Scheme of work – R016 Manufacturing in quantity

## About this scheme of work

**Our redeveloped Cambridge National in Engineering Manufacture J823 is for first teaching from September 2022.**

This qualification provides lots of flexibility, allowing you to find the best route to suit your centre’s needs.Our Curriculum planner shows you at a high level how you could teach the course over two or three years. Our schemes of work provide examples for how you could deliver each unit, integrating the knowledge and understanding learned in the externally assessed unit.

All schemes of work should provide an opportunity for integrating the knowledge and understanding learned from the externally assessed unit content alongside the NEA assessment content. This scheme of work provides one example for delivery of this unit. You may find that a different approach would work better in your centre. We have provided a blank template should you wish to create your own or adapt one of the approaches provided.

You’ve given us lots of feedback on what you need from a scheme of work, so we’ve made sure this resource features:

* a **unit-specific** and **lesson by lesson** approach
* **simple** and **editable** Word format – or you can use our [blank template](https://www.ocr.org.uk/Images/639549-scheme-of-work-template.docx) to create your own version
* links to our [curriculum planner’s first model](https://ocr.org.uk/Images/619713-curriculum-planner.docx) which is one teacher teaching the qualification over two years, broken down into half terms
* each lesson’s **key words**
* **ideas** for teaching and learning with useful **links**
* some ‘warm up’ teaching ideas if you’re teaching over three years.



**Our redeveloped Cambridge Nationals can be tailored to suit your needs – so this scheme of work and the lesson ideas are only suggestions.**

## Units and guided learning hours

Here is a reminder of the **three mandatory units** in the redeveloped Cambridge National in Engineering Manufacture:

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| **Unit** | **Unit title** | **Guided learning hours (GLH)** | **How are they assessed?** | **Mandatory or optional?** |
| R014 | Principles of engineering manufacture | 48 | E | M |
| R015 | Manufacturing a one-off product | 36 | NEA | M |
| **R016** | **Manufacturing in quantity** | **36** | **NEA** | **M** |

## Assumptions

* You will adapt the SOW and lesson content to match your own timetabling arrangements and will choose how to spread the 36 GLH over the two years as best fits your needs. We have worked on the basis that the average lesson time is around 45 minutes.
* Students can access some resources outside of lessons for any online homework or extension tasks.
* You will refer to the [specification](https://www.ocr.org.uk/Images/610947-specification-cambridge-nationals-engineering-manufacture-j823.pdf) as the key document for detailed insight into the qualification’s content and assessment requirements.

## **Summary of software/other equipment in this scheme of work**

* Engineering drawings of parts/components to manufacture and quality check.
* Engineering materials to manufacture parts/components (depends on manufacturing capabilities and equipment).
* Manufacturing aids (e.g. jigs, Go-No Go gauges).
* Materials to make templates (e.g. card, thin polymer sheet, etc.).
* CAD/CAM programming software compatible with CNC equipment being used, and capable of simulation.
* CNC machines(s) (e.g. laser cutter, CNC lathe, CNC mill or router, 3D printer).
* Measuring equipment for performing quality control (e.g. rules, callipers, micrometres, squares, protractors, height gauge, etc.).

## Week-by-week scheme of work with time allowed for working on NEA at end of delivery and practice.

NEA work could be undertaken in parallel with delivery to shorten total delivery and assessment time.
Term 1 can start when required (starts beginning of Year 10 in curriculum planner).

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| Term 1 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Preparing for manufacture** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA1Preparing for manufacture1.1 Manufacture and use production aids | You could begin this unit with an introduction to the context – that this is a highly practical unit in which students will learn practical skills in manufacturing in scale (including programming and operating CNC machines) and undertake a practical assessment activity.In this lesson you could:* introduce jigs, templates, and Go-No Go gauges
* recap on how to interpret engineering drawings of simple parts/components
* demonstrate how production aids are used in scale manufacturing operations
* task students to practise making production aids (e.g. measure, mark out and cut out templates).

