

Unit 9E(ii) Ensuring quality production

Focus: resistant materials

About the unit

The main aim of this unit is for pupils to make and produce their work in quantity.

In this unit, pupils tackle a design and make assignment (DMA) on the theme ‘Buckles and bits’, in which they present a fastening product that can be manufactured in quantity. They make their product in volume, reflecting similar processes to those that might be used commercially. They develop quality assurance procedures, and use production aids, *eg jigs, moulds, CAM (computer-aided manufacture)*, where appropriate, to improve the quality of their manufacturing.

Pupils gain the knowledge, skills and understanding they need to carry out the DMA successfully through product evaluation activities and focused practical tasks. They:

- learn how everyday products are manufactured in volume
- find out about the main commercial manufacturing processes, *eg casting, injection moulding, forming*
- learn how quality assurance systems are used to ensure quality products
- use an increasing range of hand-tools and machine-tools
- use CNC (computer numerically controlled) equipment, *eg CAD/CAM (computer-aided design and manufacture)*, to support making and to control production, where appropriate
- adapt their methods of designing and making to changing circumstances

There are also opportunities for pupils to:

- increase their understanding of how ICT influences manufacturing in industry, and how computer-controlled systems are used in industry and commerce
- find out about the concepts of quality assurance, systems and procedures

Where the unit fits in

This is one of three resistant materials units that focus on making and producing: one in year 7 on designing and making for yourself (unit 7B(ii)); one in year 8 on producing batches (unit 8E(ii)); and this one in year 9 on ensuring quality production. These units ensure progression in understanding about making and producing in quantity.

This is part of a series of three units in year 9 on ensuring quality production; there are equivalent units, with similar learning outcomes, on food and textiles. Together these units are expected to take 10–15 hours. If teachers want to work collaboratively, the DMA in this unit can be linked to the textiles DMA, ‘Designer bags’ in unit 9E(iii), with pupils designing a fastening for a particular bag. It is important that the department plans as a team so that pupils are able to draw on knowledge, skills and understanding from across the units to reinforce their learning and avoid unnecessary repetition.

This unit can be combined with unit 9B(ii) ‘Designing for markets (resistant materials)’. In this case, teachers can choose the DMA from either unit. If this unit is used towards the end of year 9, pupils should be able to complete more of the optional activities. The unit can be used as part of the end-of-key-stage assessment. If you choose not to teach this unit, then plan to include the essential activities identified by the symbol ■ as part of another unit.

■ essential activities

○ optional activities

Expectations

At the end of this unit

most pupils will: carry out their own research and use their findings about products that are produced commercially when developing their own ideas; consider the needs of a range of users; clarify their ideas through discussion, drawing and modelling, and give reasons for choosing between ideas; work safely and accurately when using a range of resources, avoiding risks; draft a production plan, identifying risks and precautions, noting any hazards to themselves and others, and identifying ways of controlling risks; try out and test ways of producing and finishing their product in volume and explain their choices; use techniques skilfully during production, including measuring, marking out, cutting, forming, moulding and casting, joining and finishing; set up tests to evaluate the effectiveness of their product in use; compare their product with the design specification and identify successful, weak or problematic parts of their work; suggest ways to improve the product’s design or production

some pupils will not have made so much progress and will: carry out research and use their findings when developing ideas; choose between available materials, tools, equipment and techniques and explain their choices; suggest the next steps for planning and constructing their product; measure, mark out and cut various materials reasonably accurately and safely during production, noting safety equipment used and its purpose; identify successful, weak or problematic parts of their work

some pupils will have progressed further and will: carry out their own research using sources not provided by the teacher, and use their findings about existing products when developing their own ideas; use prototypes effectively to explore and test their thinking, and use formal drawing methods to communicate their intentions; organise their work during trialling and production, and carry it out accurately and consistently, including measuring, moulding and casting, joining and finishing; devise tests to evaluate the effectiveness of their product in use, relating their findings to the purpose for which the product was intended; evaluate their product against a broad range of criteria and demonstrate how they have achieved their original design proposals

Prior learning

It is helpful if pupils have:

- used a range of cutting, shaping and forming processes, *eg sawing, line bending*
- used specified hand-tools to cut and form materials safely
- learnt how ICT can be used to plan their making, inform the making process, or make products using CAM
- used processes, tools, equipment and techniques to make with some precision, showing that they understand their uses
- taken account of the technical requirements needed to make a product
- justified their decisions about the selection of materials and methods of making, recognising the global dimensions of life-cycle analysis
- revised and consolidated their understanding of health and safety regulations

Pupils should have gained the above knowledge, skills and understanding in years 7 and 8, through unit 7B(ii) ‘Designing and making for yourself (resistant materials)’, unit 8C ‘Using ICT to support making’ and unit 8E(ii) ‘Producing batches (resistant materials)’, or similar projects.

