Cambridge NATIONALS

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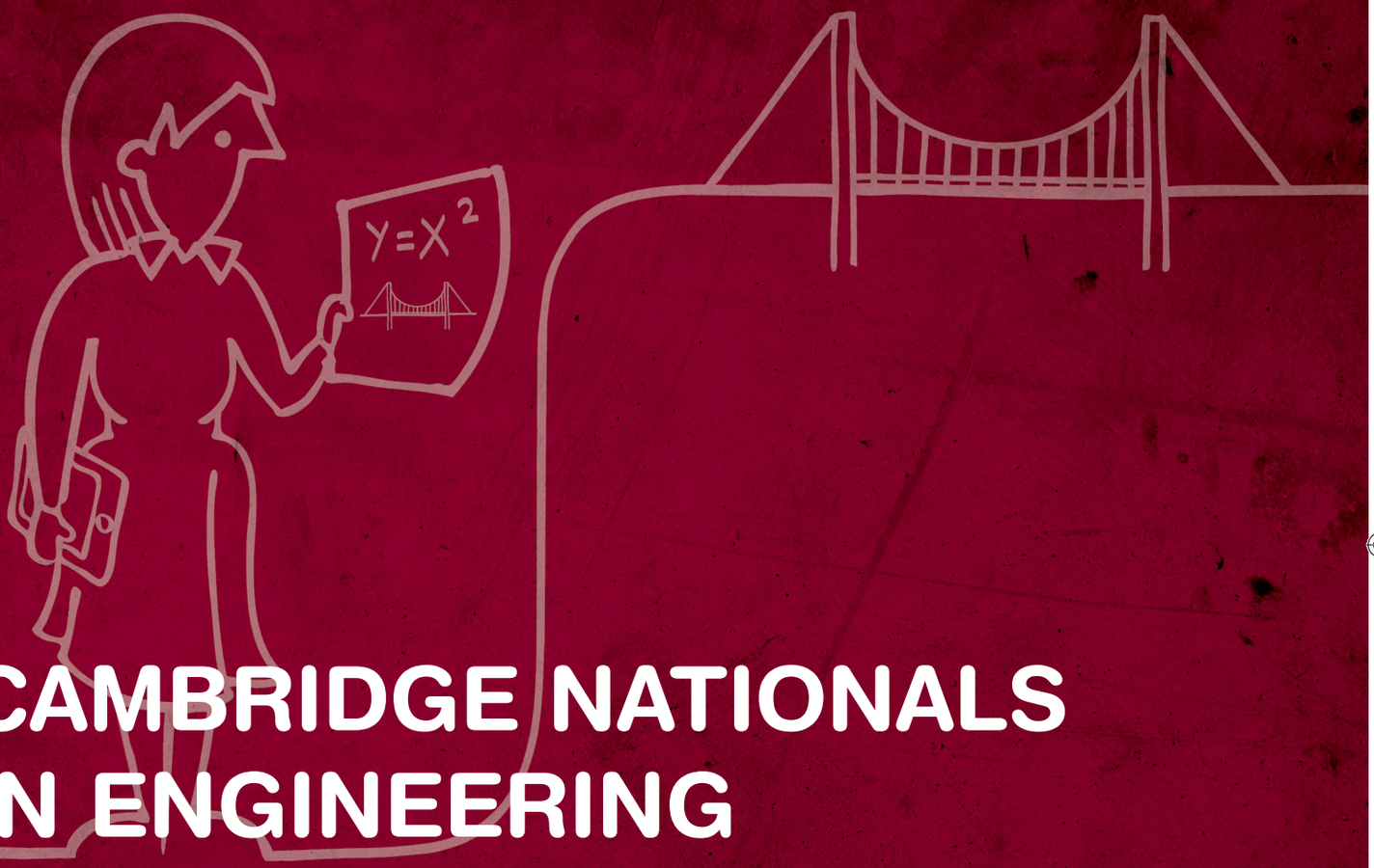


CAMBRIDGE NATIONALS IN ENGINEERING

A PROJECT APPROACH TO DELIVERY

Powering the Future - Principles in Engineering and Engineering Business

Energy Transformation - Engineering Manufacture

Energy Recovery - Engineering Design

SMART Homes - Systems Control in Engineering

LEVEL 1/2

VERSION 1

In partnership with

SIEMENS

OCR
Oxford Cambridge and RSA

CONTENTS

SUMMARY - SIEMENS PROJECT APPROACH

Created to bring together Cambridge Nationals in Engineering and Siemens Education

The purpose of this guide is to show how you could deliver Cambridge Nationals in Engineering Level 1/2 in conjunction with Siemens Education through innovative and creative projects supported by core subjects like maths and science – a holistic approach.

These projects can be delivered in conjunction with other resources available on the OCR and Siemens websites.

http://www.siemens.co.uk/education

Principles in Engineering
http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/

Engineering Design
http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-design-level-1-2-award-certificate-j831-j841/

Engineering Manufacture
http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-manufacture-level-1-2-award-certificate-j832-j842/

Systems and Control
http://www.ocr.org.uk/qualifications/cambridge-nationals-systems-control-in-engineering-level-1-2-award-certificate-j833-j843/

Teaching and learning resources for each Cambridge National in Engineering:

- Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the teaching and learning resources for each Cambridge National in Engineering to enhance teaching and learning of each Siemens project approach.

A FEW GOOD REASONS TO WORK WITH OCR AND SIEMENS

OCR and Siemens have built specifications and resources using a clear and easy-to-understand format, making them straightforward to deliver.

Cambridge Nationals provide an ideal foundation for students to progress to more advanced studies and engineering-related careers.

You can enjoy teaching engineering through projects that have been developed to help you inspire students of all abilities.

These resources provide learning for assessment and are clearly presented and sensibly structured for you and your students

Working in partnership to support you – together with Siemens we've developed a range of practical help and support to save you (the teacher) time. We provide everything you need to teach engineering at KS4 with confidence and to ensure that your students get the best from the programme of learning.

OCR will continue to work to provide new innovative support products and training – to help you get started, prepare to teach and share best practice.

OCR CAMBRIDGE NATIONALS IN ENGINEERING

The UK is in the business of high added value, high technology, sustainable engineering and manufacturing. We listened to, and worked closely with, employers such as JCB, Siemens and Rolls-Royce, and professional bodies like the Royal Academy of Engineering, as well as the University of Northampton and teachers from schools and University Technical Colleges (UTCs), to make sure that the next generation of young engineers is equipped with the skills demanded by employers in the engineering community. Cambridge Nationals deliver these skills across the whole range of learning styles and abilities, effectively engaging and inspiring all students to achieve great things.

The Cambridge Nationals in Engineering provide sufficient breadth to maintain the skills central to engineering while also allowing specialist skills to be developed. There are four separate GCSE-sized qualifications, in the areas of engineering principles, design, manufacture and systems control.

They can be delivered separately or in any combination to suit individual student needs.

A word about Siemens

As a leading global engineering and technology services company, Siemens provides innovative solutions to the world's major challenges. In the UK we have a significant presence with 13 manufacturing sites and more than 25 major offices employing over 13,730. The skills and aspirations of young people leaving the UK education system and entering the world of work is therefore of vital importance to our business.

In 2015, Siemens UK will recruit and train 400 apprentices and will employ approximately 100 graduate trainees each year across nine business sectors. Ensuring the calibre and experience of these young people is a challenge we do not face alone; research indicates that engineering companies will need 1.86 million people with engineering skills between 2010 and 2020. These statistics mean that the UK needs to double the numbers of engineering-related apprentices and graduates coming out of colleges and universities to fill the recruitment pipeline.

We were therefore delighted to be approached by OCR to partner them in helping to address the skills gap through this unique project. The Project provides students with an opportunity to engage in a series of learning tasks that facilitate vocational/applied learning and helps them to experience not only academic rigor but the technical ability needed for today's roles.

Each of the projects offered: Energy Recovery, SMART Homes and Powering The Future, gives students the chance of quality academic study combined with real world activity, a grounding which equips students earlier with skills, experience, and enthusiasm to join a workforce and make a real contribution.

The materials are adapted from a range of over 35 unique and engaging curriculum-linked schemes of work, lesson plans, worksheets and practical activities developed by educationalists and based on ground-breaking projects and technologies Siemens is engaged with in the UK and around the world. These resources are available from the Siemens Education website www.siemens.co.uk/education.

This partnership with OCR, The Curiosity Project and Siemens Education are all initiatives that Siemens is engaged in which we believe will help to support the needs of students and the education sector to provide a talent pool of highly-skilled young people.

Brenda Yearsley
UK School & Education Development Manager
Siemens plc

PRINCIPLES IN ENGINEERING AND ENGINEERING BUSINESS

Engineering is the application of scientific, economic, social and practical knowledge to design, build and maintain machines, devices, systems and structures using different materials and processes. This qualification concentrates on the wider context that underpins engineering. Your students will look at fundamental principles applied to practical applications, as well as how businesses are structured and operate in a competitive world, manage sustainable engineering and keep products and services at their optimum performance.

Units	Assessment Method	GLH	J832 Award 60 GLH	J482 Certificate 120 GLH
R101: Engineering principles	Written paper OCR set and marked 1 hour – 60 marks Students answer all questions	30	M	M
R102: The engineered business world	Centre-assessed task, OCR moderated	30	M	M
R103: Sustainable engineering	Centre-assessed task, OCR moderated	30	N/A	M
R104: Optimising performance in engineering systems and products	Centre-assessed task, OCR moderated	30	N/A	M
Key: M = mandatory unit				

A bank of model assignments is available free of charge from the OCR website for the centre-assessed units R101-R104.

ENGINEERING DESIGN

Engineering design is a process used to develop and enhance new products and systems as a response to market opportunities.

This qualification is an opportunity for your students to develop a design specification and study the processes involved in designing new engineered products. They'll use practical skills such as drawing, computer modelling and model making to communicate design ideas. The qualification will also encourage them to consult with a client and, with its practical focus, will engage them in producing, testing and evaluating a prototype in the form of a model.

Units	Assessment Method	GLH	J832 Award 60 GLH	J482 Certificate 120 GLH
R105: Design briefs, design specifications and user requirements	Written paper OCR set and marked 1 hour – 60 marks Students answer all questions	30	M	M
R106: Product analysis and research	Centre-assessed task, OCR moderated	30	M	M
R107: Developing and presenting engineering designs	Centre-assessed task, OCR moderated	30	N/A	M
R108: 3D design realisation	Centre-assessed task, OCR moderated	30	N/A	M
Key: M = mandatory unit				

A bank of model assignments is availiable free of charge from the OCR website for the centre-assessed units R105-R108.

ENGINEERING MANUFACTURE

Engineering manufacture is a discipline of engineering dealing with different manufacturing practices and processes using the machines, tools and equipment that turn raw materials into new products. This qualification will enable your students to study these processes. It will also allow them to operate the tools and equipment used to make products from the requirements of a design specification, as well as use relevant computer applications such as CAD/CAM, and CNC equipment.

What you need to run this qualification

To offer this qualification, your centre will need access to engineering production equipment such as CAD and CNC. You'll find it useful to offer it alongside Engineering Design.

Units	Assessment Method	GLH	J832 Award 60 GLH	J482 Certificate 120 GLH
R109: Engineering materials, processes and production	Written paper OCR set and marked 1 hour – 60 marks Students answer all questions	30	M	M
R110: Preparing and planning for manufacture	Centre-assessed task, OCR moderated	30	M	M
R111: Computer-aided manufacturing	Centre-assessed task, OCR moderated	30	N/A	M
R112: Quality control of engineered products	Centre-assessed task, OCR moderated	30	N/A	M
Key: M = mandatory unit				

A bank of model assignments is availiable free of charge from the OCR website for the centre-assessed units R110-R112.