Students will learn about jigs, templates, and other manufacturing aids in Unit R014 and so this could be used to complement this lesson. They will also learn about how to interpret engineering drawings in R014 which they will need to do throughout this unit.Students will revisit the use of production and quality control aids when undertaking practical quality control activities later in this unit. | **Jigs****Templates****Go-No Go gauges** | Recall how to use jigs, templates and Go-No Go gauges for work holding, marking out or quality control.Demonstrate how to use selected manufacturing and production aids. | [Templates, jigs and patterns - Making](https://www.bbc.co.uk/bitesize/guides/z6cbcj6/revision/2) - GCSE Design and Technology Revision - BBC Bitesize (bbc.co.uk)[Jigs and Fixtures for Machine Shops - Educational Video - YouTube](https://www.youtube.com/watch?v=CA3GnfImGmw)(video is dated but very useful)[Jigs & Fixtures - YouTube](https://www.youtube.com/watch?v=fcrbKURkWJQ) | R014Students will learn about the advantages and limitations of jigs, fixtures, templates, and moulds.R014Students will learn how to read and interpret engineering drawings. |
| 2 | TA1Preparing for manufacture1.2 Sequence of operations | For this lesson you could begin by introducing sequence of operations to students by:* showing examples of CNC-manufactured components
* explaining the sequence of operations (including at least one CNC process) required to manufacture the part/component
* demonstrating practically how the part/component is manufactured, including the CNC operations involved.

Students will revisit sequence of operations when programming, setting up and operating CNC machines throughout this unit. | **Operations (sequence of)** | Prepare a sequence of operations including at least one CNC process. | [Computer Aided Manufacturing (CAM) - YouTube](https://www.youtube.com/watch?v=FdipJNG_vV8)[CNC Work - An Introduction](https://technologystudent.com/cam/cnc1.htm) (technologystudent.com)[CNC Stages of Manufacture](https://technologystudent.com/cam/cnc2.htm) (technologystudent.com)[CNC Milling - a Complete Guide to Understand the Process](https://fractory.com/cnc-milling/) (fractory.com) | R015Students will undertake planning for a one-off product. |
| 3 | TA1Preparing for manufacture1.3 Operating parameters | In this lesson you could introduce students to how operating parameters are considered when manufacturing, including when using CNC-based equipment. This could be done by:* showing how manufacturer manuals and other published sources are used
* showing how the outputs of CAD software and simulation are used
* setting students an activity to determine the operating parameters for given operations.

Students will be required to determine and use operating parameters when programming, setting up and operating CNC machines later in this unit. | **Operating parameters** | Demonstrate how to use manufacturer manuals of other published sources to determine operating parameters for CNC equipment. | [G-Wizard Calculator Free Trial Signup 2020 - CNCCookbook: Be A Better CNC'er](https://www.cnccookbook.com/) (cnccookbook.com)[requires free sign up][Beginner's Guide to CNC Machine Setup [2019]](https://www.cnccookbook.com/cnc-machine-setup-setting-procedure-lathe-milling/) (cnccookbook.com)[does require free sign up, but has extensive CNC resources including free software] | R015Students will undertake planning for a one-off product. |
| 4 | TA1Preparing for manufacture1.4 Standard operating procedures (SOPs) | In the following two lessons you could show how Standard Operating Procedures (SOPs) are developed and used to detail the requirements for production operations.In this lesson you could:* define the term Stand Operating Procedures
* explain how SOPs are used to define the sequence of operations, and other requirements, for a production activity
* show and explain example SOPs highlighting the key features
* provide incomplete SOPs for students to complete working in groups (e.g. to add missing stages, tooling, equipment, health and safety considerations, quality control checks, operating parameters, etc.).
 | **SOPs (Standard Operating Procedures)** | Complete and review SOPs (Standard Operating Procedures). | [How to Write a Standard Operating Procedure](https://www.lucidchart.com/blog/how-to-write-a-standard-operating-procedure)(Lucidchart.com)[Standard Operating Procedures (SOPs) and Standards](http://www.advice-manufacturing.com/Standard-Operating-Procedures.html) (advice-manufacturing.com) | R015Students will undertake planning for a one-off product. |
| 5 | TA1Preparing for manufacture1.4 Standard operating procedures (SOPs) | In this lesson on SOPs you could consolidate knowledge developed so far by:* setting a SOP activity to complete, including creating a sequence of operations and using operating parameters for CNC equipment.
* tasking students, working in small groups, to peer review SOPs they have produced.

