Cambridge NATIONALS

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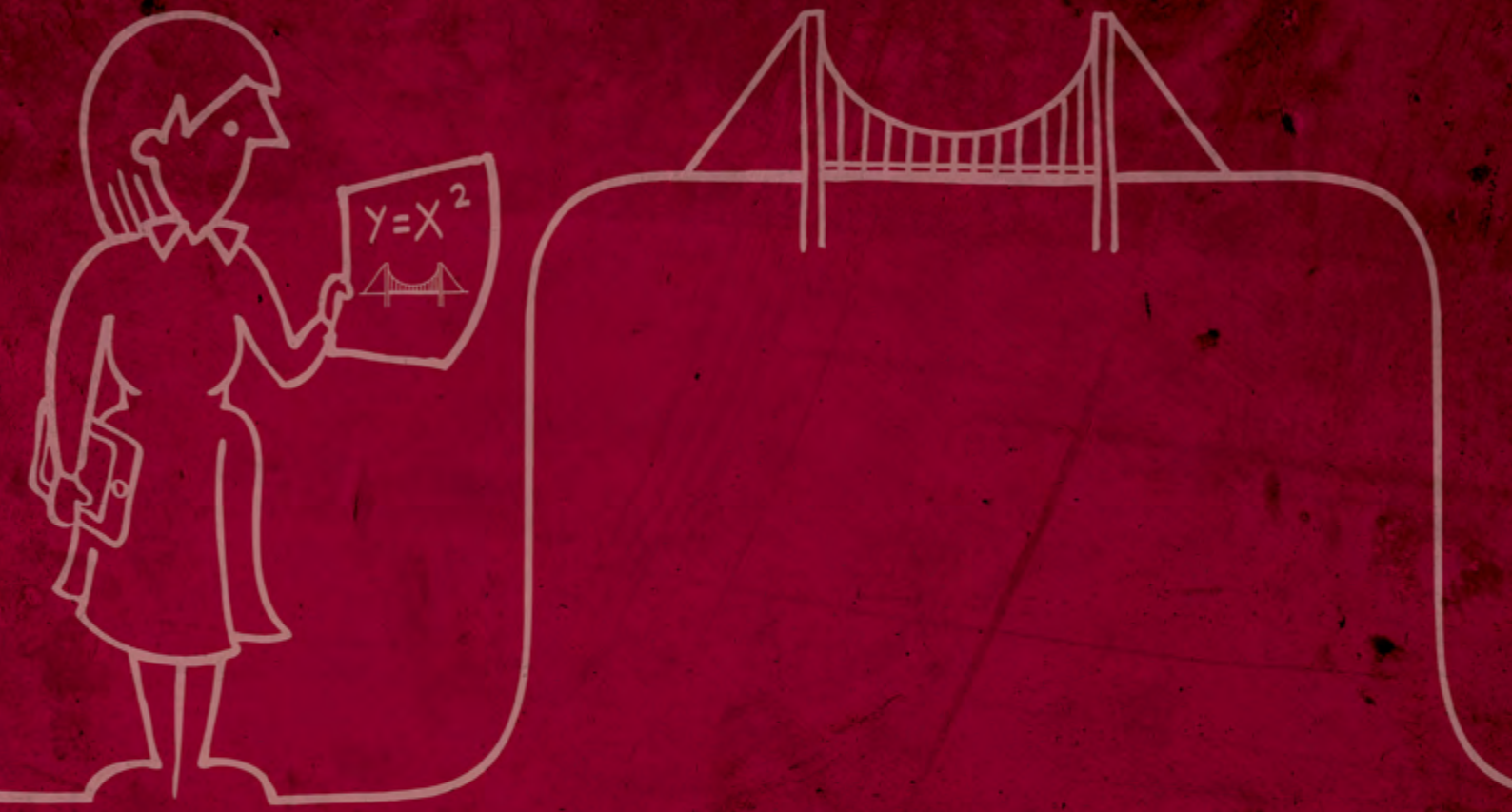


# CAMBRIDGE NATIONALS IN ENGINEERING

## R111 - COMPUTER AIDED MANUFACTURING

## DELIVERY GUIDE

VERSION 1

OCR
Oxford Cambridge and RSA

# CONTENTS



To give us feedback on, or ideas feedback text the OCR resources you have used, email resourcesfeedback@ocr.org.uk

# INTRODUCTION

This Delivery Guide has been developed to provide practitioners with a variety of creative and practical ideas to support the delivery of this qualification. The Guide is a collection of lesson ideas with associated activities, which you may find helpful as you plan your lessons.

