardboard mock-up for the manufacture of this simple introductory item. This will help the learners appreciate the finer points and problems involved in working with sheet-metal. By doing this, learners should develop the necessary personal experience to manufacture the Unit product.

Emphasis should be given to the desire for accuracy and quality in manufacturing the fitted item. If a component is produced that is not of an acceptable standard then the learner should be given the chance to replace it.

The type of item produced might require the learners to use equipment and processes from other Units in the Course, and should be sufficiently complex to stretch the more able learners in preparation for the final assessment project.

It is possible that drilling, although generally a machine process, would most likely be covered at this time. Accuracy would be determined by rule, in conjunction with Vernier calipers if necessary. If a component is produced that is not of an acceptable standard, then the learner should be given the chance to repeat and replace it. Assembly/joining methods should be covered, as should finishing with no major flaws, although there is scope here for additional support if required.

Recycling and sustainability

Integrating sustainability concepts such as the sourcing and cost of materials, recycling and re-use can be introduced into lessons whenever it occurs naturally. Discussion in general workshop learning and teaching activities, through site visits, audio or video, and/or online resources is also useful. Learners should be helped to understand what they can do as individuals and a class group in terms of practical sustainability.

Sequence of delivery of Outcomes

The sequence of delivery of the Outcomes is a matter of professional judgement and is entirely at the discretion of the centre. However, it is suggested that the most effective way is by combining Outcomes 1 and 2 together and allowing Outcome 3 to flow from one dedicated activity; alternatively it might be effective to deliver Outcomes 1, 2 and 3 together in order to provide an integrated approach to the Unit, but other possibilities exist.

For learners undertaking the complete Course, time will need to be allowed for the completion of the work required for the practical activity that forms the Course assessment. More details of this aspect of the Course are given in *Added Value Unit Specification*.

Meeting the needs of all learners

When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners. Consideration should also be given to structure, content and materials selections. Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation.

Specific differences between the National 4 Unit and the National 5 Unit relate to precision of work. Typically the National 4 Unit asks for accuracy to within 2 mm, whereas the National 5 Unit demands 1 mm accuracy.

Learners at National 4 may be afforded regular guidance and supervision to ensure that correct techniques are being followed in accordance with safe working procedures. In a multi-level class, National 4 learners will be working for the most part with guidance to allow them to meet the Assessment Standard.

In line with the underlying principles of Curriculum for Excellence, learners should be encouraged, and expected, to take an active role in their own learning. Where Course activities and materials allow them to progress in an independent manner this will allow teaching of the two groups to happen most effectively.

Useful resources

Where possible, centres should source or produce exemplars of completed work to enhance learners' ability to contextualise the Unit material. This may take the form of pre-built assemblies or workpieces that the learners can use directly or in combination with the assemblies or items they create.

Video clips and online resources

The internet provides a valuable source of video clips and films of practical metalworking techniques, processes and practices. Learners may find these both informative and interesting in class and for self-study.

Online resources:

- ◆ YouTube
- ◆ Focus Educational
- ◆ Technology Student
- ◆ Teaching Education Scotland
- ◆ STEM Central on Education Scotland
- ◆ Khan Academy
- ◆ Scottish Government
- ◆ Machine/ tool manufacturers' websites

Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Unit Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Unit where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Unit.

The Practical Metalworking: Bench Skills (National 4) Unit holds opportunities to acquire and develop a number of the broad generic skills described in the SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work*. These opportunities will arise, for the most part, as a natural part of the learning and teaching process.

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| 2 Numeracy | |
| 2.2 Money, time and measurement | <p>Measuring and marking-out materials in accordance with working drawings.</p> <p>Interpreting and calculating dimensions and scale in drawings/diagrams/orthographic projections and applying them to work pieces.</p> <p>Checking the accuracy of completed components and assemblies against drawings and cutting lists.</p> <p>Manufacturing items to strict measurements of tolerances and accuracy.</p> <p>Discussion re: costs in sustainability and recycling.</p> |
| 4 Employability, enterprise and citizenship | |
| 4.3 Working with others | <p>Workshop practice involves sharing tools, equipment and materials with others and working together to balance individual tasks and time.</p> <p>Assisting other learners to carry out tasks.</p> |
| 5 Thinking skills | |
| 5.2 Understanding | Correctly identifying the purpose of various tools and equipment and explaining the correct use in a given context. |
| 5.5 Creating | Creating an item based on given drawings and diagrams and applying their own interpretation where necessary. |

Approaches to assessment and gathering evidence

The learner must demonstrate attainment of all of the Outcomes and their associated Assessment Standards to pass the Unit. Assessment must be valid, reliable and fit for purpose.

SQA does not specify the methods of assessment to be used; assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used. In many cases, evidence will be gathered during normal classroom activities, rather than through formal assessment instruments. Whenever possible, the practical nature of this Unit should not be compromised by placing too much emphasis on the assessment of the learner than is strictly necessary for the successful completion of the individual Outcomes.

The learner should be made aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished items will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short answer, sentence completion or multiple choice tests that are mainly of a visual nature should be provided.