Students will revisit and review the use of SOPs as their knowledge and skills of programming, setting up and operating CNC machines, and applying quality control techniques develops throughout this unit. | **SOPs (Standard Operating Procedures)****Consolidation** | Prepare and review SOPs (Standard Operating Procedures). | [Operating procedures](https://www.hse.gov.uk/comah/sragtech/techmeasoperatio.htm) (hse.gov.uk) | R015Students will undertake planning for a one-off product. |

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| Term 2 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Developing programmes – CAD/CAM programming** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software | The next series of lessons could focus on using CAD/CAM (Computer Aided Design/Computer Aided Manufacture) software to simulate CNC manufacturing, and to produce a program for a CNC machine.In the first lesson you could:* introduce the selected CAD/CAM software
* give a demonstration of the software
* explain the steps involved with taking a drawing of a part/component, creating a simulation, and producing a CNC program.
 | **CAD drawings****CAM software** | Recall basic principles of using CAM software to program CNC machine. | [CAD-CAM Free Trial | NX CAM Software](https://trials.sw.siemens.com/nx-cam/?utm_source=google&utm_medium=cpc&utm_campaign=CAM_trial&utm_term=cam&cmpid=13197&s_&s_kwcid=AL!463!3!391560568052!b!!g!!cam%20simulation&s_kwcid=AL!463!3!391560568052!b!!g!!cam%20simulation&ef_id=EAIaIQobChMIzZOlyInK8gIVgtPtCh2wqwTIEAAYASAAEgINdPD_BwE:G:s&gclid=EAIaIQobChMIzZOlyInK8gIVgtPtCh2wqwTIEAAYASAAEgINdPD_BwE) Siemens Cloud - Siemens Digital Industries Software (trials.sw.siemens.com)[SOLIDWORKS Education](https://www.solidworks.com/solution/academia)(www.solidworks.com)[CAD/CAM Software](https://www.autodesk.com/solutions/cad-cam)(autodesk.com) - free trial sign upNote: centres will need to use the specific CAD/CAM software appropriate for their own CNC machinery | R014Students will learn how to interpret engineering drawings.R015Students will interpret engineering drawings for one-off manufacture. |
| 2  | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software | In this lesson you could look, in more detail, at how a third angle orthographic projection drawing of a component is used to program a CNC machine.You could do this by giving:* a recap on third angle orthographic projection drawings and how they are interpreted
* a demonstration of how the drawing is used to create working drawings within the CAD/CAM software, including the use of programming commands within the software
* providing practice activities for students to complete using software.

Students will acquire knowledge of how to interpret engineering drawings in Unit R014, so this lesson could complement this. | **CAD drawings****CAM software** | Use CAD/CAM software to produce program for CNC machine using supplied CAD drawing. | [Best Free CAD, CAM, & CNC Software](https://www.cnccookbook.com/free-cnc-software/)(cnccookbook.com) - free sign up required | R014Students will learn how to interpret engineering drawings.R015Students will interpret engineering drawings for one-off manufacture. |
| 3 | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software | For this lesson students could continue to practise using CAD/CAM software by:* using supplied third angle orthographic drawings of parts/components
* replicating drawings within CAD/CAM software in preparation for simulation, and programming of the CNC machine
* self- and peer reviewing each other’s work.
 | **CAD drawings****CAM software** | Use CAD/CAM software to produce program for CNC machine using supplied CAD drawing. | [Best Free CAD, CAM, & CNC Software](https://www.cnccookbook.com/free-cnc-software/)(cnccookbook.com) - free sign up required |  |
| 4 | TA2Develop programmes to operate CNC equipment2.2 Programme CNC machine operations t | In this lesson you could begin introducing students to CNC machine operations and how they are used when programming.In this lesson you could:* explain the use of datum points
* explain the significance of offsets
* explain the difference between absolute and incremental co-ordinates
* relate the use of datums and co-ordinates to how the CNC machine operates
* show how these are accommodated within the programming software
* provide practice examples using datums and co-ordinates for students to complete.

