Unit 4: Developing Skills in Planning and Making a Machined Product

Unit reference number: Y/600/9140

QCF level: 1

Credit value: 6

Guided learning hours: 60

Unit aim

This unit will enable learners to develop the skills needed to plan and carry out the manufacture of a product using a small range of materials, machinery and tools. This unit provides some of the knowledge, understanding and skills for the Level 1 Performing Engineering Operations NOS Unit 7: Using Lathes for Turning Operations, NOS Unit 8: Using Milling Machines and NOS Unit 9: Using Grinding Machines.

Unit introduction

In this unit learners will be introduced to some of the practical skills needed to carry out machining operation using machine tools. They will consider the importance of communicating in technical terms by using and interpreting engineering drawings, and investigate what is involved when planning the manufacture of a product. Learners will then go on to manufacture a product and carry out inspection procedures to check that it conforms to a given specification.

Learners will consider the importance of using the correct raw materials, working safely with powered machinery and the need to check that guards, isolation switches, tools and equipment are in a safe and useable condition at all times. They will appreciate that before they start up a machine they must ensure that the work piece is fixed correctly, tools are mounted properly and the appropriate personal protective equipment (PPE) is being used.

This unit will help learners to appreciate the importance of following give instructions when carrying out activities and recognise what might go wrong when working with machine tools. Cleaning down work areas on completion of activities and the return of tools and equipment to safe storage are considered in the context of good housekeeping and efficient working.

Essential resources

It would be extremely useful if learners had access to a range of equipment commonly used in engineering. It may be possible to arrange a visit to an engineering company to extend learner awareness of the range of resources used in engineering.

A typical centre engineering workshop should be equipped with the basic requirements of this unit including a range of grinding machines, milling machines and turning machines. All supporting auxiliary equipment should also be available together with appropriate safety equipment.

Workshops should be staffed appropriately to ensure health and safety requirements are met. Technician support may be required during practical work.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification
1	Know about equipment, tools and materials required to make machined products	1.1	List the types of equipment used when making machined products	□ *Equipment*: centre lathe; milling machine eg vertical, horizontal, universal; grinding machine eg cylindrical, surface; key features of the equipment eg motor, drive system, rotating parts, slideways, table, tool holding, guards, work holding, start/stop
		1.2	List the tools and work holding devices used when making machined products	□ *Tooling*: cutting tools eg single point, parting off, end mill, side cutter, face cutter, end mill, slot mill, centre drill, twist drill, reamer, tap, die, grinding wheels; work holding equipment eg vice, alignment tennons, chucks, centres, clamps, angle plates, special fixtures, magnetic plates
		1.3	List the types of materials from which machined products can be made	□ *Materials*: ferrous eg cast iron, plain carbon steels; non-ferrous eg aluminium, copper, brass; non-metallic eg polythene, PVC, nylon, bakelite, melamine
2	Be able to use simple engineering drawings to plan the manufacture of a machined product	2.1	Identify features of a component by interpreting an engineering drawing	□ *Engineering drawings*: 2D projection eg 1st angle, 3rd angle; isometric projection; details eg dimensions, text, abbreviations, hidden detail, sections; sketches
		2.2	List the steps in a plan which can be followed when manufacturing a product	□ *Planning*: raw materials; processes; tooling; sequence of operations; machine settings eg speed, feed, depth of cut; safe working

Learning outcomes		Assessment criteria		Unit amplification
3	Be able to prepare a work area for producing a machined product	3.1	Confirm with a supervisor what has to be done before manufacturing activities are carried out	□ *Before stating work*: understand the task eg what needs to be carried, order of operations, tools and equipment, quality checks; personal protection eg eye protection, hair protection, removal of loose clothing and jewellery, footwear, use of barrier cream; regulations and safety procedures; maintenance of access eg clear walkways, emergency exits; understand the need for good housekeeping eg cleanliness of work area, removal of waste materials; understand what might go wrong eg damaged materials, tool breakage, finished products not to standard; confirm proposed actions with a supervisor
		3.2	Prepare a manufacturing work area	□ *Work area preparation*: select appropriate machinery eg milling machine, centre lathe, grinding machine; obtain raw materials eg ferrous, non-ferrous, non-metallic; select tools and equipment; obtain correct personal protective equipment eg eye protection, hair protection, overalls, safety footwear; identify procedure for machine start/stop in both normal and emergency situations
		3.3	Check raw materials are correct and that machinery and tools are safe to use	□ *Check raw materials are correct and that machinery and tools are safe to use*: check materials eg correct type, correct size, free from defects; condition of machine eg guards, isolator switch, start/stop switch, emergency stop switch, limit switch, cutting lubricants; condition of cutting tools eg sharpness, tip angle, damaged teeth; condition of grinding wheels eg damage, cracks, balance, requiring dressing, condition of holding devices eg chucks eg 3 jaw, 4 jaw, collets, centres, machine vice, angle plate, blocks, clamps, magnetic plate