SYSTEMS CONTROL IN ENGINEERING

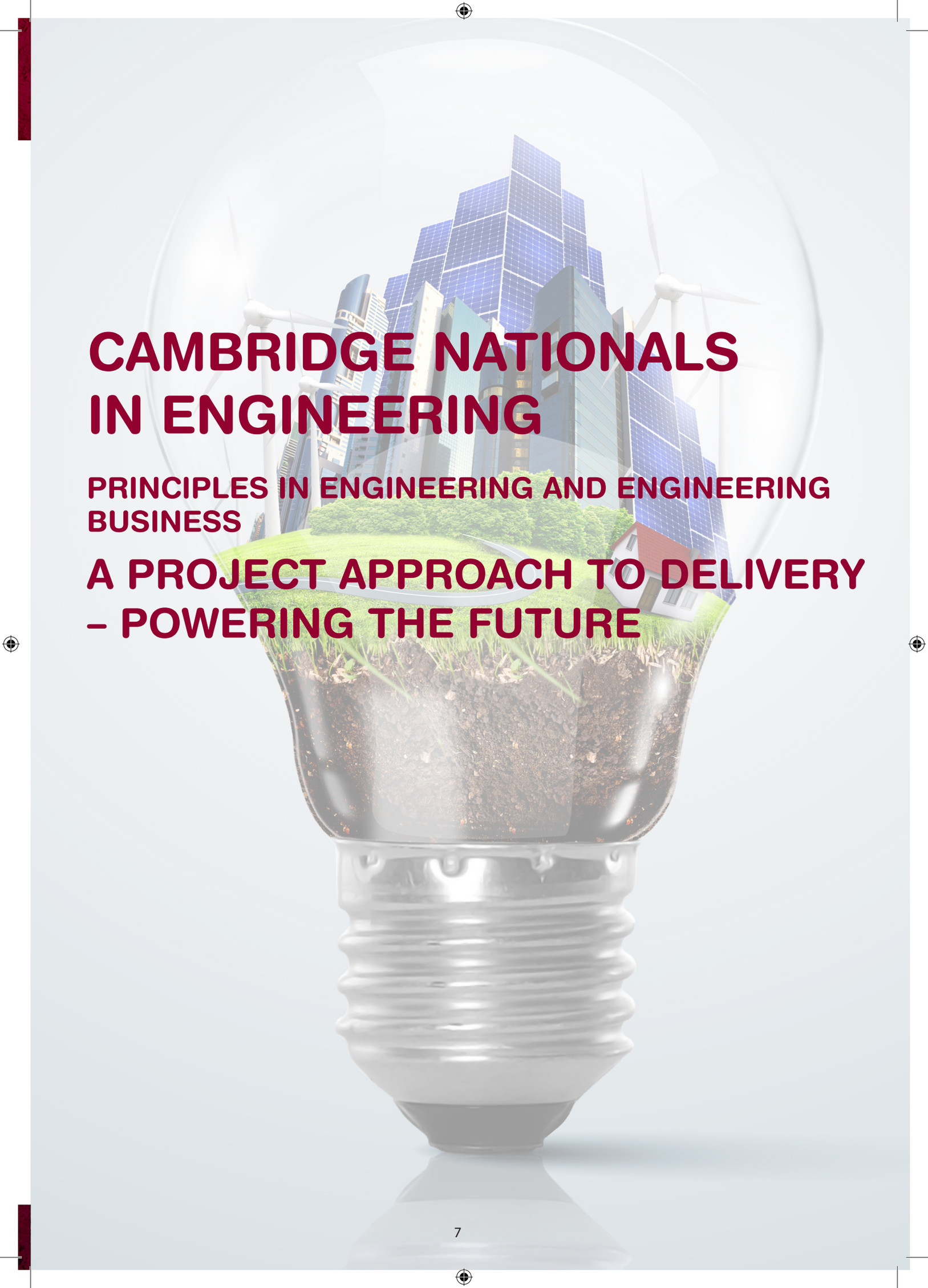
Systems control in engineering is the study of microprocessor control that uses sensors, feedback and actuators that constantly adjust for a desired performance. Through this qualification, your students will explore these computer and microprocessor applications. They'll learn how systems are used in engineering environments such as product design, automated manufacturing, maintenance and stock control. They'll also take part in engaging practical tasks such as producing simple electronic circuits, testing the operation of circuits, and designing and testing a simple control system.

What you need to run this qualification

To offer this qualification, your centre will need access to engineering production equipment such as CAD and CNC. You'll find it useful to offer it alongside the Principles in Engineering and Engineering Business qualification.

Units	Assessment Method	GLH	J832 Award 60 GLH	J482 Certificate 120 GLH
R113: Electronic principles	Written paper OCR set and marked 1 hour – 60 marks Students answer all questions	30	M	M
R114: Simulate, construct and test electronic circuits	Centre-assessed task, OCR moderated	30	M	M
R115: Engineering applications of computers	Centre-assessed task, OCR moderated	30	N/A	M
R116: Process control systems	Centre-assessed task, OCR moderated	30	N/A	M
Key: M = mandatory unit				

A bank of model assignments is availiable free of charge from the OCR website for the centre-assessed units R114-R116.



CAMBRIDGE NATIONALS IN ENGINEERING

PRINCIPLES IN ENGINEERING AND ENGINEERING BUSINESS

A PROJECT APPROACH TO DELIVERY – POWERING THE FUTURE

INTRODUCTION

The purpose of this guide is to give you an overview of how you could holistically deliver a range of units from the Cambridge National in Engineering Level 1/2 in conjunction with Siemens. When delivering any qualification it is always useful to be able to look at the variety of units and consider how they are or could be linked together – a holistic approach.

An holistic approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge could link together in a working environment.

This guide looks at the delivery and facilitation of learning of the following units:

Unit R101: Engineering principles

Unit R102: The engineered business world

Unit R103: Sustainable engineering

Unit R104: Optimising performance in engineering systems and products

In this example, the objective is for learners to develop their knowledge of engineering principles and engineering businesses through practical engagement with projects and activities designed and supported by Siemens.

The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide foundation knowledge for their final assessment. The practice review activities within the modules must not be used for Cambridge National final assessment purposes. Model assignment tasks for each of the Cambridge National qualifications can be found at www.ocr.org.uk.

It is assumed that the learners will be given the opportunity to carry out activities that will enable them to practice the skills they have learned within each module prior to being given final assessment activities.

When considering a holistic approach to delivery and learning it is important to consider the overall objectives. In this guide the objectives are to:

- Deliver all four units to achieve the Level 2 Cambridge National Certificate in Principles in Engineering and Engineering Business.
- Structure a programme of learning and reviews which are exciting and engaging for the learners.
- Provide the learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides the learners with an opportunity to consider how they would use their engineering skills holistically within the working environment.

This guide is divided into four modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each module provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding prior to final assessment and evidencing by the learner.

Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the controlled assessment units R102, R103 and R104 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R101	Module 1	Module 1		Module 1
Unit R102	Module 2 Module 4	Module 2	Module 2	Module 2
Unit R103	Module 3	Module 3	Module 2 Module 3	
Unit R104	Module 4	Module 4	Module 4	Module 4

By Module

	Unit	LO
Module 1	R101	LO1, LO2, LO4
Module 2	R102 R103	LO1, LO2, LO3, LO4 LO3
Module 3	R103	LO1, LO2, LO3
Module 4	R104 R102	LO1, LO2, LO3, LO4 LO1

Powering the Future Task

The Project Brief

(Learner version of the Project Brief is available from http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/)

Standby power supplies are needed to ensure that critical systems receive continuous power in the event of power failure, for example in a hospital. Organisations can adopt different approaches to maintaining optimum performance of their standby power supply systems.

Learners have been asked to consider the methods used to maintain optimum system performance including:

- areas at risk from component failure
- types of failure
- design for maintenance and repair.

Learners will recommend the most appropriate methods for maintaining the standby power supply system.

You will perform simple maintenance procedures to ensure optimum system performance of the standby power supply systems, following recommended maintenance procedures.

This work can be undertaken as an individual or within a team. If working within a team learners are expected to contribute to each of the areas in order to gain the experience and knowledge required to successfully complete the Cambridge National in Engineering Principles in Engineering and Engineering Business.

The Powering the future project explores the engineering principles of supplying power to our essential services and looks at how the businesses involved in keeping hospitals operating.

The project inspires learners to use IT to learn about physics, electronics, mathematics, business structure, systems design, branding, media skills and financial strategy in the context of an essential resource.

Learners will use their understanding to recommend the most appropriate methods for maintaining a standby power supply system in a hospital and demonstrate maintenance procedures.

Module 1 – Engineering Principles

The delivery begins with unit R101 (LO1, LO2, LO3 and LO4) and R102 (LO2) and R104 (LO2)

Before learners can undertake the activities they will need to have a good understanding of:

- the main engineering principles
  - mechanical
  - electrical
  - fluid power
- different types of power source and form of energy
  - mechanical
  - electrical
  - power transmission.

In addition to the curriculum specification, learners will need an understanding of:

- power generation
  - different generation methods
  - reaction time of different generation methods
  - how power is stored and transmitted.

Contained within the following assessment criteria/LO(s)/ units:

Understand physical properties and mechanical principles	LO1	R101
Understand physical properties and electrical principles	LO2	R101
Know about the systems used to transmit power in engineering	LO3	R101

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

In order to explore the range of mechanical and fluid power engineering principles, learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

The Siemens' resources 'Blowing in the Wind' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks3.htm) and 'Underwater Energy' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) provide useful background information on the different forms of energy production.

Activity 2

Learners could produce a poster or a series of posters highlighting the different Mechanical and Electrical principles at work in a generator. Different groups of learners could look at different technologies, such as wind, marine or gas powered steam turbine. The Siemens' Living Energy e-magazine will support this (http://www.energy.siemens.com/br/en/energy-topics/publications/living-energy/)

The poster/s should include the key elements from the Learning Outcomes.

Activity 3

Learners could explore different power systems and apply mathematical calculations to the generation of power and create a series of trading cards as a group. Each card will represent a different technology and power type with points awarded for given criteria such as: cost per unit, reaction time, equipment cost, environmental impact, operational life and future impact.

Module 2 The Engineered Business World

The delivery then follows through units R102 (LO1, LO2, LO3 and LO4) and R103 (LO3).

Contained within the following assessment criteria/LO(s)/ units:

Know about engineering sectors, their products and services	LO1	R102
Understand how engineering companies operate	LO2	R102
Know about employment in engineering	LO3	R102
Understand innovation and technical advances in engineering	LO4	R102
Understand the impact of global manufacturing	LO3	R102

This will allow learners to develop their understanding of how engineering companies work, the employment opportunities and responsibilities and how the global market is impacting on engineering.

During the delivery of the units, learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Teachers could introduce learners to the different classification of materials and specific material types, material characteristics and common uses. Metals might be usefully divided into two types; ferrous metals and non-ferrous metals. Learners could be presented with a range of images of Siemens' products from the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education) and asked to create sticky labels to identify parts and materials on each image.

The labels should include details of:

- the material
- key properties
- main uses
- alternatives
- any issues with its use (cost, availability, environmental impacts).

Activity 2

To develop an understanding of materials used in engineering, learners could watch the video 'How it's Made – How Train Rails are made' by accessing the following web link: http://www.youtube.com/watch?v=TXRaXHEKW5E and work through the Siemens' resource 'Ringing True' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) which focuses on the use of materials in train wheels and the broader resources on the rail industry 'Rail Solutions' (http://w3.siemens.co.uk/MOBILITY/UK/EN/RAIL_SOLUTIONS/Pages/rail_solutions.aspx)

Activity 3

The Siemens' activities 'Here comes the sun' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) and 'Sustainability at Siemens' (http://www.siemens.co.uk/pool/about_us/sustainability/siemens_sustainability_uk_1_pager_2013.pdf) explore a range of environmental and sustainability areas and could be used to support the development of sustainable design ideas for learners.

Activity 4

Learners could develop a sustainability rating system for use on engineered products and services. The objective is to compare a range of products using a rating system created by the learners, which cover a range of sustainability and environmental impact issues. Learners could then present the top three rated products based on their own research.

Siemens''Sustainability reports and documents' (http://www.siemens.com/sustainability/en/sustainability/reporting/current-report.htm) will give valuable information for the research.

Module 4 Optimising performance in engineering systems and products

The delivery then follows through units R104 (LO1, LO2, LO3 and LO4).

Contained within the following assessment criteria/LO(s)/ units:

Understand why engineering systems and products are designed and maintained for optimum performance	LO1	R104
Know methods used in engineering sectors to maintain optimum performance	LO2	R104
Understand factors that contribute to system/ product failure	LO3	R104
Be able to perform simple procedures to optimise product/system performance	LO4	R104
Know about engineering sectors, their products and services	LO1	R102

This will allow learners to develop problem solving techniques and understanding of how established systems are modified and optimised.

They will also develop the skills associated with risk assessment and contingency planning.

During the delivery of the units, learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

To develop their understanding of optimisation, learners could watch the 'Bang Goes the Theory' episode on the National Grid, accessible from: http://www.bbc.co.uk/programmes/p01tbh0j and undertake a review of how National Grid optimises the power delivery to the electricity grid.

