Unit 134: Using Secondary Machining Techniques to Produce Components

Unit code: **H/504/2275**

QCF Level 3: **BTEC Nationals**

Credit value: **20**

Guided learning hours: **120**

Aim and purpose

This unit gives learners an understanding and practical experience/knowledge of secondary machining techniques found in engineering, meeting the necessary standards that is expected in industry.

Unit introduction

For everyday products and components to be manufactured to a required standard, the machines that produce them need to be operated in an efficient and safe manner. During this process, products are manufactured to given specifications that meet the necessary criteria. Machine operators will produce better components if they are aware of a range of different secondary machining processes that can be used. A secondary machining process is where raw material or a component is taken for further working, usually involving material removal, and is carried out after a primary forming process.

This unit aims to provide learners with a detailed knowledge of the use of secondary machining techniques, utilising traditional machines (for example lathes, mills and grinding machines).

The unit gives learners an opportunity to examine a range of secondary machining techniques, their design and application. With common practices, this unit will allow for a learner to operate a secondary machine and manufacture a given product.

By carrying out common machining activities in an engineering environment the learner will be able to simulate how to operate within a machining workshop, following all codes of conduct and working safely in manufacturing.

Learning outcomes

On completion of this unit a learner should:

1 Understand how health and safety issues relate to secondary machining processes

2 Be able to set up a turning machine to safely produce a given component

3 Be able to operate a turning machine to produce components

4 Be able to set up a milling machine to safely produce a given component

5 Be able to operate a milling machine to produce components

6 Be able to set up a grinding machine to safely produce a given component

7 Be able to operate a grinding machine to produce components

Unit content

1 Understand the health and safety issues relating to secondary machining processes

Health and safety: safe working practices; use of personal protective equipment (PPE); appropriate legislation and regulations eg Health and Safety at Work Act 1974, Fire Precautions Act 1971, manual handling, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995, Provision and Use of Work Equipment Regulations (PUWER) 1998, Health and Safety (First Aid) Regulations 1981

Reducing risks: eg use of risk assessment methods, avoidance of dangerous conditions, appropriate training, good housekeeping, safe use of tools and equipment

2 Be able to set up a turning machine to safely produce a given component

Turning machine: e.g. centre lathe, capstan, turret, single-spindle automatic, multi-spindle automatic

Tools: turning tools eg turning tools, facing tools, form tools, parting-off tools, thread chaser, single-point threading, boring bars, recessing tools, centre drills, twist/core drills, solid reamers, expanding reamers, taps, dies, knurling tool

Work-holding devices: e.g. chucks (hard or soft jaws, three or four jaw, collet, power, magnetic), drive plate and centres, faceplates, magnetic or pneumatic devices, fixed steadies or travelling steadies

Machine parameters: e.g. position of workpiece, position of turning tools in relation to workpiece, workpiece revelations per minute, linear feed rate, depth of cut for roughing and finishing, machine guards and safety mechanisms, threading/profile/taper mechanisms

3 Be able to operate a turning machine to produce components

Components: materials e.g. ferrous, non-ferrous, non-metallic, stainless, special alloys, deep drawing steels; features eg flat faces, diameters (parallel, stepped, tapered), holes (drilled, bored, reamed), profile forms, threads (internal, external), eccentric features, parting off, chamfers, knurls or special finishes, grooves, undercuts

Standards: e.g. components to be free from false tool cuts, burrs and sharp edges, dimensional tolerance equivalent to BS 4500 or BS 1916 Grade 7, surface finish 63µin or 1.6µm, reamed and bored holes within H8, screw threads BS medium fit, angles within +/- 0.5 degree

Checks: diameters, hole size/fit, angle/taper, surface finish, lengths/depths, thread profile and fit, concentricity, slot/recess width

4 Be able to set up a milling machine to safely produce a given component

Milling machine: e.g. horizontal milling machine, vertical milling machine, universal milling machine, planer /gantry milling machine, boring machines with milling attachments

Tools: milling cutters e.g. face mills, slab mills/cylindrical cutters, side and face cutters, slotting cutters, slitting saws, profile cutters, twist drills, boring tools, end mills, slot drills

Work-holding devices: e.g. chucks (hard or soft jaws, three or four jaw, collet, power, magnetic), clamping direct to machine table, pneumatic or magnetic table, machine vice, angle plate, vee block and clamps, indexing head/device, rotary table

Machine parameters: e.g. alignment of work-holding device, milling cutter revs per minute, position of cutters in relationship to workpiece, machine guards/safety mechanisms, linear/table feed rate, cutting fluid flow rate, depth of cut for roughing and finishing