Centres are expected to maintain a detailed record of evidence, including photographic, oral or observational evidence. Evidence in written or presentation format should be retained by the centre.

All evidence should be gathered under supervised conditions.

In order to ensure that the learner's work is their own, the following strategies are recommended:

- ◆ personal interviews with learners where teachers can ask additional questions about the completed work
- ◆ asking learners to do an oral presentation on their work
- ◆ using checklists to record the authentication activity

Combining assessment within Units

It may be possible to develop learning / assessment activities which provide evidence that learners have achieved the standards for more than one Outcome within the Unit, thereby reducing the assessment burden on learners. Combining assessment of Outcomes (or parts of Outcomes) in this way is perfectly acceptable, but needs to be carefully managed to ensure that all Assessment Standards and Outcomes for the Unit are covered. This is particularly true if evidence is gathered for the Unit as a whole through one assessment and a single context. If this approach is used, it must be clear how the evidence covers each Outcome.

A holistic approach to assessment will enrich the assessment process for the learner, avoid duplication of assessment, provide more time for learning and teaching, and allow centres to manage the assessment process more efficiently.

In some instances work carried out for other Units can be used as evidence of the learner's performance in this Unit. If this is done it must be clear where such evidence has been taken from.

For this Unit, learners will be required to provide evidence of:

- ◆ knowledge and understanding of a range of practical metalworking hand tools, metals and materials
- ◆ practical skills in simple bench-fitting work, basic sheet-metal work and simple measuring and marking-out work
- ◆ knowledge and understanding of sustainability issues and good practice in recycling in practical metalworking activities and environments
- ◆ the ability to work in accordance with given procedures and safe working practices

Notes on assessment of Outcome 1

This Outcome is about preparing for practical activities. Evidence is required of knowledge and understanding of a range of practical tools, equipment and materials for marking out, sheet-metal and bench-fitting work.

It is recommended that evidence of knowledge and understanding is gathered, where possible, as a natural part of the learning and teaching process. There should be ample opportunity throughout the delivery of the Unit to gather evidence for all the Assessment Standards to meet the Outcome.

Assessment may be written or oral. Some evidence might be gathered through short tests that involve hands-on identification of tools, equipment and materials; others might take the form of a closed-book paper-based or electronic test which could be comprised of multiple choice, sentence completion and short answer-type questions.

Where appropriate, centres should share marking criteria for any summative assessments designed for Outcome 1 and ensure these are valid and reliable.

Notes on assessment of Outcome 2

Centres may wish to use a mixture of summative and formative approaches to assessing learners' progress in this Outcome. Where this is the case, centres should share the criteria for success with all learners at the beginning of the Unit/Outcome and use peer- and/or self-assessment approaches to monitor learners' progress.

Notes on assessment of Outcome 3

For Outcome 3, learners must produce metal work products from working drawings using bench-fitting tools.

It is assumed that assemblies in this Unit are readily portable and that the tolerances given are suitable for such work at this level. The tolerances are also given assuming that available machinery can reasonably meet these expectations. In situations where learners fail to achieve the required standard of performance in one area, this weakness can be targeted in the next part of the Course when the next item is manufactured.

Where learners have produced a practice item of a better quality, this may be used as evidence that the required skill has been achieved. Alternatively, in some instances learners could undertake additional small practical exercises that will allow for re-assessment of individual skills.

Evidence of the use of tools safely and correctly could be gathered throughout the Unit using appropriate checklists to record performance.

Some learners may require additional support and help to ensure success in the manufacturing process, but learners must also be aware that the overall Course assessment takes into account the amount of practical assistance given by the teacher/lecturer, and that ultimately a degree of independence is expected from the learner.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies. This is for both learners and centres to consider.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and where the alternative approaches to assessment will, in fact, generate the necessary evidence of achievement.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

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- ◆ [SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work](#)
- ◆ *Template and Guidance for Unit Assessment Exemplification*
- ◆ SQA Guidelines on e-assessment for Schools
- ◆ SQA Guidelines on Online Assessment for Further Education
- ◆ SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

Administrative information

Published: June 2014 (version 1.1)

History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
|--------------|---------|--|------------------------------------|-----------|
| | 1.1 | Changes to comparison table in Course Support Notes; minor changes to learning and teaching information in Unit Support Notes. | Qualifications Development Manager | July 2013 |
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Note: You are advised to check SQA's website (www.sqa.org.uk) to ensure you are using the most up-to-date version.

Unit Support Notes — Practical Metalworking: Machine Processes (National 4)



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Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Practical Metalworking: Machine Processes (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- ◆ the *Unit Specification*
- ◆ the *Course Specification*
- ◆ the *Added Value Unit Specification*
- ◆ the *Course Support Notes*
- ◆ appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to help learners build measuring and marking-out skills and to develop skills in using common metalwork machine tools, equipment and related processes. Learners will also develop their knowledge and understanding of metalworking materials, recycling and sustainability issues, as well as an appreciation of safe working practices in a workshop environment.

This Unit will also give learners the opportunity to develop thinking skills and skills in numeracy, employability, enterprise and citizenship.