OCR has collaborated with current practitioners to ensure that the ideas put forward in this Delivery Guide are practical, realistic and dynamic. The Guide is structured by learning objective so you can see how each activity helps you cover the specification.

We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

Whether you are an experienced practitioner or new to the sector, we hope you find something in this guide which will help you to deliver excellent learning opportunities.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk.

## PLEASE NOTE

The activities suggested in this Delivery Guide MUST NOT be used for assessment purposes. (This includes the Consolidation suggested activities).

The timings for the suggested activities in this Delivery Guide DO NOT relate to the Guided Learning Hours (GLHs) for each unit.

Assessment guidance can be found within the Unit document available from www.ocr.org.uk.

The latest version of this Delivery Guide can be downloaded from the OCR website

## OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT

We believe that being able to make good progress in English and maths is essential to learners in both of these contexts and on a range of learning programmes. To help you enable your learners to progress in these subjects, we have signposted opportunities for English and maths skills practice within this resource. These suggestions are for guidance only. They are not designed to replace your own subject knowledge and expertise in deciding what is most appropriate for your learners.

## KEY

English

Maths

# UNIT R111 – COMPUTER AIDED MANUFACTURING

Guided learning hours : 30

## PURPOSE OF THE UNIT

This unit covers computer applications in the design and manufacture of engineered products. Learners will produce CAD drawings of a product to produce a batch of Computer Numerical Control (CNC) manufactured examples. Also, learners will understand how computer control can be used in the high-volume/mass production of engineered products.

Learners will develop knowledge and understanding of computer applications in the design and manufacture of engineered products and know the procedures for setting up CNC equipment to produce a batch of products to required specification. Learners will also investigate methods used to compare items manufactured by manually controlled and CNC production.

On completion of this unit, learners will be able to use computer applications to manufacture engineered products and produce CAD drawings of a product. Learners will understand how computer control is used to produce engineered products in high-volume.

| **Learning Outcome — The learner will:** |
|---|
| LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines |
| LO2: Be able to interpret information from CAD to manufacture components on CNC equipment |
| LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components |
| LO4: Know about applications of computer control processes used to manufacture products |