5 Be able to operate a milling machine to produce components

Components: materials eg ferrous, non-ferrous, non-metallic; features of the workpiece eg faces (flat, square, parallel, angular), steps/shoulders, slots (pen ended, enclosed/recesses, tee), holes (drilled, bored), profile forms (vee, concave, convex, gear), serrations, indexed or rotated forms, special forms

Standards: eg components to be free from false tool cuts, burrs and sharp edges, flatness and squareness within 0.001" per inch or 0.025mm per 25mm, surface finish 63µin or 1.6µm, angles within +/- 0.5 degree, bored holes within H8

Checks: dimensions, angles, squareness, flatness, hole size/fit, slots, surface finish, recesses

6 Be able to set up a grinding machine to safely produce a given component

Grinding machine: eg horizontal surface, vertical surface, external cylindrical, internal cylindrical, universal, centreless, thread grinding, profile grinding

Tools: grinding (soft wheel, hard wheel, cup, flaring cup, straight sided wheel, recessed wheel, double recessed wheel, dish, saucer, disc, segmented)

Work-holding devices: e.g. chucks (hard or soft jaws, three or four jaw, collet, power, magnetic), centres, face plate, machine vices, clamps, angle plates, vee blocks, works rests, control stops, injector mechanisms, magnetic blocks, pots, arbors

Machine parameters: eg selection of grinding wheels for specific materials and applications (grain size, grade, structure, bond), mounting wheels (paper washers, flanges, locking pressure), testing wheels for cracks, dressing and 'trueing up' grinding wheels, wheel forming (chamfers, radii, angular forms, profiles), dressing and 'trueing up' control wheels

7 Be able to operate a grinding machine to produce components

Components: materials eg ferrous, non-ferrous, non-metallic; features of the workpiece eg faces (flat, vertical, parallel, faces square to each other), slots, diameters (parallel, tapered), bores (counter, tapered, parallel, profile), threads (left hand, right hand, single start, multi-start, internal, external)

Standards: eg components to be free from false grinding cuts, burrs and sharp edges, tolerance to BS 4500 or BS 1916 Grade 5, surface texture 8 µin or 0.2µm

Checks: dimensions, parallelism, squareness, profile, concentricity, thread form, surface texture, angle/taper, ovality/lobbing

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe the health and safety issues that relate to secondary machining techniques	M1 explain the effects of clamping the workpiece, and how this can cause distortion in the finished component	D1 evaluate the impact that aspects of working safely have on the effectiveness and accuracy for machining a given product
P2 explain methods of reducing risks when using secondary machining techniques	M2 justify the choice of machine, work holding device and tools used for manufacturing a given product	D2 evaluate and explain the importance of checking accuracy against given specifications.
P3 set up turning machine tools and work-holding devices [SM]	M3 justify the selection of an alternative secondary machining technique for manufacturing a given component.	
P4 set turning machine parameters to safely produce a given component		
P5 operate a turning machine to accurately produce a component to quality standards [SM]		
P6 check dimensional accuracy of turned component against given specifications		
P7 set up milling machine tools and work-holding devices		

Assessment and grading criteria		
P8 set milling machine parameters to safely produce a given component		
P9 operate a milling machine to accurately produce a component to quality standards [SM]		
P10 check dimensional accuracy of milled component against given specifications		
P11 set up grinding machine tools and work-holding devices		
P12 set grinding machine parameters to safely produce a given component		
P13 operate a grinding machine to accurately produce a component to quality standards [SM]		
P14 check dimensional accuracy of ground component against given specifications.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	**IE – independent enquirers** **CT – creative thinkers** **RL – reflective learners** **TW – team workers** **SM – self-managers** **EP – effective participators**

Essential guidance for tutors

Delivery

The learning outcomes of this unit are strongly linked and the delivery strategy should ensure that these links are emphasised. Because of the nature of the unit content, a mainly practical approach to delivery should be used. Work-based learners are likely to be involved with setting a defined secondary processing machine or range of machines during their work and these machines should be used in delivery.

Each learner should be given opportunities to use a range of turning, milling and grinding machines, taking into account the health and safety implications involved with each machine tool.

Delivery of learning outcome 1 would be best integrated with that of the other learning outcomes to ensure that learners are familiar with the safety requirements, hazards and risks associated with each machining process.

Learners will need to understand the importance of monitoring machine performance during the set up procedure and how to make adjustments to enable components to be produced successfully. Tutors should also ensure that learners can use appropriate measurement tools and instruments, such as micrometers and texture gauges so that they are able to check the accuracy of machined components.

Although it is the learners' responsibility to conduct themselves safely, wear relevant protective clothing and ensure each machine they use is correctly guarded before operation, the tutor should always verify this before any machine is used.

Note that the use of 'e.g.' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'e.g.' needs to be taught or assessed.