This Unit can be delivered as:

- ◆ a stand-alone Unit
- ◆ as part of the National 4 Practical Metalworking Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by one or more of the following or equivalent qualifications and/or experience:

- ◆ National 3 Practical Craft Skills Course or relevant Units
- ◆ National 3 Design and Technology Course or relevant Units

Learners may also have gained relevant skills and knowledge through other prior learning, life and work experiences.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the National 4 Practical Metalworking *Course Support Notes*.

If the Unit is being delivered as part of the National 4 Practical Metalworking Course, the teacher should refer to the 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If the Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide an appropriate progression pathway for learners:

- ◆ other Practical Metalworking (National 4) Units: *Bench Skills*; and *Fabrication and Thermal Joining*
- ◆ Practical Woodworking (National 4) Units
- ◆ National Certificate Group Awards in a range of practical technology courses
- ◆ Skills for Work Courses and sector-specific SQA qualifications
- ◆ a range of other stand-alone Units in practical technologies contexts

Approaches to learning and teaching

General advice

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

The National 4 Practical Metalworking *Course Support Notes* provide broad guidance on approaches to learning and teaching which may apply to all component Units of the Course.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards. Learning should be supported by appropriate practical activities, so that skills are developed simultaneously with knowledge and understanding.

When delivering the Unit as part of the National 4 Practical Metalworking Course, reference should be made to the appropriate content statements within the 'Further mandatory information on Course coverage' section of the *Added Value Unit Specification* to ensure the required breadth of knowledge is covered.

Delivering the Unit within the Practical Metalworking Course

It is recommended that, where this Unit is being delivered as part of the Practical Metalworking (National 4) Course, learners should first complete the initial part of the *Bench Skills* Unit in order to gain the basic skills in reading drawings and marking-out work pieces necessary to complete this Unit.

Health and safety

Each centre already has its statutory obligations and local advice on health and safety practice. In addition, it is likely that centres will have policies and approaches to learning and teaching which support best practice in the workshop environment.

Learners should be reminded of the importance and expectations of responsible working and the care and welfare of self and others. In addition, most learners will already be aware and have previous experience of workshop and practical environments and there will be opportunities to visit these responsibilities throughout the Unit.

As an initial introduction to the Unit, a brief overview of the work required for the Unit and aspects of safe working practices involving the use of machinery should be given. Appropriate videos or interactive computer programs could be used, as necessary, to introduce machining processes and safety aspects relating the work of the Unit to that of the industrial world.

Centres are likely to consider the learners positive attitudes to safety, care and attention, through observation of learners' working procedures, responsible use of tools, conversations, simple question and answer, and other opportunities as providing evidence of this standard.

Sequence of delivering learning and teaching activities within the Unit

The Unit seeks to broaden the learners' knowledge of workshop machinery available in an industrial situation. As such, an industrial visit would form an important part of the Unit. This would provide learners with the opportunity to see CNC machine tools, milling machines, and industrial cutting processes in action. Industrial standards for surface finish should also be a feature of the visit and the opportunity should be taken, wherever possible, to view machine tools, such as surface grinders, in action. If, however, access cannot be gained to an appropriate industrial centre, then videos should be used to emphasise the use of these machines, although it must be stated that there can be no substitute for the real-life experience.

For each practical exercise, learners should be shown a completed example of the work to be undertaken, enabling them to see the standard of work they are expected to produce.

As each new operation, process or stage is reached it will need to be demonstrated or discussed, possibly with reference to video material, on a need-to-know basis. This should enable learners to proceed with some confidence and safety. Teaching inputs should be kept as brief as possible to allow the main activity of 'hands-on' practical work.

For some of the skills to be covered it may be desirable for learners to produce initial practice items in order to develop the relevant skills. Where this approach is taken, these items may, if of sufficient standard, be used support assessment.

Advice specific to delivery of this Unit

Knowledge and understanding

Knowledge and understanding should not be taught in isolation from other aspects of the Course. Practical examples should be used where possible to help pupils to identify tools, equipment and processes. For example, making adjustments to machines and using the correct names and terminology should be taught as a natural part of the learner's progression through the Unit.

Reading and interpreting workshop drawings

It is expected that learners should be able to extract information from given drawings and apply it to the piece of work in hand. It would assist learners at this level if orthographic and pictorial views were provided together in order to make interpretation easier. Learners should be aware of the importance of data, and relevant current information and reference should be provided for learners to use as required. Where British Standard conventions are used as part of a drawing, these should be explained to the learner.

Using special marking-out techniques

The need for special marking-out techniques for certain precision work and irregular components should be demonstrated to learners. Marking out of larger products, and repetitive marking out, should also be covered.

Demonstrating knowledge of common machine tools and equipment

Learners should be made aware of different metal-cutting situations and should match these to particular machines. Where these machines are not available in the centre, these should be covered by an industrial visit, by visiting another centre or by video.

Performing routine user checks on tools and machinery prior to their use

The learner should be responsible for ensuring that the machinery to be used is set up appropriately, with all safety equipment in place prior to use — this should then be checked by the teacher/lecture. Similarly, the inspection of hand tools and reporting of defects should become a routine event in this Course.