To support the concept of system operation, learners could take part in the Siemens''E-Zero Island' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) activity. This models a multi-faceted system using data and logic, applying ideas about energy transfer and sustainability to a novel context to produce a practical overall system.

Alternatively, learners could use the Siemens''London Underground' (http://w3.siemens.co.uk/smartgrid/uk/en/Services/mcs/smb/Pages/Case-Studies.aspx) case study to explore how a large system is optimised. The teacher might begin with a class discussion of factors that contribute to failure of engineered products and systems.

Whichever option is taken, learners could create a worst case scenario of what would happen if all maintenance on the grid or underground ceased. This could be done in the form of a news article from the point of view of the scenario having happened.

Activity 2

Learners could use the Siemens''Power Engineering Guide' (http://www.energy.siemens.com/br/en/energy-topics/publications/power-engineering-guide/) and the 'Living Energy e-magazine' (http://www.energy.siemens.com/br/en/energy-topics/publications/living-energy/) to identify the components and processes that are maintained in a power generation system. An example of this would be a gearbox in a wind turbine generator. Learners should highlight how the system was designed to make sure maintenance can be carried out easily.

Activity 3

When exploring product lifecycle, learners could be asked to identify engineered products that are designed not to be repaired or maintained. They should consider the features or technology that prevent maintenance or repair. Suitable products include a calculator or low cost radio.

Activity 4

Learners could explore the different methods used to maintain optimum performance by considering the different approaches businesses take to maintain equipment in service, whilst minimising disruption.

Learners could research condition based monitoring to inform operation, servicing and repairs. Learners could access a video to demonstrate this at the following web links;

http://youtube/GV6JasEuGn4 and http://youtube/lq401qW-BRE

Activity 5

To support learners in understanding maintenance procedures they could be asked to disassemble an accessible engineered product that would lend itself to show types and signs of component failure, such as a hairdryer, engine block, cylinder head, electric motor, drill or other power tool. Learners could be asked to identify signs of fatigue, seizure, vibration, corrosion on moving parts and static parts. Learners could apply their knowledge of inspecting engineered products for wear and signs of failure by completing a product evaluation form.

Siemens''Customer Service Videos' (http://www.siemens-home.co.uk/features-and-benefits/customer-service-video-gallery.html) can add product information.

Learners could develop their understanding of different types of bearings and bearing surfaces by watching a video accessed at the web link; http://youtube/KGglvDNDuYc

Learners could research different modes of failure eg fatigue, signs of wear, seizure and corrosion in engineered applications such as in engines and compressors. One example can be accessed by following the web link; http://www.gregsengine.com/engine-bearing-failure-chart.html

Glossary

Trading cards – a card game where cards are created for items with a range of common attributes given individual figures or scores.

Dragon's Den – individuals or teams present an idea to a panel of up to four judges who challenge the ideas and make a decision of whether or not the idea is worth investing in.

Cost-benefit analysis – a business technique for evaluating the worth of an idea, for more information see: http://www.mindtools.com/pages/article/newTED_08.htm

Sustainability rating system – a series of criteria, related to sustainability, that allows a comparison between products. Sustainability could focus on construction, life cycle, use or a combination. The ratings could be numerical or based on high – medium – low.

Delivering the project holistically

This project should be delivered in conjunction with other resources available on the OCR website. www.ocr.org.uk/cambridgenationals in the teaching and learning resources area.

Teaching and learning resources

Teaching and learning resources for each Cambridge National in Engineering are:

- the Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the delivery guide and lesson elements to enhance teaching and learning through each module in the project approach.

The example below shows how Unit R101: Engineering principles LO1: Understand physical properties and mechanical principles can be delivered through the use of these resources.

Learners could study relevant Siemens resources bank (http://www.siemens.co.uk/education), Learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

They could for example, be taught in mathematics to use tables and graphs (both linear and non-linear) and apply this knowledge to inform a detailed and comprehensive conclusion.

Building up research skills and applying appropriate mathematics and science, learners could use resource links documents web sites such as the Siemens resources 'Blowing in the Wind' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks3.htm) and 'Underwater Energy' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) provide useful background information on the different forms of energy production as part of their research.

Use the OCR guide to research to develop learners' research skills.

http://www.ocr.org.uk/i-want-to/skills-guides/

Examples showing how the resources available from the OCR website can be used with this project approach

Unit R101: Engineering principles

LO1: Understand physical properties and mechanical principles

	Unit	Learning Outcome (LO)
Module 1	R101	LO1 LO3 LO2

The Project Approach

Activity 1 (R101 – LO1)

Learners could research, create and deliver a presentation explaining the different principles involved in producing power. Comparisons between wind, thermal generation and hydro power would demonstrate the shared and different principles at work.

The Delivery Guide (R101 – LO1)

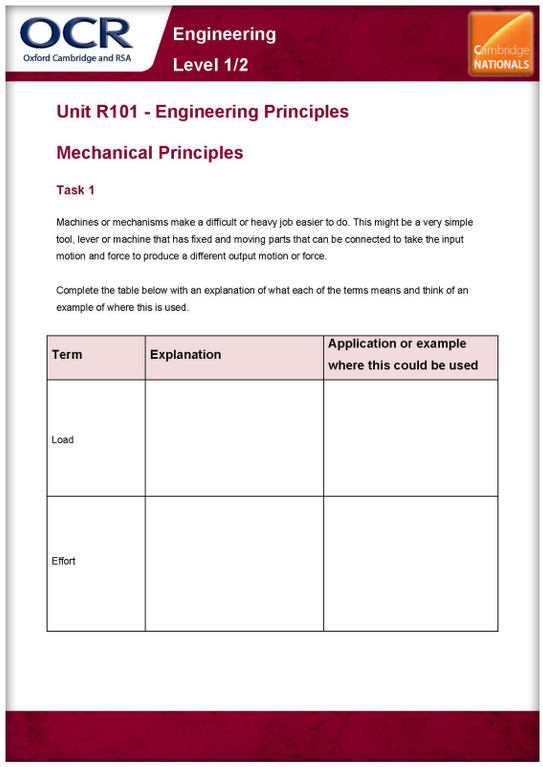
Suggested content	Suggested activities	Suggested timings	Possible relevance to
Physical Properties	Learners could be introduced to the physical properties as energy in the form of mechanical, electrical, chemical, light, sound, and heat by the teacher. Learners could be asked to work in groups to discuss examples of where the physical properties of energy forms are evident, such as a bicycle in use. Working in groups, learners could identify examples of kinetic energy and conversion of the bicycle being pedalled, the types of energy used and resulting from the brakes being applied, the use of lighting on a bicycle and two ways how the light energy could be produced.	2 hours	

Lesson Element (R101)

Mechanical Principles

This lesson element enables learners to understand about basic mechanical principles.

http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/



OCR Oxford Cambridge and RSA

Engineering

Level 1/2

Cambridge NATIONALS

Unit R101 - Engineering Principles

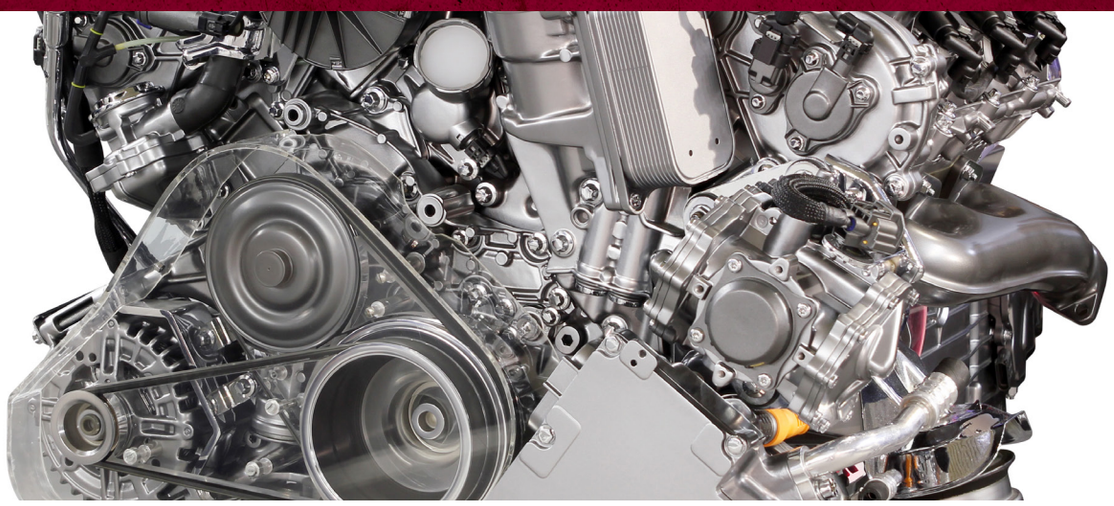
Mechanical Principles

Task 1

Machines or mechanisms make a difficult or heavy job easier to do. This might be a very simple tool, lever or machine that has fixed and moving parts that can be connected to take the input motion and force to produce a different output motion or force.

Complete the table below with an explanation of what each of the terms means and think of an example of where this is used.

Term	Explanation	Application or example where this could be used
Load		
Effort		



Cambridge Nationals in Engineering – Mapping to mathematics and science

This document will help you plan your curriculum and assist you in delivering related subjects such as maths, science and ICT when teaching your Cambridge Nationals in Engineering.

The mapping of R101 LO1 to maths foundation – initial and bronze

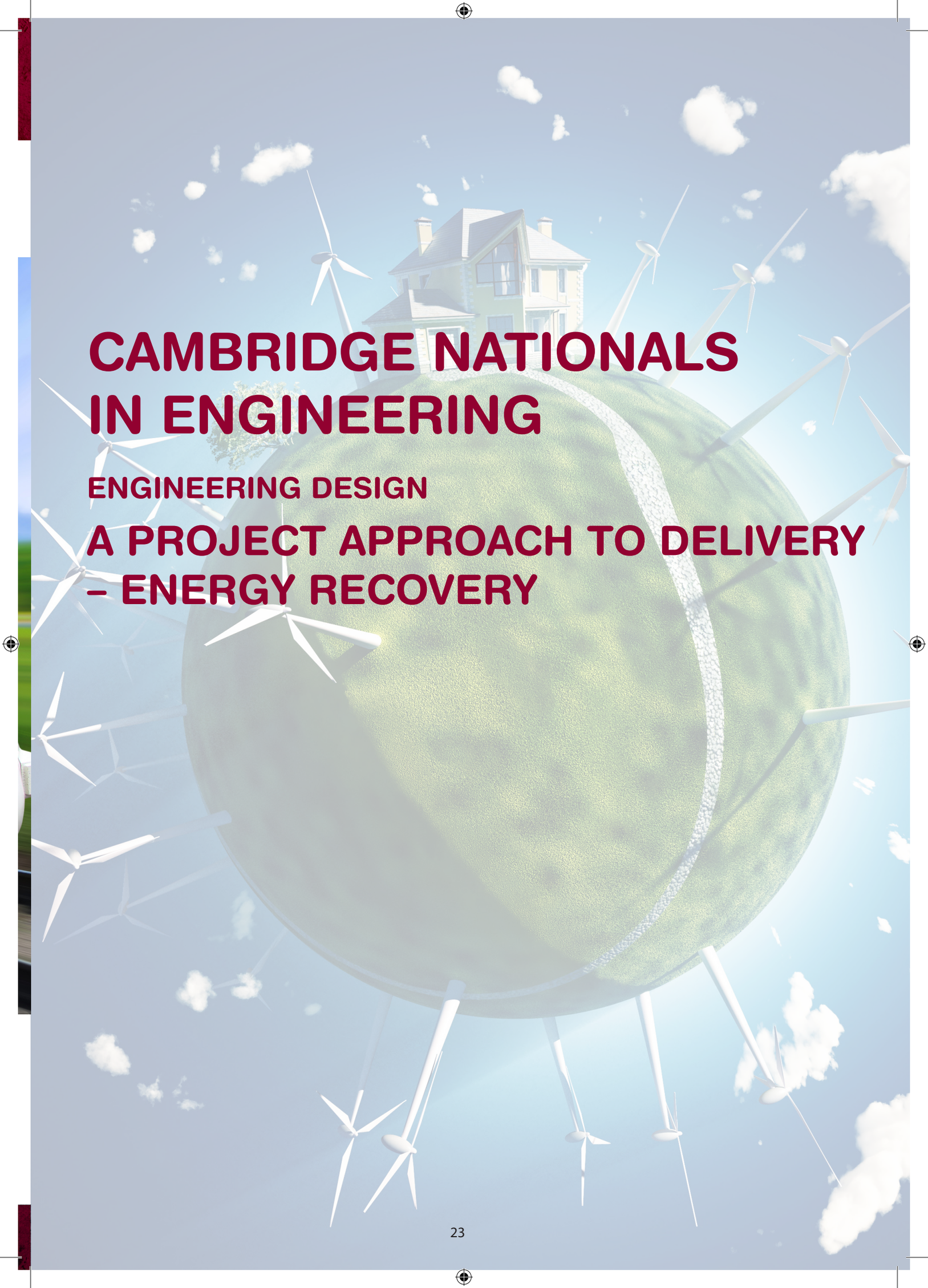
The example below is an extract from this mapping document and suggests how GCSE maths could be taught and then applied to develop skills in evaluating market data necessary for LO1.