Outline learning plan

Topic and suggested assignments/activities and/assessment
Whole-class teaching / workshop demonstration: • introduction to unit and relevant health and safety procedures • explain terminology and principles of operation of secondary machining techniques • introduce and demonstrate a range of secondary machining techniques. *Group activity:* investigate and report on the function of the different secondary machining techniques
Whole-class teaching / workshop demonstration: • explain and demonstrate the use of different turning processes. • explain and demonstrate the use of different turning set ups, including work-holding devices • explain and demonstrate the use of a range of cutting tools for a variety of turning processes • explain and demonstrate relationship between position of workpiece and tools related to turning • explain and demonstrate operation of cutting fluids and guards. • explain parameters for a range of turning processes. • explain and demonstrate materials and features of a range of components produced using a turning machine • explain and demonstrate how inspection techniques are carried out using a range of measuring equipment ***Individual learner research:*** • investigate work-holding devices, tools and parameters used for a given component that has been turned. ***Individual learner practical workshop:*** • produce turned component(s) using a range of work-holding devices and tools
Whole-class teaching / workshop demonstration: • explain and demonstrate the use of different milling processes. • explain and demonstrate the use of different milling set ups, including work-holding devices. • explain and demonstrate the use of a range of cutting tools for a variety of milling processes. • explain and demonstrate relationship between position of workpiece and tools related to milling • explain and demonstrate operation of cutting fluids and guards. • explain parameters for a range of milling processes. • explain and demonstrate materials and features of a range of components produced using a milling machine. • explain and demonstrate how inspection techniques are carried out using a range of measuring equipment

Individual learner research: • investigate work-holding devices, tools and parameters used for a given component that has been milled. ***Individual learner practical workshop:*** • produce milled component(s) using a range of work-holding devices and tools
Whole-class teaching / workshop demonstration: • explain and demonstrate the use of different grinding processes. • explain and demonstrate the use of different grinding set ups, including work-holding devices. • explain and demonstrate the use of a range of abrasive cutting tools used in grinding processes. • explain and demonstrate relationship between position of workpiece and tools related to grinding. • explain and demonstrate operation of cutting fluids and guards. • explain parameters for a range of grinding processes. • explain and demonstrate materials and features of a range of components produced using a grinding machine. • explain and demonstrate how inspection techniques are carried out using a range of measuring equipment ***Individual learner research:*** • investigate work-holding devices, tools and parameters used for a given component that has been ground. ***Individual learner practical workshop:*** • finish component(s) using a range of work-holding devices and abrasive wheels on a grinding machine
Preparing for and carrying out Assignment 1: Use turning techniques to manufacture given component (P1, P2, P3, P4, P5, P6)
Preparing for and carrying out Assignment 2: Use milling techniques to manufacture given component (P1, P2, P7, P8, P9, P10)
Preparing for and carrying out Assignment 3: Use grinding techniques to manufacture given component (P1, P2, P11, P12, P13, P14)
Preparing for and carrying out Assignment 4: Suggest and justify improvements for machining activities (M1, M2, M3)
Preparing for and carrying out Assignment 5: Evaluation of secondary machining techniques (D1, D2)
Unit evaluation, feedback and close.

Assessment

Assessment evidence for this unit is likely to come from a mixture of written records (logbook entries) and practical process evidence (witness statements/observation records).

To achieve a pass grade, learners must demonstrate that they can safely set up and operate each of the secondary processing machines covered (turning, milling and grinding) and use relevant inspection techniques to check components against specification.

Wherever possible it is important to maximise opportunities for assessment through practical tasks. To cover the pass criteria a total of three practical assignments could be used, one for each of the machining processes. Therefore assignment 1 could cover turning machines (P3, P4, P5 and P6), assignment 2 milling (P7, P8, P9 and P10) and a third assignment the criteria associated with grinding processes (P11, P12, P13 and P14). P1 and P2 should be assessed in each assignment, as each process brings with it its own health and safety procedures.

Learners should be encouraged to maintain a logbook in which to record notes on their use of the individual machining techniques, which can also include a section that covers health and safety issues (covering criteria P1 and P2).

Further assignments can be used to assess the merit and distinction criteria. These assessments can be evidenced as written reports by the individual learner, which can be issued during the manufacturing tasks.

To achieve a merit grade, learners will have to make valid suggestions and justifications on improving the health and safety issue, the choice for what equipment was selected for the practical activities and using alternative secondary machining techniques for manufacturing given products without affecting the production process. This assessment may make reference to what the learner produce for the first three assignments, therefore the tutor may want to issue the assignment along side each machining activity.

M1 could be evidenced in the form of a written report, which follows on from what was recorded in the logbooks. This report should make valid suggestions on how to improve the safety of an operator, whilst performing the individual machining activities. Each suggestion must be supported with a detailed explanation of the improvement.