Measurement using the micrometer and Vernier caliper

Learners should be encouraged to make use of both micrometers and Vernier calipers to measure completed components in order to ensure the greatest possible accuracy in manufacture. It is not essential for digital instruments to be used, but where manual instruments are used learners will need to be taught how to read the appropriate device. Digital measuring devices may prove easier to read for some learners.

Operating common machine tools in accordance with safe working practice

The learner should use as many machines and items of equipment as possible (a minimum of two), and items that are produced to given working drawings should embody as wide a range of operations as possible to give learners the experience of what can be undertaken.

If a milling machine is not available to the learners for actual use, then at least one drilling-machine operation should include an activity where the machine vice is clamped to the table. This will ensure that the learners have practical experience of work holding of this type.

If learners have already gained experience of using the drilling-machine as part of the *Bench Skills* Unit, then this will be further developed in this Unit through the use of Morse tapers being used to hold larger drill bits in a pedestal drill or, similarly, revolving (live) centres, chucks or larger bits in tailstocks.

Turning operations should include: plain parallel turning, facing, parting off, centre drilling and drilling, and knurling, although this range might well be extended, according to needs, to include boring and other relevant operations. The use of a self-centring four-jaw chuck to hold square or irregularly shaped components should also be demonstrated. Machined finishes should be without significant defects, and probably best gauged against exemplar pieces, visually and by thumbnail check.

Using the bench grinder

The use of this should be demonstrated to learners, who should also be given the opportunity, under direct supervision, to make use of it. This is subject to local restrictions about the use of such machines with learners.

Proper care of equipment and recognition of the dangers of defects with regard to quality of work and possible hazards will be a recurrent theme in the Course, and the topic should be further reinforced in this Unit, particularly in respect of machine tools and equipment.

Recycling and sustainability

Integrating sustainability concepts such as the sourcing and cost of materials, recycling and re-use can be introduced into lessons whenever it occurs naturally. Discussion in general workshop learning and teaching activities, through site visits, audio or video, and/or online resources, is also useful. Learners should be helped to understand what they can do as individuals and a class group in terms of practical sustainability.

Sequence of delivery of Outcomes

The sequence of delivery of the Outcomes is a matter of professional judgement and is entirely at the discretion of the centre. However, it is expected that in most centres the most effective way to deliver this Unit would be by combining Outcomes 1, 2 and 3 together to produce a coherent Course, with the practical aspects of the Course being used to form the basis for the coverage of Outcomes 1 and 2.

For learners undertaking the complete Course, time will need to be allowed for the completion of the work required for the practical activity that forms the Course assessment. More details of this aspect of the Course are given in the *Added Value Unit Specification*.

Meeting the needs of all learners

When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners. Consideration should also be given to structure, content and materials selections. Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation.

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Where possible, centres should source or produce exemplars of completed work to enhance learners' ability to contextualise the Unit material. This may take the form of pre-built assemblies or workpieces that the learners can use directly or in combination with the assemblies or items they create.

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Online resources:

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| 2.2 Money, time and measurement | <p>Measuring and marking out materials to specified tolerances.</p> <p>Interpreting and calculating dimensions and scale in drawings/diagrams and applying them to work pieces.</p> <p>Checking the accuracy of completed components and assemblies against drawings and cutting lists.</p> <p>Reading sizes from a micrometer or Vernier caliper.</p> <p>Manufacturing items to strict measurements of tolerances and accuracy.</p> <p>Discussion re: costs in sustainability and recycling.</p> |
| 4 Employability, enterprise and citizenship | |
| 4.3 Working with others | <p>Workshop practice involves sharing tools, equipment and materials with others and working together to balance individual tasks and time.</p> <p>Assisting other learners to carry out tasks.</p> |

| | |
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| 5 Thinking skills | |
| 5.2 Understanding | Correctly identifying the purpose of various tools and equipment and explaining the correct use in a given context. |
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- ◆ knowledge and understanding of a range of practical metalworking machine tools, equipment, processes and materials
- ◆ practical skills in using machine tools, equipment, materials and related processes
- ◆ knowledge and understanding of sustainability issues and good practice in recycling in practical metalworking activities and environments
- ◆ the ability to work in accordance with given procedures and safe working practices

Notes on assessment of Outcome 1

It is recommended that evidence of knowledge and understanding is gathered, where possible, as a natural part of the learning and teaching process.

Assessment may be written or oral. Some evidence might be gathered through short tests that involve hands-on identification of tools, equipment and materials; others might take the form of a closed-book paper-based or electronic test which could be comprised of multiple choice, sentence completion and short answer-type questions.

Notes on assessment of Outcome 2

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Notes on assessment of Outcome 3

For Outcome 3, learners must manufacture a metalwork product from working drawings using machine tools.

It is assumed that assemblies in this Unit are readily portable and that the tolerances specified in the Evidence Requirements are suitable for such work at this level. The tolerances are also given assuming that available machinery can reasonably meet these expectations. In situations where learners fail to achieve the required standard of performance in one area, this weakness can be targeted in the next part of the Unit or Course when the next item is manufactured.