Learning outcomes		Assessment criteria		Unit amplification
4	Be able to make an engineered product to a specification, using appropriate equipment and processes which are carried out in a safe manner	4.1	Use machines, tools and equipment to manufacture a product	□ *Making a machined component*: turning eg plain and stepped diameters, faces, drilled and reamed holes, chamfers and radii, knurling, grooves and undercuts, parting off; milling eg horizontal faces, parallel faces, vertical faces, open-ended slot, enclosed slot; grinding eg flat surface, cylindrical surface, shoulder; machine settings and adjustments eg spindle speed, feed rate, guards, safety devices; cutting lubricants eg fluids, compounds
		4.2	Check that the product meets the standard required	□ *Component checks*: appearance eg cuts, burrs, sharp edges; tolerances for turning eg dimensions +/- 0.25 mm, surface finish 1.6 um; tolerances for milling eg dimensions +/- 0.25 mm, flatness and squareness within 0.125 mm per 25 mm, surface finish 1.6 um; tolerances for grinding eg dimensions +/- 0.1, flatness and squareness within 0.025 per 25 mm, surface finish 0.4 um; measuring equipment eg micrometer, vernier, rule, gauges, dial test indicator
		4.3	Clean down work area and return tools to storage	□ *Cleaning down and putting away*: collection of swarf eg brush, collection pan, recycling container; tools and equipment eg cleaning cloth, tool case, toolbox, remove cutting tools; return to stores eg tools, equipment, surplus materials; machine isolation, inspection of work area eg visual, sign off

Information for tutors

Delivery

This unit is essentially practical and learners would benefit from practising their skills before being assessed. Learners should think about the processes needed and actions to be taken to prepare their workplace and then make basic components. Learners should have opportunities to talk about what they are going to do and how they propose to overcome any problems which may occur while they are using machine tools. It is important that learners understand the hazards involved when working with powered machinery and the measures which must be taken in order to minimise risk. They should also be fully aware of what to do in the case of an emergency.

The development of a production plan should be encouraged together with the use of engineering drawings which detail the features to be machined.

The product should be relatively simple and made up from a small number of components which will allow use of the different machining processes to be demonstrated and assessed, for example a small hand vice, toolmaker's clamp, adjustable square. It will add interest if learners can keep what they manufacture.

Outline learning plan

The outline learning plan has been included in this unit as guidance.

Topic and suggested assignments/activities
List the type of equipment used when making machined products. Tutor-led unit introduction covering content, method of working and assessment. Tutor-led overview of the manufacturing skills learners will develop. Small-group activity to identify the key features of a small range of given machine tools.
List the tools and work holding devices used when making machined products. Whole-class, tutor-led discussion about tools and work holding equipment. Paired activity to match tools and work holding devices to appropriate machinery.
List the types of materials machined products can be made from. Whole-class, tutor-led discussion about the types of materials which are available to use in a workshop. Paired activity to identify samples of given materials. Follow up by looking at machined components – identify the material and think about the manufacturing process it is used within.
Assessment activity – types of equipment, tools and materials used when manufacturing products. Individual activity based on a given engineered product which addresses the unit content and assessment criteria 1.1,1.2 and 1.3.