	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Mechanical principles using calculation of: – levers (Class 1, 2 and 3) pulleys and gears (simple and compound) static and moving bodies	Understand physical properties and mechanical principles	FIN4 Multiply and divide a three-digit number by a two-digit number. Multiply numbers with up to two decimal places by an integer.	FBA2 Substitute positive numbers into simple algebraic formulae. Derive a simple formula.

Learners are required to interpret and develop calculations of pulleys and gears (R101) which will require them to understand how applied force and distance from a fulcrum applies to gear/pulley ratios. In maths, (FIN4) learners are required to multiply and divide a three-digit number by a two-digit number, then multiply numbers with up to two decimal places by an integer. They need to substitute positive numbers into simple algebraic formulae (FBA2) and derive a simple formula. In maths, learners could explore how force could be negative as well as positive which could be represented by integers. Simple algebraic formula could be used when solving compound gear and pulley ratios of speed and torque. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.

The Skills Guides.

Learners could use the OCR guide to research skills and the OCR guide to presentation skills to help them develop these skills.
http://www.ocr.org.uk/i-want-to/skills-guides/



CAMBRIDGE NATIONALS IN ENGINEERING

ENGINEERING DESIGN

A PROJECT APPROACH TO DELIVERY – ENERGY RECOVERY

INTRODUCTION

The purpose of this guide is to give you an overview of how you could holistically deliver a range of units from the Cambridge National in Engineering Level 1/2 in conjunction with Siemens. When delivering any qualification it is always useful to be able to look at the variety of units and consider how they are or could be linked together – a holistic approach.

An holistic approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge could link together in a working environment.

This guide looks at the delivery and facilitation of learning of the following units:

Unit R105: Design briefs, design specifications and user requirements

Unit R106: Product analysis and research

Unit R107: Developing and presenting engineering designs

Unit R108: 3D design realisation

In this example, the objective is for learners to develop their knowledge of design and manufacturing through practical engagement with projects and activities designed and supported by Siemens.

The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide foundation knowledge for their final assessment. The practice review activities within the modules **must not** be used for Cambridge National final assessment purposes. Model assignment tasks for each of the Cambridge National qualifications can be found at www.ocr.org.uk.

It is assumed that the learners will be given the opportunity to carry out activities that will enable them to practice the skills they have learned within each module prior to being given final assessment activities.

When considering a holistic approach to delivery and learning it is important to consider the overall objectives. In this guide the objectives are to:

- Deliver all four units to achieve the Level 2 Cambridge National Certificate in Engineering Design.
- Structure a programme of learning and reviews which are exciting and engaging for the learners.
- Provide the learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides the learners with an opportunity to consider how they would use their engineering skills holistically within the working environment.

This guide is divided into four modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each module provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding prior to final assessment and evidencing by the learner.

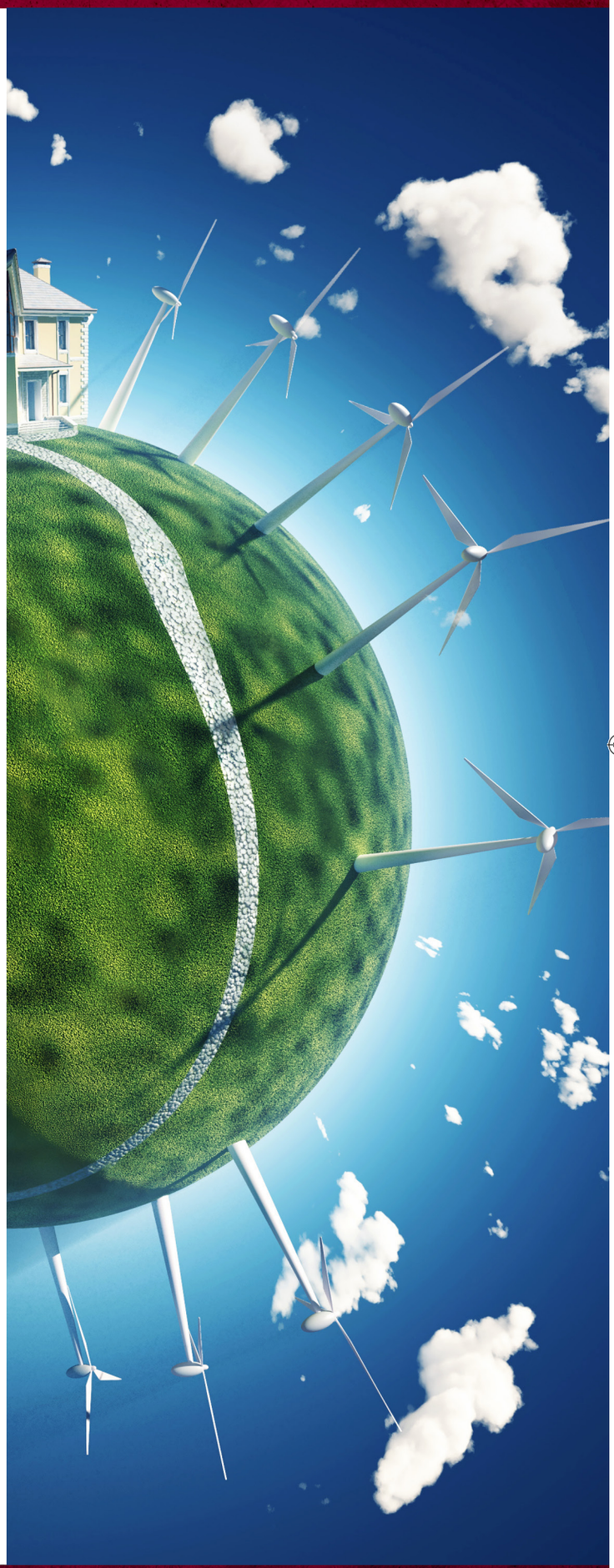
Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the controlled assessment units R106, R107 and R108 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R105	Module 1 Module 4	Module 1 Module 4	Module 1	
Unit R106	Module 2	Module 2	Module 2	
Unit R107	Module 3	Module 3	Module 3	
Unit R108	Module 4	Module 4	Module 4	Module 4

By Module

	Unit	LO
Module 1	R105	LO1 LO2 LO3
Module 2	R106	LO1 LO2 LO3
Module 3	R107	LO1 LO2 LO3
Module 4	R108 R105	LO1, LO2, LO3, LO4 LO1, LO2



Energy Recovery Project

The Project Brief

(Learner version of the Project Brief is available from http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-design-level-1-2-award-certificate-j831-j841/.)

Learners have been asked to design or modify a system that recovers or converts energy from existing energy sources.

Learners will:

Apply the design cycle elements to:

- identify the key requirements for the energy recovery system
- researching commercial energy recovery systems through primary and secondary methods
- develop a justified design specification for the energy recovery system
- produce design ideas for the energy recovery system
- optimise the energy recovery system components through the use of prototyping and modelling
- evaluate the success of the prototype of the energy recovery system components.

This work can be undertaken as an individual or within a team. If working within a team learners are expected to contribute to each of the areas in order to gain the experience and knowledge required to successfully complete the Cambridge National in Engineering Design.

The Energy Recovery Project explores the technologies being used to improve the efficiency and lower the running costs of a range systems that use energy

From trains and buses to Formula 1 cars, energy recovery systems are commonly used. With the high cost of fuel and environmental concerns affecting everyone, this project will help learners develop an understanding of how technological advances in engineering contribute to environmental improvements.

Learners will engage with a range of construction techniques and simulation software to design and test environmental solutions with learners applying CAD/CAM software to design and prototype an energy recovery system.

Module 1 – Briefs and Specifications

The delivery begins with unit R105 (LO1, LO2, LO3 and LO4)

Before learners can start the design process for an energy recovery system, or other engineered product, they need to have a good understanding of:

- the four phases of the design cycle
  - o identify phase
  - o design phase
  - o optimise phase
  - o validate phase
- how commercial production methods, quality and legislation impact on the design of products and components
- the identification of design needs
  - o initial design brief from client
  - o information which may inform the design brief
  - o the relationship between a design brief and a design specification
- the wider influences on the design of new products.

Contained within the following assessment criteria/LO(s)/ units:

Understand the design cycle and the relationship between design briefs and design specifications	LO1	R105
Understand the requirements of design specifications for the development of a new product	LO2	R105
Know about the wider influences on the design of new products	LO3	R105

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could create and deliver a presentation explaining the four phases of the design cycle. The purpose of the presentation would be to explain how the learners are planning to approach the design of the energy recovery system for the Energy Recovery Project.

Activity 2

Learners could work from a given client design brief, found in the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education) and explore the situation and context that has led to the brief, the needs of the client eg. corporate branding, target audience, the purpose and functions of the product. Learners should consider other information which may inform the design brief, ie market research, strengths and weaknesses of competitors' products, improvements in materials and production processes and budgetary constraints.

Learners should analyse the information gained before the production of a final design brief from which a specification could be developed.

Activity 3

Learners could use the 'Green Racers' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm), based on the 'Green Power Challenge' (http://www.siemens.co.uk/education/en/activities-challenges.htm) from Siemens to explore the impact of ideas, design decisions and technological advances and how these provide opportunities for new design solutions. Learners can compare the different ways in which the same design brief has been interpreted by different teams.

Activity 4

Learners could examine the wider influences upon the design of products such as hybrid vehicles. The Siemens''Inspired Bus Company' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) has a useful graph showing the relationship between diesel, hybrid and hydrogen powered vehicle outputs.

'Siemens' Product and technology videos' (http://www.energy.siemens.com/br/en/energy-topics/videos/) contain examples of Siemens products.

Activity 5

Learners could use the Siemens''I can see clearly now' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) materials, responding creatively to briefs, developing their own proposals and producing specifications for products to solve technical problems.

Activity 6

To understand the wider influences on the design of new products, learners could use the Siemens' resources 'Underwater Energy' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) and then create a presentation that explains how the design of the Seagen turbine has been influenced by:

- market pull / technology push
- fashion trends
- legislation, life cycle analysis
- sustainable design
- new materials
- environmental pressures

The Siemens' Seagen video can be accessed from: http://youtube/ZPi9HeDgN58

The Siemens''Crystal Sustainable Cities Initiative' (http://www.siemens.co.uk/education/en/teachers/the-crystal.htm) has specific topic related work sheets that can be used during a visit.

Activity 7

To develop an understanding of intellectual property, learners could research the regulations and safeguards in place. These include copyright, patents, registered designs, trademarks, British Standards, European Conformity. Learners could create chart showing how each method is used by Siemens to cover at least one of its products or services. Where applicable, learners could highlight where Standards are different in different countries.

Module 2 Product Analysis and Research

The delivery then follows through units R106 (LO1, LO2, and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Know how commercial production methods, quality and legislation impact on the design of products and components	LO1	R106
Be able to research existing products	LO2	R106
Be able to analyse an existing product through disassembly	LO3	R106

This unit will support learners in developing their understanding of both formulating and interpreting design specifications. They will develop skills of analysis, using primary sources and secondary analysis techniques. Learners will, through examination of products, begin to recognise the wider influences upon product design.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

To better understand commercial production methods and manufacturing, an industrial visit to a Siemens manufacturing facility could be arranged. Siemens also provide a range of videos illustrating the manufacturing processes they have and support. See 'Project Approach Resource Bank' (http://www.siemens.co.uk/education)

Activity 2

Manufacturing processes and their impact on design decisions might also be seen as part of an industrial visit. Manufacturing processes may include moulding, pressing/forming, shaping (including computer numeric control), machining, finishing and assembly. If a visit is not possible then learners could be shown suitable videos of manufacturing processes and then be asked to research their impact on design decisions.

The following video link shows injection moulding taking place: http://youtube/y1Zhpdx-XtA

The production of Siemens' composite rotor blades is covered in this video link: http://youtube/UN83zG7jHIk illustrating the impact of manufacturing location on design.