Language for learning

Through the activities in this unit, pupils will be able to understand, use and spell correctly words relating to:

- designing, *eg CAD, computer-aided design, quality control, quality assurance, production plan, scaling up, pattern, template*
- making, *eg casting, engraving, moulding, injection moulding, milling, jigs, presses, mould, molten, gate, clamp, riser, sprue, flash, die, pressure, force, solid, solidify, batch and volume production, CNC, computer numerical control, CAM, computer-aided manufacture, standard component, bulk, wastage, reliable, identical, production line, production cell*

Speaking and listening – through the activities pupils could:

- ask different sorts of questions to extend thinking and refine ideas, *eg Does that imply that...? Does that mean...? Would we need to...?*

Writing – through the activities pupils could:

- understand the effect of different aspects of formality, *eg passive verbs, third person, abstract nouns*

Resources

Resources include:

- products, or pictures/photographs of products, that are made using different manufacturing methods, *eg cast products (lamp posts, sewing machine chassis, kitchen tools, a garlic press, a stapler body, the chassis inside an old TV), injection mouldings (trainer soles, stereo enclosures, CD cases), vacuum-formed products (food containers, ‘bubble pack’ packaging for items)*

Future learning

This unit has links with the key stage 4 programme of study. In particular, pupils will learn:

- 2a) to select and use tools, equipment and processes effectively and safely to make products that match a specification
- 2b) to use a range of industrial applications when working with familiar materials and processes
- 2c) to manufacture single products and products in quantity, applying quality assurance techniques
- 2d) to use CAM in single item production and in batch or volume production
- 2e) to simulate production and assembly lines, including the use of ICT
- 4c) how materials are prepared for manufacture and how pre-manufactured standard components are used

(Extracts from the D&T key stage 4 programme of study)

Out-of-school activities and homework

Pupils could:

- collect small, low-cost items or pictures of them and identify how they have been manufactured. They could compare similar products, one high cost and one low cost, giving reasons for the differences in price
- collect as many different kinds of one product or pictures of them as possible to show the diversity of the product, *eg different fasteners*. They could record their findings as sketches, notes, pictures or a chart
- find out what products were produced in the local area, where the resources came from, and where the products went to. Teachers should explain that a century ago most manufacturing took place where there was a local supply of raw materials and people with the necessary skills
- find out how to make manufacturing more environmentally friendly. Teachers should explain that some manufacturing industries can use huge quantities of raw materials and resources, *eg electricity, water*, and also produce waste products

Links with other subjects

- ICT: using CNC equipment, *eg CAD/CAM*, the influence of ICT on the manufacturing industry and commerce.
- English: drawing up a specification, writing report(s).

Pupils should learn:

Pupils:

DESIGN AND MAKE ASSIGNMENT (DMA)

- to make a product in volume, using similar processes to those used commercially, by applying the knowledge, skills and understanding they developed during the product evaluation activities and focused practical tasks

Set the pupils a DMA in which they make a product in volume using similar processes to those used commercially. They should develop quality assurance procedures and use production aids, *eg jigs, moulds, patterns, CAM*, where appropriate, to improve the quality of their manufacturing.

Example

This example DMA has been written so it can be copied and given directly to pupils. Further details and contexts can be added, as appropriate.

Buckles and bits (linked to DMA 'Designer bags' in unit 9E(iii) 'Ensuring quality production (textiles)')

Design a fastening product that can be manufactured in quantity, rather than only made once. You will need to think about the kinds of materials and processes that are most suitable when many identical products have to be made.

Note: If this DMA is linked to 9E(iii), the fastening product will need to be designed for a particular bag.

- select information sources, deciding which will help them with ideas for their design
- seek the opinions of potential users of the product
- draw up a detailed design specification that specifies criteria to take into account, including aesthetics, function, reliability, maintenance, quality, and health and safety implications
- write full technical reports, including the import of data exchange files (DXFs)
- produce plans that specify the exact details to make a product in volume
- work within the constraints, considering and reflecting on the design criteria as closely as possible
- prioritise and reconcile decisions on materials, time and production
- adapt methods of working to changing circumstances
- use competently hand-tools, power-tools and CNC equipment, if appropriate
- take action to control identified hazards to themselves and others
- review the extent to which their product meets the design specification at appropriate stages of the development

Language for learning when writing design specifications and technical reports

- Remind pupils of different approaches to language in design specifications and technical reports, *eg how to link abstract concepts to descriptions of function, construction, finish, materials, making processes; the effect of passive and active verb constructions, first person and third person.*
- It is useful to have a range of design and technical documents available for pupils to refer to as models. Some pupils may need more structured frameworks to enable them to produce effective documentation.

Language for learning when reviewing a product outcome

- Ask pupils to carry out a mutual review in groups of two or three. The reviewees begin by explaining progress and suggesting the particular points that they want feedback on. Reviewers ask questions to help the reviewees refine their ideas.