Topic and suggested assignments/activities
Identify features of a component by interpreting an engineering drawing. Tutor-led discussion about different types of engineering drawings – present simple exemplars. Paired activity to extract information from a given engineering drawing. Paired activity to identify key features of components from 2D orthographic and isometric projection drawings.
List the steps in a plan to follow when manufacturing a product. Whole-class, tutor-led discussion about how engineers plan the manufacture of engineering products. Using one or two basic components as examples – tutor presents drawing(s)/sketch(es), list of tools, machines, materials, sequence of operations, quality checks. Paired activity to plan the manufacture of a given product.
Assessment activity – identify features of a component and plan its manufacture. Individual activity based on a given engineered product which is made up from a small number of basic components. The activity should address the unit content and assessment criteria 2.1 and 2.2.
Confirm with a supervisor what has to be carried out before manufacturing activities are carried out. Tutor-led discussion about PPE, where and when it is necessary and how it works. Individual activity – identify specific risks when operating a lathe, milling machine and a grinding machine and the actions to take reduce risk of injury. Tutor-led discussion about the need to confirm proposed activities with a supervisor. Tutor-led discussion about emergency procedures to be followed if problems arise when working with machine tools.
Prepare a manufacturing work area. Whole-class, tutor-led discussion about the need to prepare manufacturing work areas – present exemplars of poor and good preparation. Paired activity to identify hazards/bad practices in workshops – presented as images with a checklist to complete.
Check raw materials are correct and that machinery and tools are safe to use. Whole-class, tutor-led discussion about why raw materials, machinery and tools should be checked before use. Tutor presents a small range of examples which show the consequences of working with materials, machinery and tools that are not fit for purpose. Small-group activity to identify the risks involved when working with lathes, milling machines and grinding machines and the measures which should be taken to reduce these risks.

Topic and suggested assignments/activities
Use machines, tools and equipment to manufacture a product. Paired and individual activities to develop skills when working with machine tools – work and tool holding, trial cuts, checking accuracy, different type of machining process, application of lubricants. Individual manufacture of components using machine tools. Setting up and adjusting machine settings, cutting materials and carrying out dimensional checks. Paired activity – machine isolation and clean down.
Check that the product meets the required standard. Whole-class, tutor-led discussion about why machined features should be checked against the specification. Paired activity to check that the manufactured product meets the specification.
Clean down work area and return tools to storage. Tutor-led discussion about the need for 'good housekeeping' in engineering workshops. Paired activity – machine isolation, clean down, return of tools, equipment and unused raw materials to storage.
Assessment activity – prepare a work area and manufacture a product using machine tools. Individual activity to manufacture a product using processes, tools and procedures which address the unit content and assessment criteria 3.1, 3.2, 3.3, 4.1, 4.2, 4.3. This assessment activity is linked to the previous one covering 2.1 and 2.2.
Seek and respond to guidance from the tutor. Tutors should encourage learners to have a dialogue with them. This could be prompted by the tutor asking learners to explain what they are doing, why they are doing it and how they are able to work safely. This does not require a formal allocation of time and should occur during delivery and assessment of the unit.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Learners will benefit from access to a range of assessment opportunities. Examples might include observed practice, recorded explanations, checklists and annotated photographic records. Entries within a logbook and a finished product inspection record, both validated by the tutor, are also appropriate methods for recording achievement. Competence in practical activities should be evidenced through witness testimonies or observation records signed by the tutor.

Suggested resources

Books

Boyce et al – *Engineering Level 1 Foundation Diploma* (Edexcel/Pearson, 2008) ISBN 9780435756253

Chapman et al – *GNVQ Intermediate Engineering* (Longman, 2000) ISBN 9780582381384

Darbyshire et al – *GNVQ Intermediate Engineering* (Nelson Thornes, 1997) ISBN 9780748729364

Jensen C – *Interpreting Engineering Drawings* (Delmar, 2001) 9781418055738

Simmons C and Maguire D – *Manual of Engineering Drawing to British and International Standards* (Butterworth-Heinemann, 2003) ISBN 9780750651202

Timings R L – *Basic Manufacturing* (Newnes, 1998) ISBN 9780750659901

Timings R L – *Manufacturing Technology Volume One* (Longman, 1998) ISBN 9780582356931

Tooley M – *Engineering GNVQ Intermediate* (Butterworth-Heinemann, 1996) ISBN 9780750625975

Waters F – *Fundamentals of Manufacturing for Engineers* (UCL Press, 1996) ISBN 9781857283389

Other publications

British Standard PP 8888 – 1: 2001 (A school version)

Tutor resource disks

Boyce et al – *Engineering Level 1 Foundation Diploma* (Edexcel/Pearson, 2008) ISBN 9780435756260

Websites

www.hse.gov.uk