M2 and M3 can also be evidenced by means of a separate written report. This should focus on the practical activities that are performed, and for the learners to be able to justify their methods of production and validation of using other secondary machining techniques for manufacturing the given components.

To achieve a distinction grade, learners will need to evaluate the importance of checking the machined articles to required specifications. They will need to make reference to the measuring equipment used and discuss how the equipment is applied to check the finished product.

They also need to be able to evaluate the impact of working safely on the effectiveness and accuracy of setting up a secondary processing machine. They need to consider whether the use of the safety equipment conflicts with the set up and manufacturing process. Again, the required evidence for these criteria is likely to be in the form of a written response to tasks set for the learner.

In addition learners are required to justify their reasons for selecting equipment for manufacturing the given products, which can be achieved by means of a written report that can make reference to pass criteria P3, P4, P7, P8, P11 and P12. Also, learners are to make valid suggestions that justify the use of alternative secondary machining techniques for manufacturing the given products.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, P4, P5, P6	Use turning techniques to manufacture given component	Learners are to safely manufacture a given component using turning techniques and inspect the finished product against set specifications	A practical assignment evidenced through tutor observation records and learners' notes
P1, P2, P7, P8, P9, P10	Use milling techniques to manufacture given component	Learners are to safely manufacture a given component using milling techniques and inspect the finished product against set specifications	A practical assignment evidenced through tutor observation records and learners' notes
P1, P2, P11, P2, P13, P14	Use grinding techniques to manufacture given component	Learners are to safely manufacture a given component using grinding techniques and inspect the finished product against set specifications	A practical assignment evidenced through tutor observation records and learners' notes
M1, M2, M3	Suggest and justify improvements for machining activities	Learners are to make suggestions and justifications on improving all aspects to do with manufacturing given products	A written report detailing how each machine functions, the holding devices, tools and machine parameters associated with each
D1, D2	Evaluation of secondary machining techniques	Learners are to evaluate each machining technique	A written report evaluating the health and safety aspects and their impact on manufacturing accuracy, and also the importance of checking accuracy against given

			specifications

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
		Unit 16: Engineering Drawing for Technicians
		Unit 21: Engineering Secondary and Finishing Techniques

The unit also covers some of the knowledge and understanding associated with the SEMTA Level 3 National Occupational Standards in Mechanical Manufacturing Engineering, particularly:

- Unit 4: Setting Centre Lathes for Production
- Unit 6: Setting Turret Lathes for Production
- Unit 8: Setting Milling Machines for Production
- Unit 16: Setting Horizontal Boring Machines for Production
- Unit 18: Setting Vertical Boring Machines for Production
- Unit 22: Setting Grinding Machines for Production
- Unit 53: Setting Capstan and Turret Lathes for Production Operations
- Unit 54: Setting Single-Spindle Automatic Turning Machines for Production
- Unit 55: Setting Multi-Spindle Automatic Turning Machines for Production
- Unit 56: Setting Single and Multi-Spindle Drilling Machines for Production
- Unit 57: Setting Tool and Cutter Grinding Machines for Production.

Essential resources

To meet the needs of this unit it is essential that the centre can provide access to grinding, turning and milling machines. All auxiliary equipment such as that required for measuring accuracy should also be made available.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience / Workplace learning frameworks — Centre for Education and Industry (CEI -University of Warwick) — www.warwick.ac.uk/wie/cei/
- Learning and Skills Network — www.vocationallearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme — www.stemnet.org.uk
- National Education and Business Partnership Network — www.nebpn.org
- Local, regional Business links — www.businesslink.gov.uk
- Work-based learning guidance — www.aimhighersw.ac.uk/wbl.htm

Indicative reading for learners

Textbooks

Timings R L — *Manufacturing Technology* (Prentice Hall, 1998) ISBN 0582356938

Timings R L – *Basic Manufacturing* (Newnes, 2004) ISBN 0750659904

Black B J – Workshop Processes, Practices and Materials (Newnes, 2010) ISBN 0080890647

Delivery of personal, learning and thinking skills

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

Skill	When learners are …
Self-managers	managing resources effectively when using a turning machine to produce components managing work within given timescales when using a turning machine to produce components

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are …
Independent enquirers	investigating work-holding devices, tools and parameters used for a given component that has been turned.

Functional Skills — Level 2

Skill	When learners are …
ICT — Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT — Find and select information	
Select and use a variety of sources of information independently for a complex task	
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
ICT — Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: text and tables images numbers records	
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Evaluate the selection and use of ICT tools and facilities used to present information	

Skill	When learners are …
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	Obtaining information about components that are to be produced by a turning machine
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	Reporting on health and safety issues that relate to secondary machining techniques