Note: the capabilities of the CNC machines being used in this unit, and the programming software, will determine which machine operations are available. You should use your judgement when delivering programming, simulation, CNC machine setup and operation lessons based on this. | **CNC machine operations****Datums****Co-ordinates** | Use datums and co-ordinates when performing CNC programming operations. | [CNC Milling Coordinate System Made Easy](https://www.autodesk.com/products/fusion-360/blog/cnc-coordinate-system-made-easy/)Fusion 360 Blog (autodesk.com)[Learn how to set the datums on a CNC machine - G54, G55](https://cncphilosophy.com/setting-the-datums-on-your-cnc-machine/) (cncphilosophy.com)[Setting the Datum on a CNC Machine](https://www.practicalmachinist.com/videos/g-code-tutorials/setting-the-datum-on-a-cnc-machine/)(practicalmachinist.com)  | R014Students will learn how to interpret engineering drawings.R015Students will interpret engineering drawings for one-off manufacture. |
| 5 | TA2Develop programmes to operate CNC equipment2.2 Programme CNC machine operations | For this lesson you could continue with CNC programming operations by looking at:* sequence of operations
* tool changeover.

This could be done by:* showing how CNC machines operate based on a sequence of operations
* explaining how CNC machines can have multiple tools, and how too changeover is achieved
* demonstrating how this is programmed using CAD/CAM software
* providing practice examples for students to program a simple sequence of operations and implement tool changeovers.
 | **CNC machine operations****Tool changeover** | Use tool changeover when performing CNC programming operations. | [CNC Tool Changers, Operation and Alignment - YouTube](https://www.youtube.com/watch?v=7wE6zOkPbHw)[Understanding Tool Change Command - YouTube](https://www.youtube.com/watch?v=x_DNhu06_mg)[Loading Tools Into the Spindle: CNC Training Series - YouTube](https://www.youtube.com/watch?v=kkGQuBYEGMM) | R014Students will learn how to interpret engineering drawings.R015Students will interpret engineering drawings for one-off manufacture. |

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| Term 3 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Programming CNC operations/CNC machine operation** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA2Develop programmes to operate CNC equipment2.2 Programme CNC machine operations | In this lesson you could continue to explore programming operation, looking at:* tool offsets.