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Evidence of the use of equipment safely and correctly could be gathered throughout the Unit, using appropriate checklists to record performance.

Some learners may require additional support and help to ensure success in the manufacturing process, but learners must also be aware that the overall Course assessment takes into account the amount of practical assistance given by the teacher/lecturer, and that ultimately a degree of independence is expected from the learner. Where additional assistance has been given to a learner, this should be recorded by the teacher/lecturer and taken into account when assessing the completed work.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies. This is for both learners and centres to consider.

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|--------------|---------|--|------------------------------------|-----------|
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Unit Support Notes — Practical Metalworking: Fabrication and Thermal Joining (National 4)



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Please refer to the note of changes at the end of this document for details of changes from previous version (where applicable).

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing the Practical Metalworking: Fabrication and Thermal Joining (National 4) Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- ◆ the *Unit Specification*
- ◆ the *Course Specification*
- ◆ the *Added Value Unit Specification*
- ◆ the *Course Support Notes*
- ◆ appropriate assessment support materials

General guidance on the Unit

Aims

The general aim of this Unit, as stated in the *Unit Specification*, is to help learners develop skills in fabrication, forming and joining of simple metalwork components. Learners will develop skills in thermal joining techniques and build their skills in measuring and marking out. In addition, learners will develop their knowledge and understanding of metalwork materials, recycling and sustainability issues, as well as an appreciation of safe working practices in a workshop environment.

This Unit will also give learners the opportunity to develop thinking skills and skills in numeracy, employability, enterprise and citizenship.

This Unit can be delivered as:

- ◆ a stand-alone Unit
- ◆ as part of the National 4 Practical Metalworking Course

Progression into this Unit

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained useful skills, knowledge and understanding from prior learning, such as:

- ◆ National 3 Practical Craft Skills Course or relevant Units
- ◆ National 3 Design and Technology Course or relevant Units

Learners may have also gained relevant skills and knowledge through other prior learning, life and work experiences.

Skills, knowledge and understanding covered in this Unit

Information about skills, knowledge and understanding is given in the National 4 Practical Metalworking *Course Support Notes*.

If the Unit is being delivered as part of the National 4 Practical Metalworking Course, the teacher should refer to the 'Further mandatory information on Course coverage' section within the *Added Value Unit Specification* for detailed content.

If the Unit is being delivered on a free-standing basis, teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Progression from this Unit

On successful completion of this Unit, the following Units and Courses provide a selection of progression pathways available to learners:

- ◆ other Practical Metalworking (National 4) Units: *Bench Skills* and *Machine Processes*
- ◆ Practical Woodworking (National 4) Units
- ◆ National Certificate Group Awards in a range of practical technology Courses
- ◆ Skills for Work Courses and sector-specific SQA qualifications
- ◆ a range of other stand-alone Units in practical technologies contexts

Approaches to learning and teaching

General guidance

The Unit is designed to provide flexibility and choice for both the learner and the teacher.

The National 4 Practical Metalworking *Course Support Notes* provide broad guidance on approaches to learning and teaching which may apply to all Units of the Course.

Learning and teaching activities should be designed to stimulate learners' interest, and to develop skills and knowledge to the standard required by the Outcomes and to the level defined by the associated Assessment Standards. Learning should be supported by appropriate practical activities, so that skills are developed simultaneously with knowledge and understanding.

When delivering the Unit as part of the National 4 Practical Metalworking Course, reference should be made to the appropriate content statements within the 'Further mandatory information on Course coverage' section of the *Added Value Unit Specification* to ensure the required breadth of knowledge is covered.

Delivering the Unit within the Practical Metalworking Course

When delivering this Unit as part of the National 4 Practical Metalworking Course, it is recommended that *Bench Skills* would be the first Unit undertaken by learners; however, the available equipment may dictate that several Units are run at the same time. If this is the case then it would be advisable to use the first part of the *Bench Skills* Unit to develop the learner's initial skills in reading drawings and basic marking out prior to introducing the other Units.

Sequence of delivering learning and teaching activities within the Unit

As each new operation, process or stage is reached, it will need to be demonstrated or discussed, possibly with reference to video material, on a need-to-know basis. This should enable learners to proceed with some confidence and safety. Teaching inputs should be kept as brief as possible to allow the main activity of 'hands-on' practical work.

For each practical exercise, learners should be shown a completed example of the work to be undertaken, enabling them to see the standard of work they are expected to produce.

Health and safety

Each centre already has its statutory obligations and local advice on health and safety practice. In addition, it is likely that centres will have policies and approaches to learning and teaching which support best practice in the workshop environment.

Learners should be reminded of the importance and expectations of responsible working and the care and welfare of self and others. In addition, most learners will already be aware and have previous experience of workshop and practical environments and there will be opportunities to visit these responsibilities throughout the Unit.

As an initial introduction to the Unit, learners should be given a thorough introduction to the work required and aspects of safe working practices. Appropriate videos or interactive computer programs could be used as necessary to introduce processes and safety aspects relating the work of the Unit to that of the industrial world.