Activity 3

Learners could engage in a class discussion about the end of life implications for products including recycling of materials, reusing components and safe disposal of toxic hazards. The relationship to design could also be made.

The video Car Transplants at http://youtube/61FE2ABVOOU looks at end of life engineering for cars.

End of life considerations could be researched for a range of Siemens' products.

Suitable products might be a train, a wind turbine, a washing machine, a computer or mobile telephone. Learners could be asked to identify which components are recycled, reused and disposed of, and how this takes place. For the example of the mobile phone this might be: case (recycled), printed circuit board (reused), battery (disposed). Recycling websites might be useful, including www.recycling-guide.org.uk/.

Learners could prepare a presentation, based on the end of life disposal / recycling / reuse of components from within the product.

Activity 4

Learners could undertake the disassembly of a physical item. Learners could undertake the safe disassembly of an item. They should follow a structured approach, to disassembly, using manufacturer's instructions and manuals where available. Learners will need to consider safe use of appropriate tools including: screwdrivers, pliers, cutters, spanners, and measuring equipment.

Learners should document each stage of disassembly.

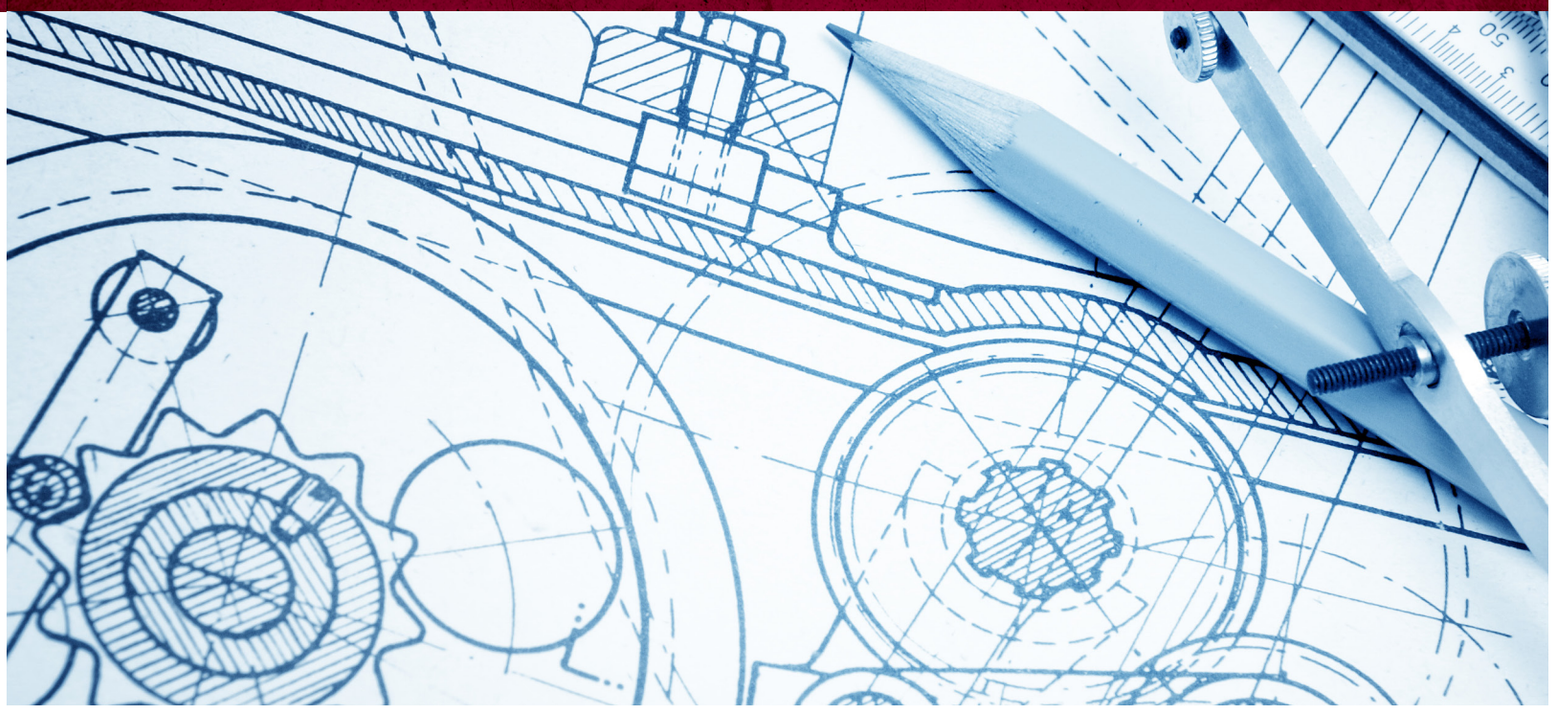
Siemens''Customer Service Videos' (http://www.siemens-home.co.uk/features-and-benefits/customer-service-video-gallery.html) provide some detail on domestic product servicing.

Suitable items in relation to the overall task might be a hair dryer, wind up torch or wind-up radio.

The following two web sites have supporting information for the disassembly of a hairdryer:

http://home.howstuffworks.com/how-to-repair-small-appliances9.htm

http://youtube/WITmaE5F9bI



Module 3 Developing and Presenting Engineering Designs

The delivery then follows through units R107 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Be able to generate design proposals using a range of techniques	LO1	R107
Know how to develop designs using engineering drawing techniques and annotation	LO2	R107
Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals	LO3	R107

This will allow learners to develop techniques in the generation, concept development and the communication of design ideas using hand rendering and computer-based presentation techniques. They will learn to analyse designs as they develop and will consider the design brief and specification within their design development work.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could be presented with an image of a Siemens' product (see 'Project Approach Resource Bank') (http://www.siemens.co.uk/education). Learners should develop a range of design ideas for the exterior housing of this product using a range drawing and presentation techniques.

The techniques should include freehand sketching in 2D and 3D with shade, tone and texture.

Suitable products could include: invertor drives, portable radios, washing machines or other domestic products.

Activity 2

To develop their skills in presenting engineering designs, learners could draw 2D and 3D representation of an existing energy conversion system from a train, bus or car, using different techniques to render the object and evaluate the rendering techniques used. The existing system could be presented as a model, photograph or drawing.

Activity 3

To develop the range of techniques, learners could use 'exploded drawing' to show an energy recovery product assembly, such as a wind up torch.

Activity 4

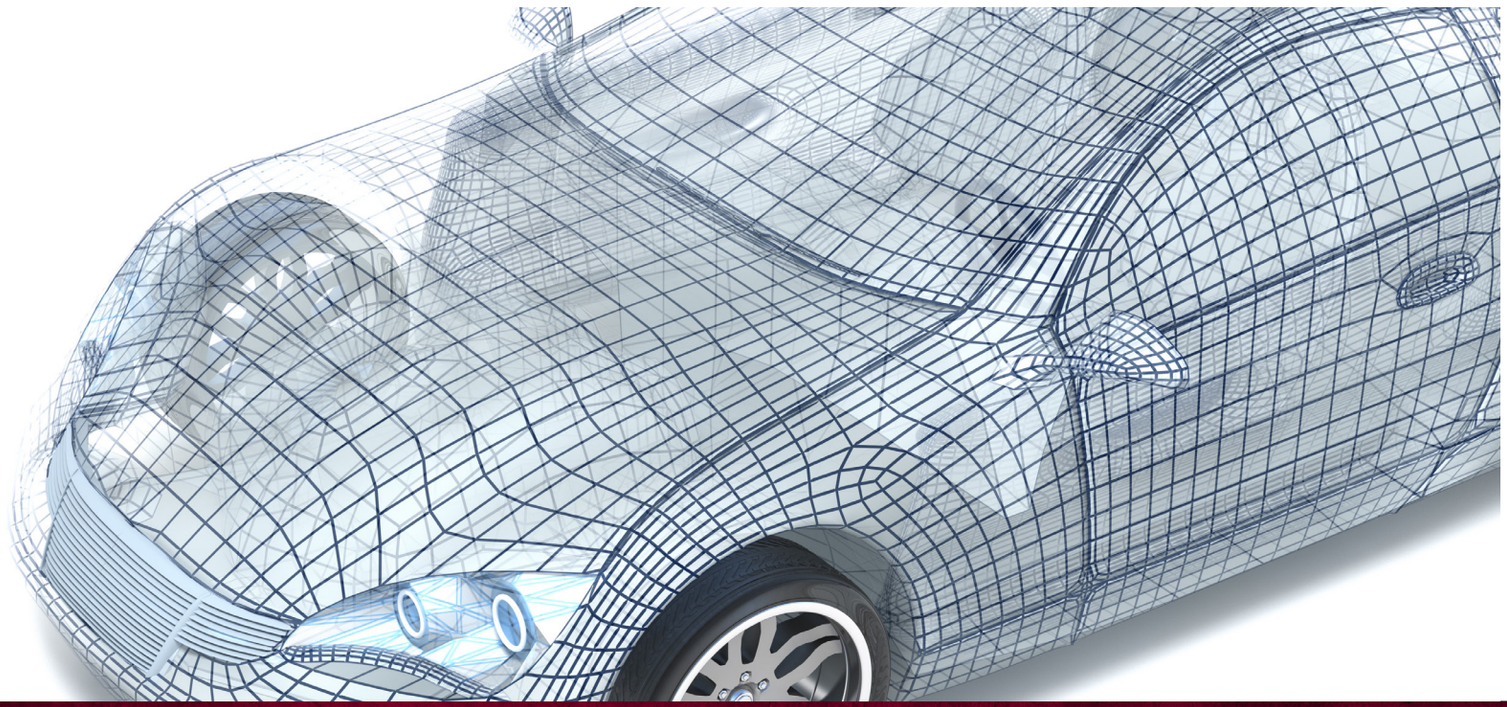
Learners could produce a working drawing for an energy recovery product using the free Siemens' education 3D software Solid Edge or other 3D package. 'Solid Edge Student Edition' (https://www.plm.automation.siemens.com/en_us/academic/resources/solid-edge/student-download.cfm?)

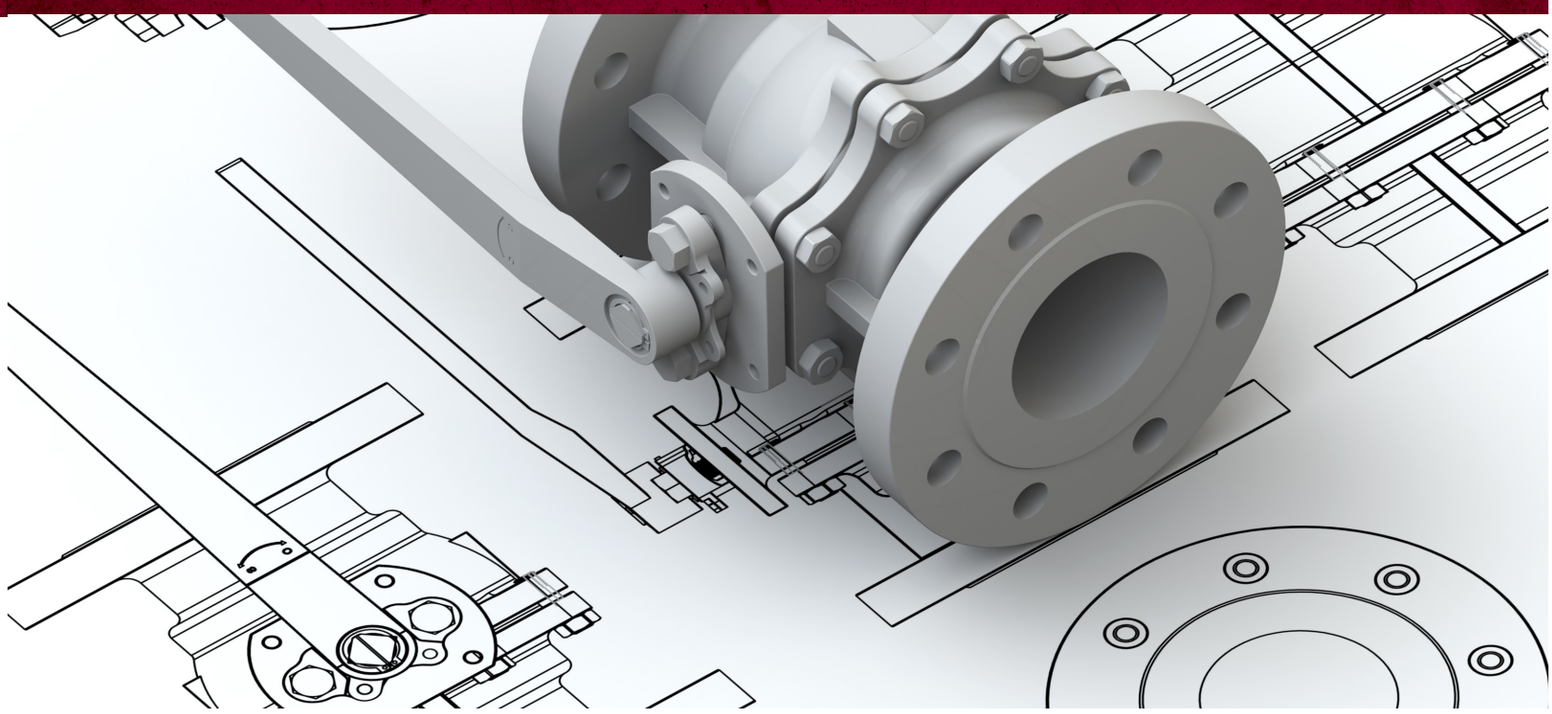
Activity 5

Learners could produce and present design drawings for an engineered product using Siemens education 3D software Solid Edge or other 3D package. 'Solid Edge Student Edition' (https://www.plm.automation.siemens.com/en_us/academic/resources/solid-edge/student-download.cfm)

Learners should be encouraged to expand the ways in which they communicate their design proposals including display boards, models and PowerPoint. Learners might be given the opportunity to take design drawings produced for a given design proposal and use suitable techniques to develop and present these. This might also include producing physical models. Some example presentations are shown at: http://www.technologystudent.com/despro_flsh/desidea1.html.