# LO1 - BE ABLE TO PLAN THE PRODUCTION OF COMPONENTS ON COMPUTER NUMERICAL CONTROL (CNC) MACHINES

| Learning Outcome — The learner will: |
|---|
| LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 1 Planning CNC machining: planning operations and sequence  | The teacher might begin with a discussion of how engineered components can be produced by Computer Numeric Control (CNC) machines including the benefits of fast, accurate and repeatable manufacture. Learners could be asked to consider, for a given engineered component, how it could be CNC machined (eg the processes involved) and the tooling and sequence of operations required. The teacher could further explain how this is achievable with CNC machines. The use of suitable internet videos showing CNC machining in operation, including tool changes, might be useful. The planning process could be developed throughout LO1 for an actual component into its manufacture by CNC in LO2 and LO3. A thematic approach might be adopted and the component could be one that has previously been hand-produced in R110. | 1 hour | |
| 2 Planning CNC machining: type of machine  | The teacher could use suitable internet sources and videos to demonstrate to leaner's a range of CNC machining operations including milling, turning and fabrication. The following video shows CNC milling: https://www.youtube.com/watch?v=9rIwyGOPb0o The teacher could develop an activity where learners match and justify the CNC process appropriate for manufacturing given engineered components. If possible, an industrial visit could be used to show learners the application of different types of CNC manufacture. | 1 hour | R106 (LO1) |
| 3 Planning CNC machining: scale of manufacture  | Learners could be asked to consider and compare, as a research activity, CNC machining operations against manual engineering techniques for one-off, batch and mass production of engineered components. Suitable internet videos might be used as an introduction (eg http://www.youtube.com/watch?v=DTWnQDAhp9k which shows job, batch and flow production taking place). Learners could justify the use of automatic (CNC) machining for a range of machining techniques (eg milling, turning, fabrication) against manual manufacturing in terms of the minimisation of waste. | 1 hour | R106 (LO1) |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 4 Planning CNC machining: tools  | The teacher could further develop the CNC planning process by introducing learner's to machine setting and machining tools. Learners could research and explain the application of:<br>Setting tools: eg spanners, allen keys, clamps.<br>Machining tools: eg drills, turning tools, end mills.<br>Cutting tools: eg cutting blades, CNC router.<br>The teacher may be able to show leaner's setting tools and machining tools in a practical setting. | 2 hours | |
| 5 Planning CNC machining: materials  | Materials selection and 'speeds and feeds' form a natural extension to understanding the application of cutting tools in CNC machines. The teacher might introduce learners to a range of materials and cutting tools and explain their relationship to cutting speed and rate of tool feed for efficient and safe operation. Internet sources may prove useful in explaining this relationship eg http://en.wikipedia.org/wiki/Speeds_and_feeds (speeds and feeds).<br>Teachers could further develop learners understanding through simple calculations of spindle speed and cutter feed rate for a range of scenarios. (see http://www.hsmworks.com/docs/cncbook/en/#Ch03_CuttingSpeedsAndFeedsFormulas for examples)<br>Simple online speeds and feeds calculators might prove useful. See Lesson Element: Planning CNC machining materials. | 2 hours | R103 (LO1) |

# LO2 - BE ABLE TO INTERPRET INFORMATION FROM CAD TO MANUFACTURE COMPONENTS ON CNC EQUIPMENT

| Learning Outcome — The learner will: |
|---|
| LO2: Be able to interpret information from CAD to manufacture components on CNC equipment |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 1 Uses of CAD in CNC machining  | Learners may have already been exposed to CAD software to draw engineering components. If not, then the teacher might begin with a basic introduction to CAD with a supplied drawing. A thematic approach might be adopted and the drawing might be that for a component hand-produced in R110 that could be CNC machined. The teacher might explain and demonstrate how a CAD drawing can be exported from the CAD software package to a CNC machine in order to manufacture the component. Learners will further be introduced to CNC programming throughout LO2 and LO3.<br><br>The teacher could introduce learners to on-screen CNC simulation using suitable software eg http://cncsimulator.info/ (free simulator software) and http://website.denford.ltd.uk/software-menu (Denford simulation software).<br><br>A practical approach to exporting CAD drawings to CNC will most likely be useful in developing understanding. | 3 hours | R107<br>R108<br>R110 (LO1)<br>R115 (LO1) |
| 2 CNC programming operations  | Teachers might further develop learners' skills at understanding how CNC machines are programmed by introducing: setting datum points, co-ordinate systems (absolute and incremental), tool change-over, tool offsets, and programming language (G-codes). Internet resources might prove useful in explaining these concepts eg http://www.cnccookbook.com/CCCNCGCodeCourse.htm which explains basic CNC programming.<br><br>Learners could practice simple CNC programming using an on-screen simulator before moving onto using an actual CNC machine in LO3. See Lesson Element: CNC programming operations. | 3 hours | |