Proper care of tools and recognition of the dangers of tool defects with regard to quality of work and possible hazards will be a recurrent theme in the Course, and the topic should be covered in this Unit.

Centres are likely to consider the learners positive attitudes to safety, care and attention, through observation of learners' working procedures, responsible use of tools, conversations, simple question and answer, and other opportunities as providing evidence of this standard.

Advice specific to delivery of this Unit

Knowledge and understanding

Knowledge and understanding should not be taught in isolation from other aspects of the Course. Practical examples should be used where possible to help pupils to identify tools, equipment, processes, metals, alloys and their uses. For example, when learning which metals are associated with different fabrication and joining techniques, this should be related to other work being undertaken in the Unit.

Reading and interpreting workshop drawings

It is expected that learners should be able to extract information and apply it to the piece of work in hand, and as such, it would assist learners at this level if orthographic and pictorial views were provided together in order to make interpretation easier. Where British Standard conventions are used as part of a drawing, these should be explained to the learner.

Using hot-forging techniques to form shapes and components as an alternative to material removal

Forging is related to fabrication. It might best be introduced by a video showing the processes, terminology, equipment and applications used in an industrial context. The advantages of creating shapes by hot-forging rather than removing material should be discussed and practical applications provided. Learners should be given the practical experience of using the basic hot-forging shaping processes. Exercises undertaken by learners should cover hot-bending of the strip on the flat surface or on edge, drawing down, flattening and twisting. Wherever possible, these exercises should be incorporated into the completed items.

Hot treatment of metals

The forging process would naturally lead on to the observation of effects of heat on carbon steels, and this might be best studied through the manufacture of a cold chisel or screwdriver; the latter having the advantage that skills from the *Machine Processes* Unit can also be covered.

Thermal joining techniques

Learners should be introduced to the thermal joining techniques used in industry. This is best carried out through an industrial visit wherever possible; however, suitable video material can be used if necessary.

The joining of components by manual metal arc (MMA), metal inert gas (MIG) or tungsten inert gas (TIG) and by resistance (spot) welding should be covered to allow an insight into permanent methods common in steel fabrication work. It is recommended that learners are given practical experience in as many techniques as possible. Other thermal processes for joining metals, for example brazing and soldering, should also be covered as required.

Using mechanical fixings and adhesives

Learners are expected to use a range of mechanical fixings and/or adhesive bonding to join metal sections and sheet materials.

The use of screws, fixing, riveting, bolting and proprietary fixings is best demonstrated through the use of examples that are related, where possible, to the learners' own experience, for example in holding the parts of a bicycle together; this can also be used to introduce the concept of permanent and temporary fixing of components.

Where metalwork adhesives are used, learners will need to be shown how to achieve neat secure joints; the use of such adhesives in the industrial context should also be discussed. All of these joining techniques may be covered by learners producing test pieces rather than complete items, in order to gain the confidence and skills required prior to working on a final product.

Using fabrication and thermal joining techniques to manufacture a product

One or two items could be produced to incorporate most of the skills required for this Unit, providing an opportunity to revisit skills from other areas of the Course as required.

At this stage it will be necessary to cover all stages of manufacture by demonstration and to supervise activities.

Emphasis should be given to the desire for accuracy and quality in manufacturing an item. If a component is produced that is not of an acceptable standard then the learner should be given the chance to replace it.

Adhering to safe working practices at all times

Thermal joining and forging have their own safety-specific practices and procedures, including personal protective equipment, ventilation, shielding/screening, equipment checks and work holding. These should be fully covered and enforced at all times.

Recycling and sustainability

Integrating sustainability concepts such as the sourcing and cost of materials, recycling and re-use can be introduced into lessons whenever it occurs naturally. Discussion in general workshop learning and teaching activities, through site visits, audio or video, and/or online resources, is also useful. Learners should be helped to understand what they can do as individuals and a class group in terms of practical sustainability.

Sequence of delivery of Outcomes

The sequence of delivery of the Outcomes is a matter of professional judgement and is entirely at the discretion of the centre. It would be best practice, however, to deliver Outcomes 1 and 2 prior to Outcome 3 as the practical work involved is dependent on the knowledge gained in the first two Outcomes.

For learners undertaking the complete Course, time will need to be allowed for the completion of the work required for the practical activity that forms the Course assessment. More details of this aspect of the Course are given in the *Added Value Unit Specification*.

Meeting the needs of all learners

When delivering this Unit to a group of learners, with some working towards National 4 and others towards National 5, it may be useful for teachers to identify activities covering common knowledge and skills for all learners, and additional activities required for National 5 learners. Consideration should also be given to structure, content and materials selections. Where National 5 learners have studied National 4 in a previous year, it is important to provide them with new and different contexts for learning to avoid demotivation.

In line with the underlying principles of Curriculum for Excellence, learners should be encouraged, and expected, to take an active role in their own learning. Where Course activities and materials allow them to progress in an independent manner, this will allow teaching of the two groups to happen most effectively.