Learners could be more innovative with the presentation techniques they use to include videos, simple web pages and animations.





Module 4 3D Design Realisation

The delivery then follows through units R108 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Know how to plan the making of a prototype	LO1	R108
Understand safe working practices used when making a prototype	LO2	R108
Be able to produce a prototype	LO3	R108
Be able to evaluate the success of a prototype	LO4	R108
Understand the design cycle and the relationship between design briefs and design specifications	LO1	R105
Understand the requirements of design specifications for the development of a new product	LO2	R105

This unit will allow learners to develop techniques for the evaluation of prototype products and the associated production planning against product specifications and briefs. Learners will identify possible improvements to their designs through the analysis of the performance of their prototype products. They will also develop the skills associated with self-evaluation as they assess their own performance.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners might begin by interpreting the requirements of a design specification, provided by Siemens 'Project Approach Resource Bank' (http://www.siemens.co.uk/education), in preparation for the making of a prototype.

Learners progress from the design specification to the consideration of the materials and processes they might use for making a prototype and for the actual (production) item. Learners might, at this stage, begin to develop a basic plan for the making of a prototype in terms of materials and processes. This could be limited to the resources available to them.

Learners could be encouraged to modify a wind up torch to be used as an energy recovery device.

Activity 2

Learners should develop a production plan for the prototype product. Elements of a typical plan might include resources (eg materials, component parts, cutting lists, tools/ equipment, health and safety requirements, hazards and time requirements) and stages of development (eg making, process testing and evaluation).

The plan might account for some or all of these. Learners might use online tools to help produce a plan. The following is a free Gantt chart tool: http://www.tomsplanner.com/. Similar tools are available for producing flow charts and tables.

Learners could undertake a risk assessment prior to the manufacturing process and add this detail to the production plan.

Activity 3

Learners should be encouraged to keep a diary, documenting their prototype production activities.

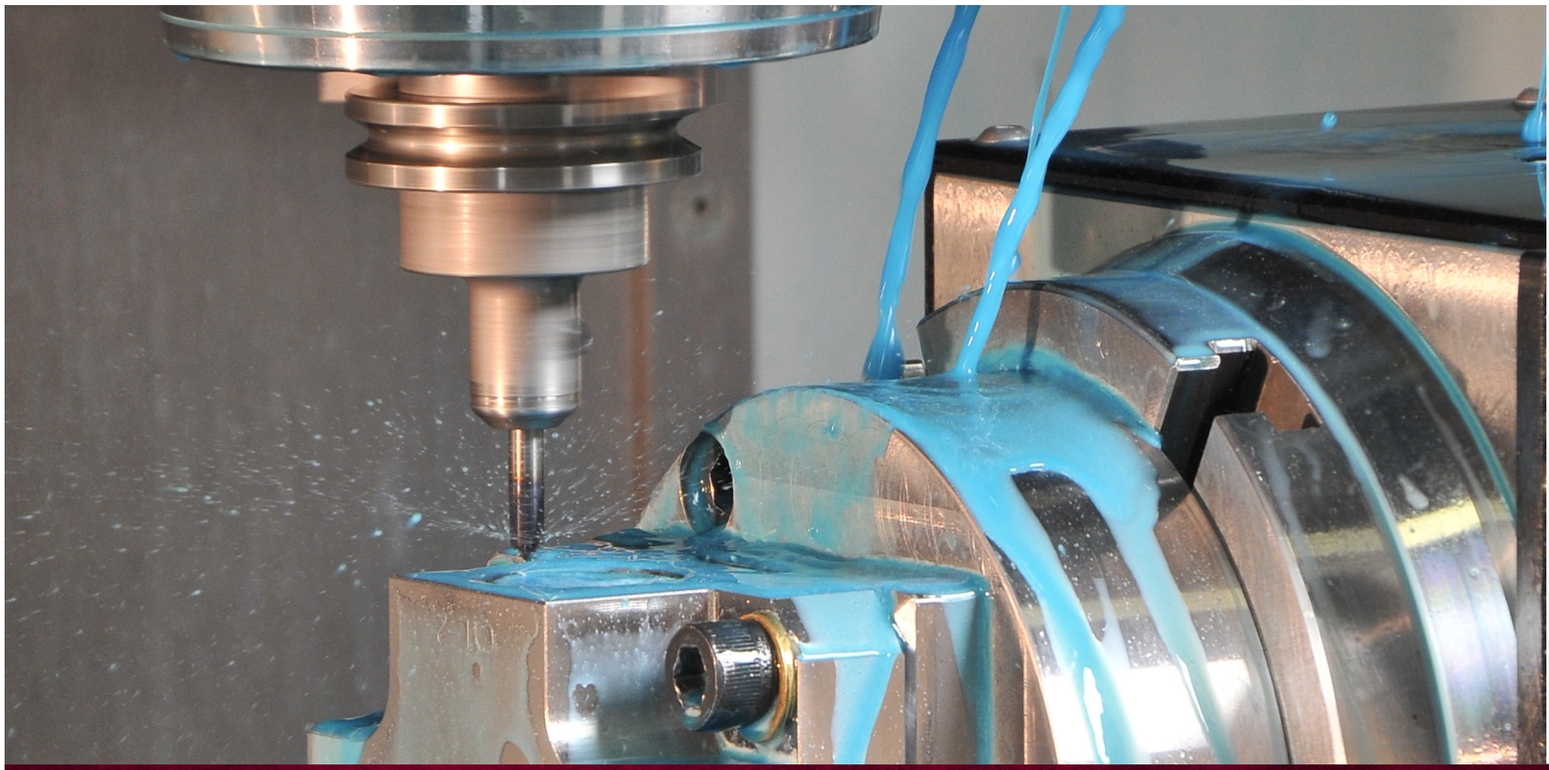
Learners will need to identify an appropriate method for recording the making of the prototype, this could include note taking, photographs, video, audio or a combination of all of these. This activity will allow learners to develop their recording skills before they need to apply this in the actual assessment.

Activity 4

Learners could create a prototype of a component from the energy conversion system using the supplied engineering drawing and the learner developed production plan.

If working in a group then learners could create different components from the system.

Learners could then evaluate the effectiveness of the design and manufacture using the records made of the process.



Delivering the project holistically

This project should be delivered in conjunction with other resources available on the OCR website. www.ocr.org.uk/cambridgenationals in the teaching and learning resources area.

Teaching and learning resources

Teaching and learning resources for each Cambridge National in Engineering are:

- The Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the delivery guide and lesson elements to enhance teaching and learning through each module in the project approach.

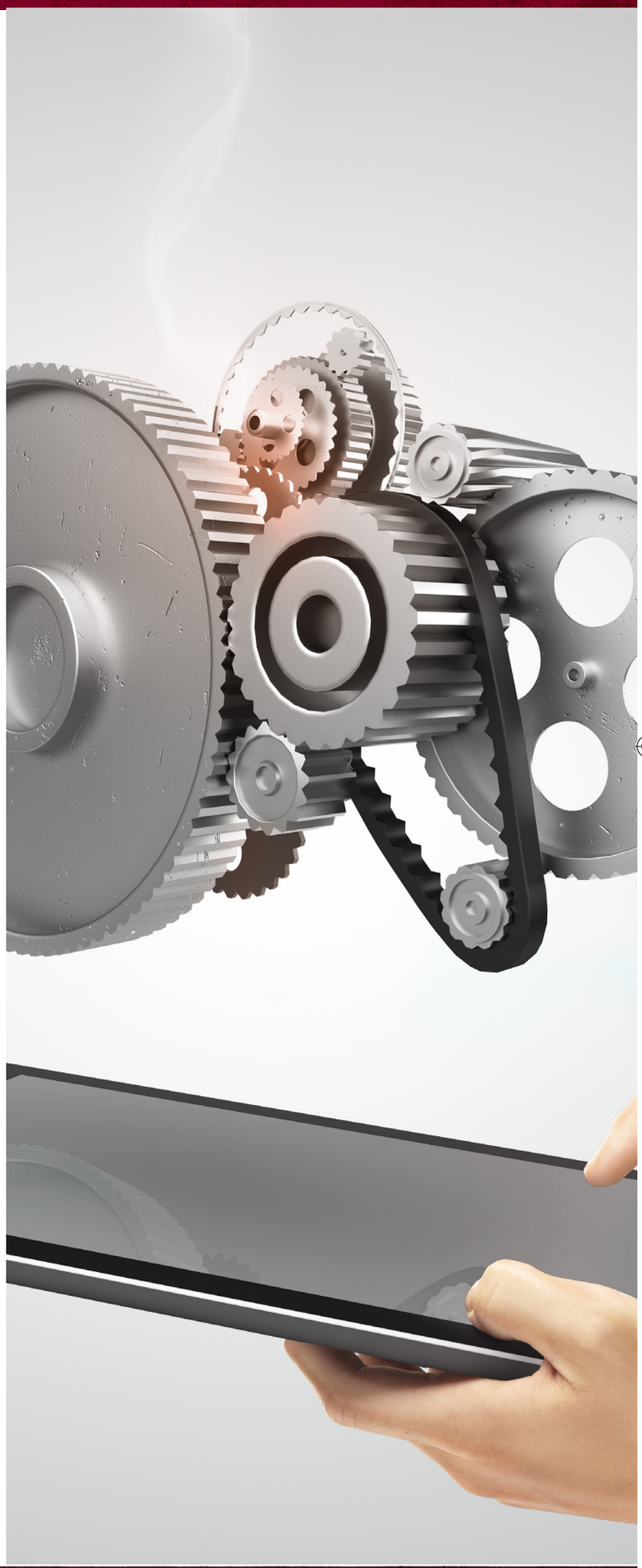
The example below shows how Unit R105: Design briefs, design specifications and user requirements LO1: Understand the design cycle and the relationship between design briefs and design specifications can be delivered through the use of these resources.

Learners could study relevant Siemens resources bank (http://www.siemens.co.uk/education), identifying the key phases of the development cycle. They could for example, be taught in mathematics to use tables and graphs (both linear and non-linear) and apply this knowledge to inform a detailed and comprehensive conclusion.

Building up research skills and applying appropriate mathematics and science, learners could use resource links documents web sites such as www.technologystudent.com/designpro/despro1.htm as part of their research. From this, learners could be better informed to present their ideas through the use of well researched analysis.

Use the OCR guide to research to develop learners' research skills.

http://www.ocr.org.uk/i-want-to/skills-guides/



Examples showing how the resources available from the OCR website can be used with this project approach

Unit R105: Design briefs, design specifications and user requirements

LO1: Understand the design cycle and the relationship between design briefs and design specifications

	Unit	Learning Outcome (LO)
Module 1	R105 R106	LO1 LO3 LO2

The Project Approach

Activity 1 (R105 – LO1)

Learners could create and deliver a presentation explaining the four phases of the design cycle. The purpose of the presentation would be to improve understanding of the design cycle in learners joining a Key Stage 4 Engineering course.