As in previous lessons on programming operations, this could be done by:* explaining how CNC machines operate based on tool offsets
* demonstrating how this is programmed and displayed using CAD/CAM software
* providing practice examples for students to use or interpret tool offsets to program a CNC machine.
 | **CNC machine operations****Tool offsets** | Use tool offsets when performing CNC programming operations.Know how to export information from CAM software to NC machine. | [Lesson 5: Everything about CNC Tool Length Offsets. Positive and Negative (G43 g-code, H offset)](https://zero-divide.net/?&article_id=4768_lesson-5-everything-about-cnc-tool-length-offsets-positive-and-negaive-g43-g-code-h-offset) - HSM Advisor(zero-divide.net)[Machining Fundamentals: Tool Length Offset - YouTube](https://www.youtube.com/watch?v=AAnfchymXnE) | R014Students will learn about the advantages and limitations of CAM machines. |
| 2  | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software2.2 Programme CNC machine operations | In this lesson you could introduce on-screen simulation of CNC operations using CAD/CAM software.You could do this by:* recapping the use of programming software to program a CNC machine
* demonstrating how the software (and any complementary software needed) can be used to perform an on-screen simulation
* explain how the simulation is used to check for correct and efficient operation before operating the physical CNC machine
* provide practice activities for students to perform simulations.
 | **CAM software****On-screen simulation**  | Consolidate knowledge of using CAM software to program CNC machine including on-screen simulation. | [Fusion 360 Machine Simulation - Get the basics - YouTube](https://www.youtube.com/watch?v=JFPHMw78V94)[CAD/CAM software for CNC machines, laser cutters & engravers](https://www.boxford.co.uk/software) (boxford.co.uk)CAD/CAM specialists - [Denford Ltd](http://website.denford.ltd.uk/)(denford.ltd.uk)Note: centres will need to use the specific CAD/CAM simulation software appropriate for their own CNC machinery | R014Students will learn about the advantages and limitations of CAM machines. |
| 3 | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software2.2 Programme CNC machine operations | For this lesson on simulation, students could continue to practise using CNC programming software and performing simulations.You could get students to:* use supplied third angle orthographic projection drawings of parts/components
* replicate drawings within CAD/CAM software (or starting with previously prepared representations in the software)
* use programming operations and instructions to program a CNC machine
* perform on-screen simulations
* self- and peer review each other’s work.
 | **CAM software****On-screen simulation** | Consolidate knowledge of using CAM software to program CNC machine including on-screen simulation. | [Fusion 360 Machine Simulation - Get the basics - YouTube](https://www.youtube.com/watch?v=JFPHMw78V94)[CAD/CAM software for CNC machines, laser cutters & engravers](https://www.boxford.co.uk/software) (boxford.co.uk)CAD/CAM specialists - [Denford Ltd](http://website.denford.ltd.uk/)(denford.ltd.uk)Note: you will need to use the specific CAD/CAM simulation software appropriate your centre’s own CNC machinery. | R014Students will learn about the advantages and limitations of CAM machines. |
| 4 | TA2Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software2.2 Programme CNC machine operations | In this final lesson on programming and simulation, students could continue to practise using CAM software for CNC programming and simulation.In this lesson you could also:* introduce how the finished program is transferred/exported to the CNC machine
* demonstrate the export of the program
* provide practice activities to allow students to export their own programs to a CNC machine.
 | **CAM software****On-screen simulation****Exporting information** | Consolidate knowledge of using CAM software to program CNC machine including on-screen simulation. | [From CAD to CAM From a dxf drawing file to G code program I need for my small cnc lathe. - YouTube](https://www.youtube.com/watch?v=mgJA-aJFDHU)Note: centres will need to demonstrate the export process from CAD/CAM software to CNC machine for their particular setup | R014Students will learn about the advantages and limitations of CAM machines. |
| 5 | TA3Safely use processes and equipment to make products in quantity3.1 Setting up of CNC equipment | Over the next series of lessons, students could be shown how to safely setup and operate a CNC machine.In this lesson you could:* show the CNC machine(s) to be used
* explain the key parts and features of the CNC machine
* explain safety features and requirements when setting up and operating the CNC machine
* undertake a simple risk assessment activity, including the use of preventative measures (e.g. PPE)
* set an activity for students to complete to familiarise themselves with the CNC machine, and safety procedures.

Students will return to machine safety and safe set up and operation of a CNC machine throughout this unit, and when they undertake the assessment activity. | **CNC machine safety****Risk assessment** | Prepare for the safe use of CNC machines. | [Health and safety in engineering](https://www.hse.gov.uk/engineering/)(hse.gov.uk)- includes a booklet of health and safety in the engineering workshop to download[Managing risks and risk assessment at work – Overview - HSE](https://www.hse.gov.uk/simple-health-safety/risk/index.htm)(hse.gov.uk)[What are the five steps to risk assessment?](https://worksmart.org.uk/health-advice/health-and-safety/hazards-and-risks/what-are-five-steps-risk-assessment)(worksmart.org.uk) | R015Students will undertake risk assessments when preparing to use manufacture one-off components. |

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| Term 4 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **CNC machine operation** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA3Safely use processes and equipment to make products in quantity3.1 Setting up of CNC equipment | In this lesson you could focus in more detail on setting up the CNC machine, looking at:* tooling.