Useful resources

Where possible, centres should source or produce exemplars of completed work to enhance learners' ability to contextualise the Unit material. This may take the form of pre-built assemblies or workpieces that the learners can use directly or in combination with the assemblies or items they create.

Video clips and online resources

The internet provides a valuable source of video clips and films of practical metalworking techniques, processes and practices. Learners may find these both informative and interesting in class and for self-study.

Online resources:

- ◆ YouTube
- ◆ Focus Educational
- ◆ Technology Student
- ◆ Teaching Education Scotland
- ◆ STEM Central on Education Scotland's website
- ◆ Khan Academy
- ◆ Scottish Government
- ◆ Machine/ tool manufacturing companies' websites

Developing skills for learning, skills for life and skills for work

Learners are expected to develop broad generic skills as an integral part of their learning experience. The *Unit Specification* lists the skills for learning, skills for life and skills for work that learners should develop through this Course. These are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and must be built into the Unit where there are appropriate opportunities. The level of these skills will be appropriate to the level of the Unit.

The *Practical Metalworking: Fabrication and Thermal Joining* (National 4) Unit holds opportunities to acquire and develop a number of the broad generic skills described in the SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work*. These opportunities will arise, for the most part, as a natural part of the learning and teaching process.

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| 2 Numeracy | |
| 2.2 Money, time and measurement | <p>Measuring and marking-out materials in accordance with working drawings.</p> <p>Interpreting and calculating dimensions and scale in drawings/diagrams/orthographic projections and applying them to work pieces.</p> <p>Checking the accuracy of completed components and assemblies against drawings and cutting lists.</p> <p>Manufacturing items to strict measurements of tolerances and accuracy.</p> <p>Discussion re: costs in sustainability and recycling.</p> |
| 4 Employability, enterprise and citizenship | |
| 4.3 Working with others | <p>Workshop practice involves sharing tools, equipment and materials with others and working together to balance individual tasks and time.</p> <p>Assisting other learners to carry out tasks.</p> |
| 5 Thinking skills | |
| 5.2 Understanding | Correctly identifying the purpose of various tools and equipment and explaining the correct use in a given context. |
| 5.5 Creating | Creating an item based on given drawings and diagrams and applying their own interpretation where necessary. |

Approaches to assessment and gathering evidence

The learner must demonstrate attainment of all of the Outcomes and their associated Assessment Standards to pass the Unit. Assessment must be valid, reliable and fit for purpose.

SQA does not specify the methods of assessment to be used; assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used. In many cases, evidence will be gathered during normal classroom activities, rather than through formal assessment instruments. Whenever possible, the practical nature of this Unit should not be compromised by placing too much emphasis on the assessment of the learner than is strictly necessary for the successful completion of the individual Outcomes.

The learner should be made aware that certain performances are being monitored constantly and recorded on an observation checklist, and that finished items will be tested against the stated criteria for accuracy and quality. Lengthy written tests are not required for tool, process or equipment recognition and use. Short answer, sentence completion or multiple choice tests that are mainly of a visual nature should be provided.

Centres are expected to maintain a detailed record of evidence, including photographic, oral or observational evidence. Evidence in written or presentation format should be retained by the centre.

All evidence should be gathered under supervised conditions.

In order to ensure that the learner's work is their own, the following strategies are recommended:

- ◆ personal interviews with learners where teachers can ask additional questions about the completed work
- ◆ asking learners to do an oral presentation on their work
- ◆ using checklists to record the authentication activity

Combining assessment within Units

It may be possible to develop learning / assessment activities which provide evidence that learners have achieved the standards for more than one Outcome within the Unit, thereby reducing the assessment burden on learners. Combining assessment of Outcomes (or parts of Outcomes) in this way is perfectly acceptable, but needs to be carefully managed to ensure that all Assessment Standards and Outcomes for the Unit are covered. This is particularly true if evidence is gathered for the Unit as a whole through one assessment and a single context. If this approach is used, it must be clear how the evidence covers each Outcome.

A holistic approach to assessment will enrich the assessment process for the learner, avoid duplication of assessment, provide more time for learning and teaching, and allow centres to manage the assessment process more efficiently.

In some instances work carried out for other Units can be used as evidence of the learner's performance in this Unit. If this is done it must be clear where such evidence has been taken from.

For this Unit, learners will be required to provide evidence of:

- ◆ knowledge of a range of practical metalwork fabrication and joining techniques, tools, equipment and materials
- ◆ practical skills in using a range of practical metalworking tools, machines, equipment and materials for metalwork fabrication, joining and related processes
- ◆ knowledge and understanding of sustainability issues and good practice in recycling in practical metalworking activities and environments
- ◆ the ability to work in accordance with given procedures and safe working practices

Notes on assessment of Outcome 1

It is recommended that evidence of knowledge and understanding is gathered, where possible, as a natural part of the learning and teaching process.

Assessment may be written or oral. Some evidence might be gathered through short tests that involve hands-on identification of tools, equipment and materials; others might take the form of a closed-book paper-based or electronic test which could be comprised of multiple choice, sentence completion and short answer-type questions.