The Delivery Guide (R105 – LO1)

Suggested content	Suggested activities	Suggested timings	Possible relevance to
The design cycle: identify and design phases	Learners could use a product case study in order to explore the four stages of the design cycle: identify, design, optimise and validation. The first two stages involve devising the design brief, undertaking research, process planning, producing a specification, design, and producing manufacturing plans. Websites might prove useful to teachers for explaining the design cycle such as BBC Bitesize : http://www.bbc.co.uk/schools/gcsebitesize/design/systemscontrol/designevaluationrev1.shtml	2 hours	

Lesson Element (R105)

Life Cycle Analysis

This lesson element gives learners the opportunity to practice life cycle analysis.

http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-design-level-1-2-award-certificate-j831-j841/

OCR Oxford Cambridge and RSA

Engineering

Level 1/2

Cambridge NATIONALS

Unit R105 – Design briefs, designs specifications and user requirements

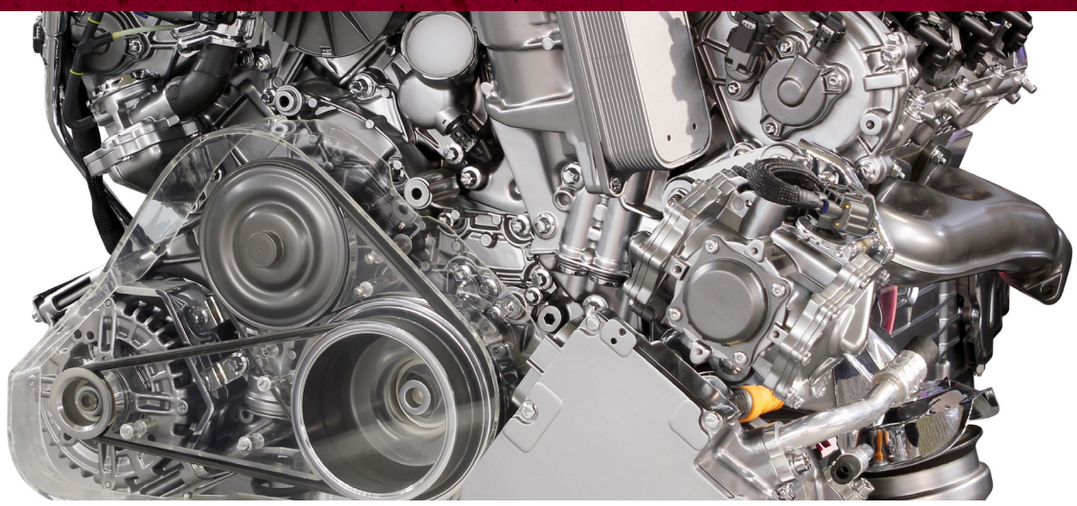
Life Cycle Analysis

Task 1:

When designing and manufacturing products, it is important to consider life cycle analysis (LCA). Life cycle covers the time from when a product is manufactured to its recycling or disposal.

Some products have a relatively short life cycle, and some have a life cycle that is much longer.

Look at the photos below. Working in groups; research the life cycle for glass bottles and the mobile phone. Draw diagrams to show the life cycle for each product and make sure to label your diagrams and add notes.



Cambridge Nationals in Engineering – Mapping to mathematics and science

This document will help you plan your curriculum and assist you in delivering related subjects such as mathematics, science and ICT when teaching your Cambridge Nationals in Engineering.

The mapping of R105 LO1 to maths foundation – initial and bronze

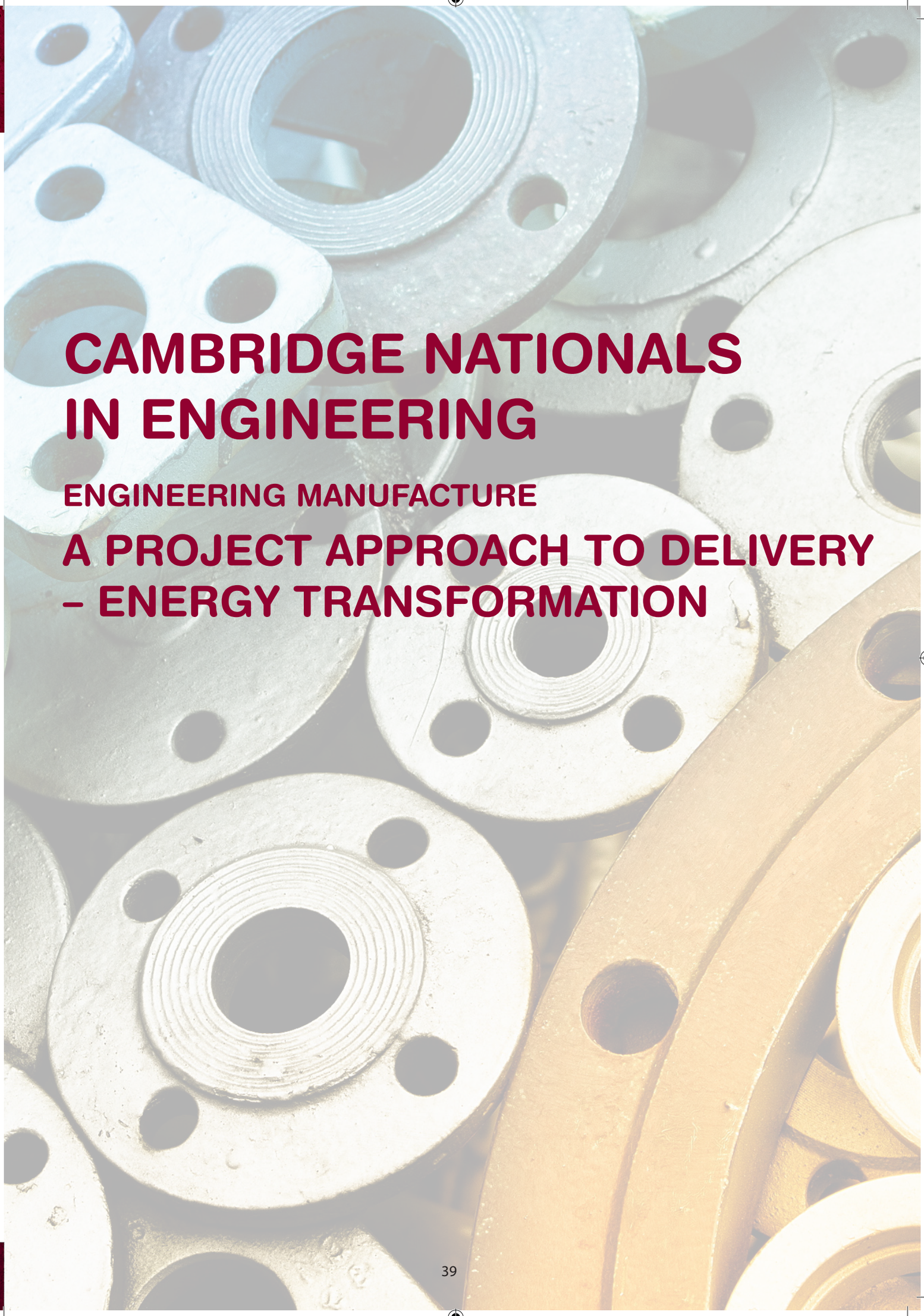
The example below is an extract from this mapping document and suggests how GCSE mathematics could be taught and then applied to develop skills in evaluating market data necessary for LO1.

	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Market research (surveys) Improvements in materials Budgets	Be able to interpret data (market research) used to influence the design process.[Direct]	FIA5 Construct and interpret simple graphs, including conversion graphs. FIS4 Draw and interpret simple frequency tables, charts, pictograms and bar charts for discrete data. FIS5 Extract and use information from common two-way tables including timetables.	FBA5 Interpret information presented in a range of linear and non-linear graphs, including travel (distance/time) graphs. FBS3 Construct and interpret pie charts. FBS4 Interpret graphs representing real data, including recognising misleading diagrams.

Learners are required to interpret data that will influence a design idea (R105) which will require them to make comparisons of relevant data and perhaps present them visually. In maths, (FIS4) learners are required to draw and interpret simple frequency tables, charts, pictograms and bar charts for discrete data, then FIS5) extract and use information from common two-way tables including timetables. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.

The Skills Guides.

Learners could use the OCR guide to research skills and the OCR guide to presentation skills to help them develop these skills.



CAMBRIDGE NATIONALS IN ENGINEERING

ENGINEERING MANUFACTURE

A PROJECT APPROACH TO DELIVERY – ENERGY TRANSFORMATION

INTRODUCTION

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An holistic approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge could link together in a working environment.

This guide looks at the delivery and facilitation of learning of the following units:

Unit R109: Engineering materials, processes and production

Unit R110: Preparing and planning for manufacture

Unit R111: Computer aided manufacturing

Unit R112: Quality control of engineered products

In this example, the objective is for learners to develop their knowledge of engineering manufacturing through practical engagement with projects and activities designed and supported by Siemens.

The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide foundation knowledge for their final assessment. The practice review activities within the modules **must not** be used for Cambridge National final assessment purposes. Model assignment tasks for each of the Cambridge National qualifications can be found at www.ocr.org.uk.

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- Provide the learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides the learners with an opportunity to consider how they would use their engineering skills holistically within the working environment.

This guide is divided into four modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each module provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding prior to final assessment and evidencing by the learner.

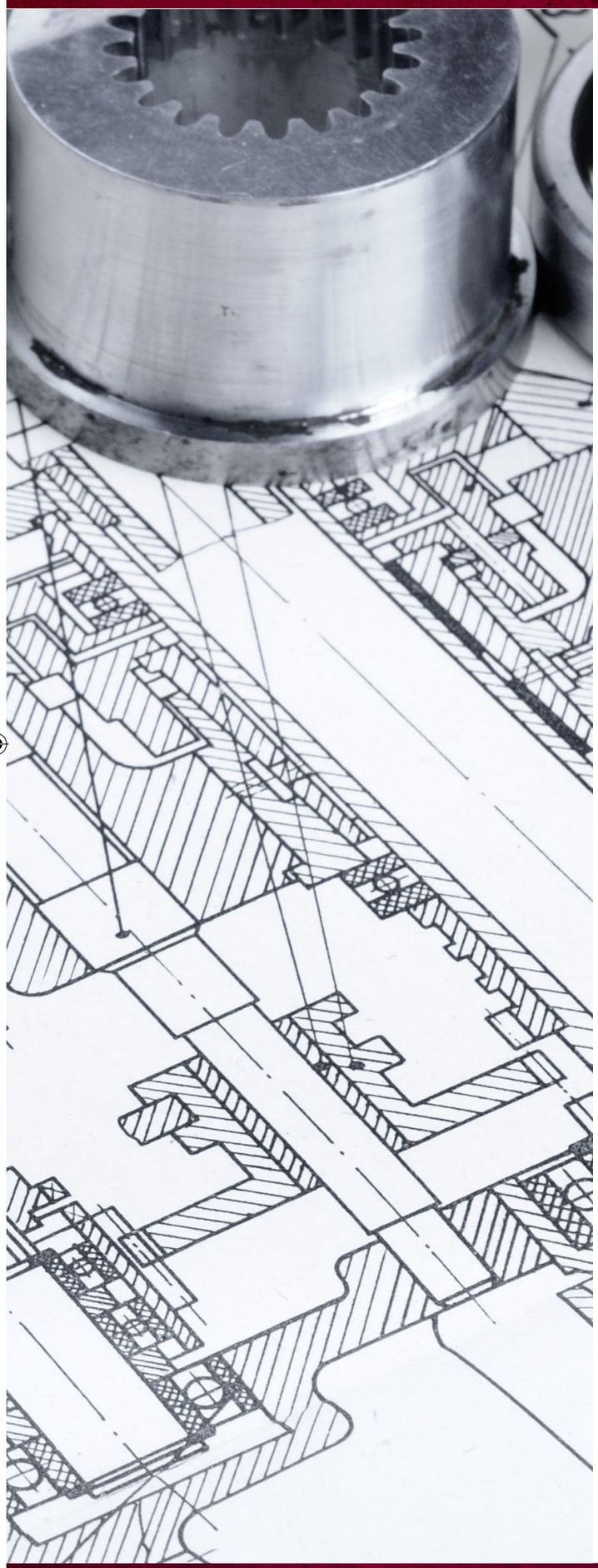
Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the controlled assessment units R110, R111 and R112 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R109	Module 1	Module 1	Module 1	Module 1
Unit R110	Module 2	Module 2	Module 2	
Unit R111	Module 3	Module 3	Module 3	Module 3
Unit R112	Module 4	Module 4	Module 4	Module 4 Module 2

By Module

	Unit	LO
Module 1	R109	LO1 LO2 LO3 LO4
Module 2	R110 R112	LO1 LO2 LO3 LO4
Module 3	R111	LO1 LO2 LO3 LO4
Module 4	R112	LO1 LO2 LO3 LO4



Energy Transformation Project

The Project Brief

(Learner version of the Project Brief is available from http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-manufacture-level-1-2-award-certificate-j832-j842/)

Learners have been asked to take the CAD drawing of a component, a fly wheel or fly wheel holder would be suitable, and:

- consider alternative materials and suggest the most appropriate material for use in the manufacture of the component
- produce a pre-production version of the component using manual methods
- produce a batch of identical components using CNC manufacturing methods.