■ essential activities

○ optional activities

Pupils should learn:

Pupils:

PRODUCT EVALUATION

- Organise a range of activities that give pupils an opportunity to:
- find out how everyday products are made and how identical products are achieved in spite of complex production processes
 - understand how some processes used in school are the same as those used in industry
 - find out how ICT influences manufacturing in industry and how computer-controlled systems are used in industry and commerce

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| <ul style="list-style-type: none"> ■ how everyday products are made in high volume, how identical products are achieved at the end of a complex production process, and why these products are often cheaper than if we were to buy the raw materials and to make them ourselves | <ul style="list-style-type: none"> ■ Discuss with the pupils how items similar to those used for the DMA are produced cheaply and in quantity so that they all come out the same. As part of this discussion, the pupils could be asked the following questions <ul style="list-style-type: none"> – <i>What kinds of materials, tools, equipment and processes are most suitable when a large number of identical products have to be made?</i> – <i>How serious would it be if one product was below standard?</i> ■ Discuss with the pupils how to investigate methods of producing an item and how to collect data when testing to help choose between two methods. | <ul style="list-style-type: none"> ■ describe what must be done to ensure that when a particular buckle is made, it is identical each time |
| <ul style="list-style-type: none"> ○ that some small-scale processes used in school are the same as those used in industry for high-volume production | <ul style="list-style-type: none"> ○ Discuss with the pupils what specialised tools and equipment they can use to simulate small-scale processes and high-volume production, <i>eg casting, injection moulding, forming</i>. Point out how it is the same as the manufacturing industry uses. If it is different, ask them <i>Why do you think this is?</i> | <ul style="list-style-type: none"> ○ give two examples of how the process used in school is the same as that in industry |
| <ul style="list-style-type: none"> ○ that casting, moulding and forming are common production methods used for everyday items | <ul style="list-style-type: none"> ○ Organise a quiz based on a display of items that are mass-produced, <i>eg</i> <ul style="list-style-type: none"> – <i>cast products, such as lamp posts, a sewing machine chassis, kitchen tools, a garlic press, a stapler body, the chassis inside an old TV</i> – <i>injection-moulded products, such as trainer soles, stereo enclosures, CD cases</i> – <i>vacuum-formed products, such as food containers, 'bubble pack' packaging for items</i> ○ Ask the pupils to match each item to a method of manufacture. Discuss with the pupils the answers they have given and the clues that give away methods of manufacture in everyday products. Point out to the pupils that some products rely on a combination of methods, <i>eg the body of a kettle might be cast in aluminium, the handle injection moulded and attached to the body with a bolt</i>. Pupils could also visit a manufacturer or look at a video or slides to see some of the processes and how computers are used. | <ul style="list-style-type: none"> ○ match common products to their production process, <i>eg a stapler body is cast, a CD case is moulded</i> |

■ essential activities

○ optional activities

Learning objectives

Pupils should learn:

- that materials, tools and equipment used have to be adapted and controlled carefully to assure quality during high-volume production

Possible teaching activities

- Introduce the pupils to a case study of making fasteners in high volume. Discuss any differences in the materials used, and any differences in the processing methods from those adopted in the classroom.

Learning outcomes

Pupils:

- explain three ways in which the process of making buckles by hand is different from that of commercial high-volume manufacturing

Points to note**FOCUSED PRACTICAL TASKS (FPTs)**

These practical tasks should focus on the knowledge, skills and understanding outlined in 'About the unit'. They should give pupils an opportunity to practise any new skills they will need during the DMA, *eg how to use an increasing range of hand-tools and machine-tools*.

- how to use injection moulding and casting safely and effectively

- Revise and demonstrate to the pupils manufacturing methods that can be used for small items, *eg fasteners*, building on work from years 7 and 8, *eg injection moulding, casting pewter in MDF moulds made using a CNC mill/engraver*. (For demonstration purposes, acrylic sheet can be used for the blanking board so that the pupils can see the flow of pewter into the mould. Extra screening precautions are advised if this is done.) Give the pupils an opportunity to compare different methods of making the same product and to discuss how the method chosen affects quality, cost, time taken, tools, equipment and expertise needed.

- use injection moulding or casting safely and effectively to produce a simple item and select a process to achieve a particular outcome



Health and safety – if pupils carry out the heat treatment of metals, and in particular casting, the obvious precautions need to be considered. Only teachers trained in casting safety procedures should supervise pupils for casting activities. If pewter is cast, only low-lead content or lead-free (white metal) should be used. Teachers should know the position and operation of fire and safety equipment. Pupils should be reminded of procedures in the case of an accident or fire. All appropriate health and safety regulation notices and signs should be displayed and explained to pupils. Teachers must carry out a health and safety risk assessment

- how to use CAD/CAM and jigs for folding or presswork

- Introduce the pupils to new techniques, tools and equipment, as appropriate to your school, *eg a CAD/CAM machine, folding or presswork with jigs*. Ask the pupils to write a process plan or a simple flow chart of instructions for future reference.

- use specific techniques safely and effectively, *eg CAD/CAM, folding or presswork with jigs*, and produce a simple flow chart of instructions and compare the methods used

- how to ensure repetitive quality, *eg accurate measuring, the use of jigs*

- Discuss with the pupils, using examples to show different ways of achieving high quality when manufacturing a product by implementing quality assurance throughout all stages of production, *eg accurate measuring, inspection and testing, using templates, jigs and guides*.

- demonstrate how quality can be achieved, *eg using a template, jig or CAM*

■ essential activities

○ optional activities