# LO3 - BE ABLE TO SET-UP AND USE COMPUTER NUMERICAL CONTROL (CNC) EQUIPMENT TO MANUFACTURE COMPONENTS

| Learning Outcome — The learner will: |
|---|
| LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 1 Setting up CNC equipment  | Teachers and learners may adopt a practical approach throughout this Learning Outcome by safely settling up and using a CNC machine. A thematic approach might be adopted and the component to be CNC manufactured could be identical to one hand-produced in R110. Procedures for setting up of the CNC machine will probably include tooling, work holding, the computer interface and health and safety procedures. | 2 hours | R110 |
| 2 Using CNC equipment  | A practical approach will most likely be taken here with the learner setting up and using a CNC machine under teacher guidance. Learners might produce, using the CNC machine, a batch of engineered components to be compared to a component manufactured manually (eg with a hand-produced component from R110).<br>The CNC machining process will most likely include: initial setting up, safe use - recognising potential hazards and the use of Personal Protective Equipment. Learners could undertake a simple risk assessment before using the CNC machine. | 7 hours | R110 |
| 3 Comparing CNC and manually produced items  | Once a batch of CNC components has been manufactured, these could be compared against one another and against a hand-produced component (eg from R110). Methods used to compare the components will most likely include: visual (surface finish), dimensional (accuracy and tolerances), cycle time (assembly) and consistency (batch tolerance). Teachers might explain and demonstrate how to undertake these checks (including introducing appropriate test and measurement equipment and techniques). Learners might tabulate their findings and draw conclusions. | 3 hours | R110 (LO1)<br>R112 (LO2) |

# LO4 - KNOW ABOUT APPLICATIONS OF COMPUTER CONTROL PROCESSES USED TO MANUFACTURE PRODUCTS

| Learning Outcome — The learner will: |
|---|
| LO2: Know about applications of computer control processes used to manufacture products |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 1 Computer controlled manufacturing: rapid prototyping and additive manufacturing  | Teachers might have access to rapid prototyping facilities that could be demonstrated and investigated by learners. The use of internet videos might be useful to show a range of rapid prototyping and additive manufacturing techniques in operation including: laminating, 3D printing, stereo lithography and laser sintering. The following videos show stereo lithography and laser sintering: https://www.youtube.com/watch?v=BUfh5wxj3qA (stereo lithography) https://www.youtube.com/watch?v=wD9-QEo-qDk (laser sintering).<br>Learners could independently research and compare a range of commercial rapid prototyping and additive manufacturing techniques, and present their findings as a presentation or poster. | 1 hour | R108<br>R109 |
| 2 Computer controlled manufacturing: CNC machining  | Learners could extend their research of commercial manufacturing to consider advanced applications of CNC machining. If possible, an industrial visit could be used to demonstrate a range of CNC machining techniques. Internet videos may prove useful to show a range of techniques which learners could investigate, describe and compare. The following video shows multi-axis CNC machining: https://www.youtube.com/watch?v=CqePrbeAQoM | 1 hour | |
| 3 Computer controlled manufacturing: robotics  | Learners could complete their research of commercial computer controlled manufacturing processes by investigating the application of robotics in welding, riveting, pick-and-place assembly and other applications. If possible, an industrial visit could be used to demonstrate robotics in operation, or alternatively internet videos could be used (eg https://www.youtube.com/watch?v=IfojHo9cVOk<br>Learners could research the range of types of industrial robot available, the differences in their operation and capabilities, and typical functions they perform. See Lesson Element: Computer controlled manufacturing robotics | 1 hour | |

| Suggested content | Suggested activities | Suggested timings | Possible relevance to |
|---|---|---|---|
| 4 Computer controlled manufacture and scales of production  | If possible, an industrial visit could be used to highlight a range of commercial production methods including one-off, batch and mass production. Automatic (CNC) and manual production methods could also be identified. If a visit is not possible then suitable videos could be shown to learners of manufacturing taking place (eg http://www.youtube.com/watch?v=DTWnQDAhp9k which shows job, batch and flow production taking place). A case study approach could be adopted for a particular engineered product (eg the motor car) where learners could independently research the range of commercial production methods using CNC that are employed in its manufacture and present their findings. | 1 hour | R106 (LO1) |

# POSSIBLE INTERNET SOURCES

| Source | Website |
|---|---|
| CNC CookBook | www.cnccookbook.com |
| CNC Simulator (free) | cncsimulator.info |
| Denford (simulator) | website.denford.ltd.uk/software-menu |
| Wikipedia | en.wikipedia.orgf |
| YouTube | www.youtube.com |

## Contact us

Staff at the OCR Customer Contact Centre are available to take your call between 8am and 5.30pm, Monday to Friday.


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