You could do this by:* explaining the tooling available on the selected CNC machine
* demonstrating how the tooling is set up on the CNC machine
* relating tooling and tool changes (if applicable) to programming the CNC machine
* providing practice activities for students to select and set up tooling on a CNC machine.
 | **CNC machine safety****Risk assessment****Tooling** | Safely set up tool holding on a CNC machine. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. | R014Students will learn about levels of automation in scale manufacturing.R015Students will undertake risk assessments when preparing to use manufacture one-off components. |
| 2  | TA3Safely use processes and equipment to make products in quantity3.1 Setting up of CNC equipment | For this lesson, you could continue with CNC machine setup, looking at:* work holding.

You could do this by:* explaining the methods for work holding on the selected CNC machine
* demonstrating how work holding is set up on the CNC machine
* providing practice activities for students to set up work holding on a CNC machine.
 | **Work holding** | Safely set up work holding on a CNC machine. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 3 | TA3Safely use processes and equipment to make products in quantity3.1 Setting up of CNC equipment | In this final lesson on safely setting up a CNC machine you could look at:* setting datums.

This could be done by:* explaining how datums are set up on the selected CNC machine.
* demonstrating how to set up datums on the CNC machine.
* relating datums on the CNC machine to CNC programming.
* providing practice activities for students to set up datums on a CNC machine.
 | **Setting datums** | Setup datums on a CNC machine. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 4 | TA3Safely use processes and equipment to make products in quantity3.2 Operating CNC equipment | The following block of lessons could be reserved to give students the opportunity to program, set up and operate CNC machines.Students could, for the selected programming software and CNC machine(s):* use third angle orthographic projection drawings pf parts/components to create and simulate a CNC program
* export the program
* safely set up the machine
* safely operate the CNC machine
* receive feedback
* self- and peer review the parts/components made.

Note that practical activities must always be undertaken under supervised and safe conditions.You could use components manufactured by CNC machine later in this unit as the items for performing quality control on. | CNC practical work | Demonstrate safe use of CNC machine to manufacture components. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 5 | TA3Safely use processes and equipment to make products in quantity3.2 Operating CNC equipment | Students could continue to program, safely setup and operate CNC machines in this lesson. | CNC practical work | Demonstrate safe use of CNC machine to manufacture components. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |

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| Term 5 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **CNC machine operation/Applying quality control** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA3Safely use processes and equipment to make products in quantity3.2 Operating CNC equipment | Students could continue to program, safely setup and operate CNC machines in this lesson. | CNC practical work | Demonstrate safe use of CNC machine to manufacture components. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 2  | TA3Safely use processes and equipment to make products in quantity3.2 Operating CNC equipment | Students could continue to program, safely setup and operate CNC machines in this lesson. | CNC practical work | Demonstrate safe use of CNC machine to manufacture components. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 3 | TA3Safely use processes and equipment to make products in quantity3.2 Operating CNC equipment | Students could continue to program, safely setup and operate CNC machines in this lesson. | CNC practical work | Demonstrate safe use of CNC machine to manufacture components. | Setup and safe operation of CNC machines(s) will be specific to the resources available within your centre. |  |
| 4 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture  | In the final series of lessons, you could introduce quality control techniques, the measuring devices required to perform quality control checks and the use of statistical methods.In this first lesson you could:* give an overview of quality control and its significance in scale manufacturing
* highlight different techniques for applying quality control
* explain and show how to compare the dimensional information on engineering drawings when applying quality control methods
* demonstrate how to use Go-No Go gauges to check the quality of a part/component
* provide practice activities for students to use Go-No Go gauges (they could check parts they have previously manufactured in this unit or in Unit R015).

Students should already be familiar with Go-No Go gauges covered as part of production aids used in scale manufacturing elsewhere in this unit, and from unit R014. | Quality controlGo-No Go gauges | Apply quality control techniques to components – Go-No Go gauges. | [Go / No-Go Gages | Slater Tools - YouTube](https://www.youtube.com/watch?v=Tm8Wqq7Jql0)[Year 10 Manufacturing (Resistant Materials) L11 Clock gauges](https://design-technology.org/CDT10gauge.htm) (design-technology.org) | R014Students will learn about quality control techniques and how to measure parts.R15Students will use measuring equipment when marking out. |
| 5 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | For this lesson you could introduce the use of measuring equipment used to measure linear and angular dimensions e.g.* steel rule
* square
* protractor
* vernier calliper
* micrometre.