Notes on assessment of Outcomes 2

Centres may wish to use a mixture of summative and formative approaches to assessing learners' progress in this Outcome. Where this is the case, centres should share the criteria for success with all learners at the beginning of the Unit/Outcome and use peer- and/or self-assessment approaches to monitor learners' progress.

The use of jigs is permitted in fabrication work. Such jigs might include clamping, holding and assistance using welding magnets. Note must be taken of when jigs are used and also when jigs are made by learners themselves; the manufacture of jigs could also be used as evidence of manufacturing skills, if appropriate.

The joining techniques applicable to this Unit include thermal joining techniques, mechanical joining techniques and the use of adhesives.

Permitted thermal joining techniques come under the three headings of: welding, brazing, and soldering. There are several distinct techniques to be found under each of these headings. Evidence Requirements for this Unit do not preclude any particular thermal joining technique. However, it is acknowledged that, in practice, the range of thermal joining equipment available in educational workshops is likely to be limited. It should be noted that where thermal joining techniques are used, there must be a continuous unbroken run of at least 30mm and that the weld must be free from defects. Spot welds should be consistent and neatly applied.

Mechanical joining techniques that may be used in this Unit include riveting, bolting, screw-fixing and the use of proprietary metalwork fixings. Where these techniques are used, the joints produced should be secure, with the fixing free from damage in the case of bolting and screw-fixing. Rivets should have well-formed heads, with the surrounding material free from any major hammer marks.

Adhesives used in joining metal sections and sheet workpieces must be of a proprietary metalworking variety.

It is assumed that assemblies in this Unit are readily portable and that the tolerances specified in the Evidence Requirements are suitable for such work at this level. The tolerances are also given assuming that available machinery can reasonably meet these expectations. In situations where learners fail to achieve the required standard of performance in one area, this weakness can be targeted in the next part of the Unit or Course when the next item is manufactured.

Notes on assessment of Outcome 3

For Outcome 3, learners are required to produce an item, with a minimum of three components from a working drawing using fabrication and joining techniques.

It is assumed that the product used as the assessment vehicle for Outcome 3 will be portable. There is scope for personalisation and choice in allowing the learner to choose the type of metalworking models and products they might make.

Where learners have produced a practice item of a better quality, this may be used as evidence that the required skill has been achieved. Alternatively, in some instances learners could undertake additional small practical exercises that will allow for re-assessment in individual skills.

Evidence of the safe and correct use of tools could be gathered throughout the Unit, using appropriate checklists to record performance.

Some learners may require additional support and help to ensure success in the manufacturing process, but learners must also be aware that the overall Course assessment takes into account the amount of practical assistance given by the teacher/lecturer, and that ultimately a degree of independence is expected from the learner.

Equality and inclusion

The requirement to develop practical skills involving the use of equipment and tools may present challenges for learners with physical or visual impairment. In such cases, reasonable adjustments may be appropriate, including (for example) the use of adapted equipment or alternative assistive technologies. This is for both learners and centres to consider.

It is recognised that centres have their own duties under equality and other legislation and policy initiatives. The guidance given in these *Unit Support Notes* is designed to sit alongside these duties but is specific to the delivery and assessment of the Unit.

Alternative approaches to Unit assessment to take account of the specific needs of learners can be used. However, the centre must be satisfied that the integrity of the assessment is maintained and where the alternative approaches to assessment will, in fact, generate the necessary evidence of achievement.

Appendix 1: Reference documents

The following reference documents will provide useful information and background.

- ◆ Assessment Arrangements (for disabled learners and/or those with additional support needs) — various publications on SQA’s website: www.sqa.org.uk/sqa/14977.html
- ◆ [*Building the Curriculum 4: Skills for learning, skills for life and skills for work*](#)
- ◆ [*Building the Curriculum 5: A framework for assessment*](#)
- ◆ [*Course Specifications*](#)
- ◆ [*Design Principles for National Courses*](#)
- ◆ [*Guide to Assessment \(June 2008\)*](#)
- ◆ *Principles and practice papers for curriculum areas*
- ◆ *Research Report 4 — Less is More: Good Practice in Reducing Assessment Time*
- ◆ *Coursework Authenticity — a Guide for Teachers and Lecturers*
- ◆ [*SCQF Handbook: User Guide*](#) (published 2009) and SCQF level descriptors (reviewed during 2011 to 2012): www.sqa.org.uk/sqa/4595.html
- ◆ [*SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work*](#)
- ◆ *Template and Guidance for Unit Assessment Exemplification*
- ◆ SQA Guidelines on e-assessment for Schools
- ◆ SQA Guidelines on Online Assessment for Further Education
- ◆ SQA e-assessment web page: www.sqa.org.uk/sqa/5606.html

Administrative information

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History of changes to Unit Support Notes

| Unit details | Version | Description of change | Authorised by | Date |
|--------------|---------|--|------------------------------------|-----------|
| | 1.1 | Changes to comparison table in Course Support Notes; minor changes to learning and teaching information in Unit Support Notes. | Qualifications Development Manager | July 2013 |
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