You could do this by:* showing how to use selected measuring equipment
* explaining how to record and compare the outcomes of quality checks with the dimensional requirements of engineering drawings
* providing practice activities for students to complete (i.e. engineering drawings of parts/components along with physical parts for quality checking)
* giving feedback on accuracy of outcomes
* student self- and peer review of the measurements and comparisons made.
 | Quality controlMeasuring devices | Apply quality control techniques to components using selected measuring devices. | [Top-10 Mechanical Measuring Instruments](https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/)(gaugehow.com) | R014Students will learn about quality control techniques and how to measure parts.R15Students will use measuring equipment when marking out. |

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| Term 6 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Applying quality control** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | In this lesson, students could continue to practise using measuring equipment to perform quality control checks on parts/components.Students could:* interpret the dimensional requirements of supplied engineering drawings
* use measuring equipment to measure the corresponding dimensions on physical parts
* use suitable methods to record and compare readings.
 | **Quality control****Measuring devices** | Apply quality control techniques to components using selected measuring devices. | [Top-10 Mechanical Measuring Instruments](https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/)(gaugehow.com) | R014Students will learn about quality control techniques and how to measure parts.R15Students will use measuring equipment when marking out. |
| 2  | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | The following two lessons could be used for students to continue practising using quality control methods including the use of:* Go-No Go gauges
* measuring devices.
 | **Quality control**Practical work | Consolidate knowledge of quality control using selected measuring devices to check components against dimensional requirements. | [Top-10 Mechanical Measuring Instruments](https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/)(gaugehow.com) | R014Students will learn about quality control techniques and how to measure parts.R15Students will use measuring equipment when marking out. |
| 3 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | Students could continue to practise applying quality control techniques in this lesson. | **Quality control**Practical work | Consolidate knowledge of quality control using selected measuring devices to check components against dimensional requirements. | [Top-10 Mechanical Measuring Instruments](https://gaugehow.com/2019/05/26/mechanical-measuring-instruments/)(gaugehow.com) | R014Students will learn about quality control techniques and how to measure parts.R15Students will use measuring equipment when marking out. |
| 4 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | For the remaining taught lessons in this unit, you could introduce SPC (Statistical Process Control) methods used in quality control. In this lesson you could:* introduce SPC and its applications in quality control
* show example data and charts for components with and without quality issues
* explain how SPC data is used to create SPC charts and how these are interpreted
* set practice SPC activities for students to complete.

Note that students are not required to create control charts or perform process calculations but are required to enter data onto the control chart and identify if any interventions are required. | **SPC (Statistical Process Control)** | Recall how to use SPC to determine the quality of selected components. | [Honda Statistical Process Control - YouTube](https://www.youtube.com/watch?v=Sdj-8ZBYYmo) | R014Students will learn about quality assurance techniques. |
| 5 | TA3Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | In this final taught lesson, students could continue to use SPC charts to determine if interventions are required.You could provide SPC charts for analysis where:* no interventions are required due to good part/components quality
* interventions can be identified due to unacceptable part/component quality.
 | **SPC (Statistical Process Control)** | Use SPC to determine the quality of selected components, identifying is interventions are required. | [OCR Cambridge Technicals in Engineering- lesson element on Inspection and testing](https://www.ocr.org.uk/Images/256725-spc-moving-range-charts-teacher-instructions-.pdf)With student activity sheet [SPC – moving range charts](https://www.ocr.org.uk/Images/256726-spc-moving-range-charts.docx)And [moving average and moving range charts data](https://www.ocr.org.uk/Images/256727-spc-moving-range-charts-data-.xls)(orc.org.uk)Note: although developed for Cambridge Technicals Engineering Unit 19 (Inspection and testing), the SPC charts and data in the spreadsheet in these links could be used to for simpler analysis | R014Students will learn about quality assurance techniques. |

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| Term 7 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Working on OCR-set assignment (supervised)** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Working on OCR-set assignment Tasks | You could reserve a block of lessons for students to work on the Tasks within the OCR-set assignment. Alternatively, students could use this time to complete relevant assessment Tasks interleaved with other taught and practice lessons.Time allowed for working on the OCR-set assignment is typically 10-12 hours.Students must be supervised for safety purposes when undertaking any practical assessment work.In an early lesson you could:* introduce students to the OCR-set assignment brief and associated Tasks
* explain the marking criteria and how students will be assessed
* hold a class discussion to confirm the exact requirements for each Task
* task students, working in small groups, to review and discuss the Set Assignment brief and confirm how they will produce and present evidence for assessment.
 |  | Understand the OCR-set assignment brief including Tasks and marking criteria.Understand how to record and present evidence for assessment. | Access resources via the OCR [qualification home page](https://www.ocr.org.uk/qualifications/cambridge-nationals/engineering-manufacture-level-1-2-j823/) including:* OCR-set assignment briefs
* sample assessment materials
* candidate exemplars
* supporting the moderation process (online training)
* examiner and moderator reports (for past series, after first assessment in 2024).

(ocr.org.uk)Note – some of the above resources will become available as the qualification develops. |  |
| 2 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 3 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 4 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 5 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |

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| Term 8 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Working on OCR-set assignment (supervised)** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 2  | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 3 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 4 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 5 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |

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| Term 9 |
| **Summary of what you will cover from the** [**curriculum planner**](https://www.ocr.org.uk/Images/619713-curriculum-planner.docx)**:** | **Working on OCR-set assignment (supervised)** |

| Lesson no. | Topic areas/sub topic areas  | Lesson ideas and activities | Lesson key words | Lesson outcome(s)At the end of the lesson, students will be able to: | Useful links/resources | How does this link to other units? |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 2  | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 3 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 4 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |
| 5 | Working on OCR-set assignment Tasks |  Working on Tasks continues. |  |  |  |  |

## Teaching over three years

Some centres may choose to start their delivery of the qualification earlier in Year 9, and so deliver over three years. The following topic areas are suggestions of what could form part of early delivery.

| **Topic area** | **Warm up/introductory activities** | **Length of time activity may take** |
| --- | --- | --- |
| TA1 Preparing for manufacture1.4 Standard operating procedures (SOPs) | You could show students how to develop a Standard Operating Procedure (SOP) for an activity, and practise producing their own SOPs. These do not necessarily need to relate to manufacturing in scale and could be daily activities such as boiling a kettle or using a washing machine. You could use or develop a simple SOP template for students to use. Tip - You can find some examples online by searching for ‘SOP template’. | 3-4 hours with additional time for students to develop their own SOPs. |
| TA2 Develop programmes to operate CNC equipment2.1 Use Computer Aided Design (CAD) software2.2 Programme CNC machine operations | Students could start to develop their skills at using CAD/CAM software to program a CNC machine. You could introduce simple activities for them to do, such as programming for engraving or laser cutting their initials into a piece of material, turning a simple shape or 3D printing a keyring with their initials. They could also perform simulation activities within software. | 5-6 hours with additional time to complete a programming activity. |
| TA3 Safely use processes and equipment to make products in quantity3.1 Setting up of CNC equipment 3.2 Operating CNC equipment | Students could take the items programmed in the previous warm up activity, and with support and guidance manufacture these using a CNC machine. This could include being shown under supervision how to safely set up and operate the machine, exporting their own program to the machine, and manufacturing a part/component. | 5-6 hours with additional time to manufacture a part using a CNC machine. |
| TA3 Safely use processes and equipment to make products in quantity3.3 Apply quality control methods for volume manufacture | You could introduce students to quality control and simple quality control methods. They could use basic measuring equipment (e.g. steel rule, vernier calliper) to take measurements from supplied components and compare these with the corresponding dimensions shown on an engineering drawing. Examples could include components where the dimensions of features pass or fail quality control (tolerance) requirements. | 3-4 hours with additional time to perform quality checks of components. |

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