Learners will carry out quality inspection in which they:

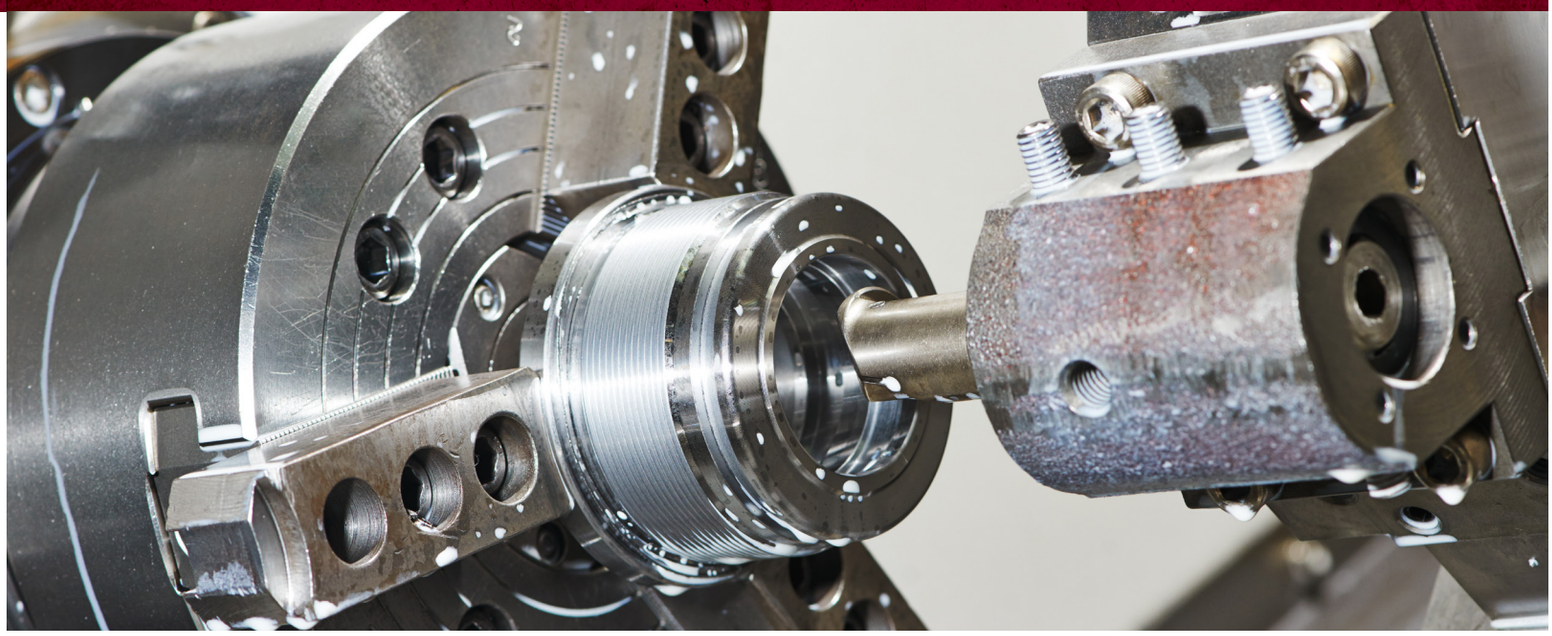
- compare the pre-production version on the component to the those produced using CNC methods
- evaluate the consistency of the batch of components.

This work could be undertaken as individuals or within a team. If working within a team all learners are expected to contribute in each of the areas in order to gain the experience and knowledge required to successfully complete the Cambridge National in Engineering Manufacture.

The Energy Transformation Project explores the challenges of modern manufacturing in the innovative area of energy transformation.

By linking the manufacturing process to the cutting edge area of energy recovery, learners will see the relevance and challenges of the modern engineering manufacture.

Learners will engage with a range of manufacturing methods and approaches before manufacturing a key energy transformation component themselves using CAD and CNC.



Module 1 - Engineering Materials, Processes and Production

The delivery begins with unit R109 (LO1, LO2 and LO3).

Before learners can start to design and test a manufacturing system they need to have a good understanding of:

- engineering materials
- engineering processes
- developments in engineering
- the impact of modern technology on engineering.

Contained within the following assessment criteria/LO(s)/ units:

Know about properties and uses of engineering materials	LO1	R109
Understand engineering processes and their application	LO2	R109
Know about developments in engineering processes	LO3	R109
Understand the impact of modern technologies on engineering production	LO4	R109

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

To help learners relate to the range of engineering materials they have been studying, they could annotate engineering drawings or diagrams showing the different materials, classification and the properties of the materials. The drawings should cover a range of materials and learners could include descriptions of the properties and uses of the materials in the annotation. The given drawings or diagrams could be for a single product or a range of products depending on group size for the task. The 'Project Approach Resource Bank' (http://www.siemens.co.uk/education) contains a number of suitable drawings for this purpose.

Activity 2

Learners could embed their understanding of engineering processes and the safe use of tools and equipment by producing a short video showing how to conduct a risk assessment and the correct ways to use engineering equipment. Different groups of learners could be given different workshop processes to focus on. Ideally the processes would link to the process to be used in this project.

Activity 3

Learners could develop their understanding of the application of processes by creating a card or board game where they have to match potential processes with a range of products, highlighting which processes could be used in making the products (a range of Siemens products should be chosen that could be made using multiple processes) Siemens' 'Products and technology videos' (http://www.energy.siemens.com/br/en/energy-topics/videos/).

Learners could take the full list of processes from the learning outcomes listed on pages 8 and 9 of the specification (http://www.ocr.org.uk/Images/150704-specification.pdf) and create a card for each, with a description of the process and its uses. They could then create a series of 'Product' cards with a description of the materials and major components. Learners could then compete to find the product that could be made using the most different processes.

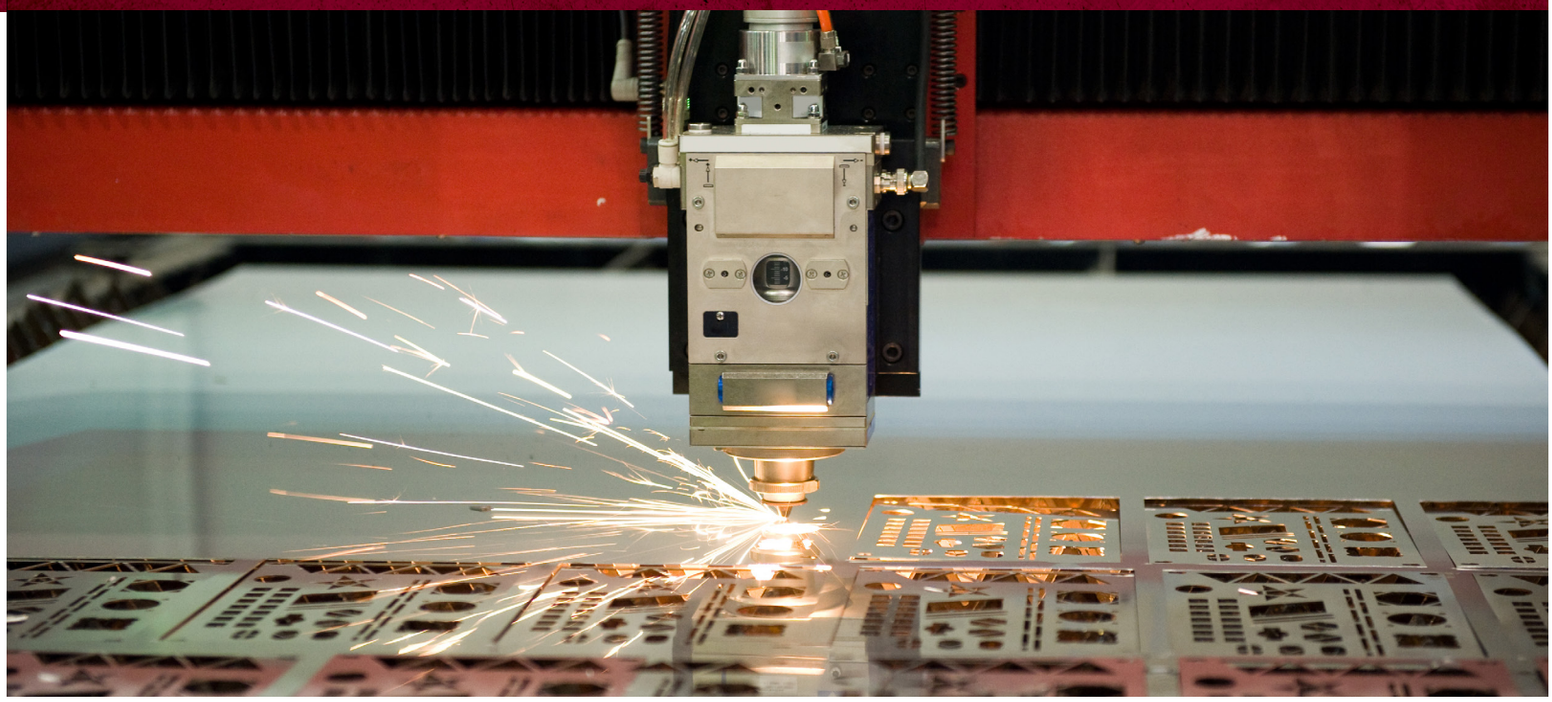
The objective of the game is to get learners to discuss different ways the same component can be made.

Activity 4

Learners could explore the different uses of materials by engaging with the Siemens' 'Green Racers' (http://www.siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) materials. Based on 'The Green Power Challenge' (https://www.plm.automation.siemens.com/en_us/academic/resources/solid-edge/student-download.cfm?), the different materials used in the construction of the racers is discussed and learners can apply knowledge of materials and production processes to design products and produce practical solutions that are relevant and fit for purpose. Learners could use the information gained to outline their own materials list.

Activity 5

Learners could develop their practical understanding of how modern technology is impacting on manufacturing by visiting a modern manufacturing facility. A visit to the Siemens' Crystal Sustainable Cities Initiative (http://www.siemens.co.uk/education/en/teachers/the-crystal.htm) in London could also be considered. Learners could be given a range of tasks related to identifying and explaining the examples of new technology in engineering.



Module 2 - Preparing and Planning for Manufacture

The delivery then follows through units R110 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Be able to plan for the making of a pre-production product	LO1	R110
Be able to use processes, tools and equipment safely to make a pre-production model	LO2	R110
Be able to modify a production plan for different scales of production	LO3	R110

This will allow learners to develop their skills in using a range of engineering processes to produce a model of the component to be manufactured.

Using knowledge gained researching real life manufacturing processes learners may develop their planning and organisational skills.

During the delivery of the units learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learnerscould develop their understanding of engineering drawings by producing a production plan based on a series of given 2D and 3D engineering drawings of a product.

See 'Project Approach Resource Bank' (http://www.siemens.co.uk/education).

The plan should include details of tools, equipment, sequence of operation, health and safety and quality checks for the production.

Activity 2

Learners could develop their practical understanding of production plans by creating a flow chart summarising the stages in the production of a product.

Activity 3

Learners may practice their use of tools, equipment and processes by following the flow chart they have created to manufacture a pre-production model of the product. Learners should be encouraged to consider how they could record and present the work they are undertaking through the use of; photographs, logs, video, audio and diagrams.

Activity 4

Learners could develop their understanding of production planning by taking part in the Siemens''Lean Machines' (http://www.siemens.co.uk/education/en/students/interactives.htm) game. Learners could undertake the activity in class time or a competition could be set up for the learners to compete in their own time. A follow on presentation could be included where learners explain how they optimised the production of the MINIs.

Activity 5

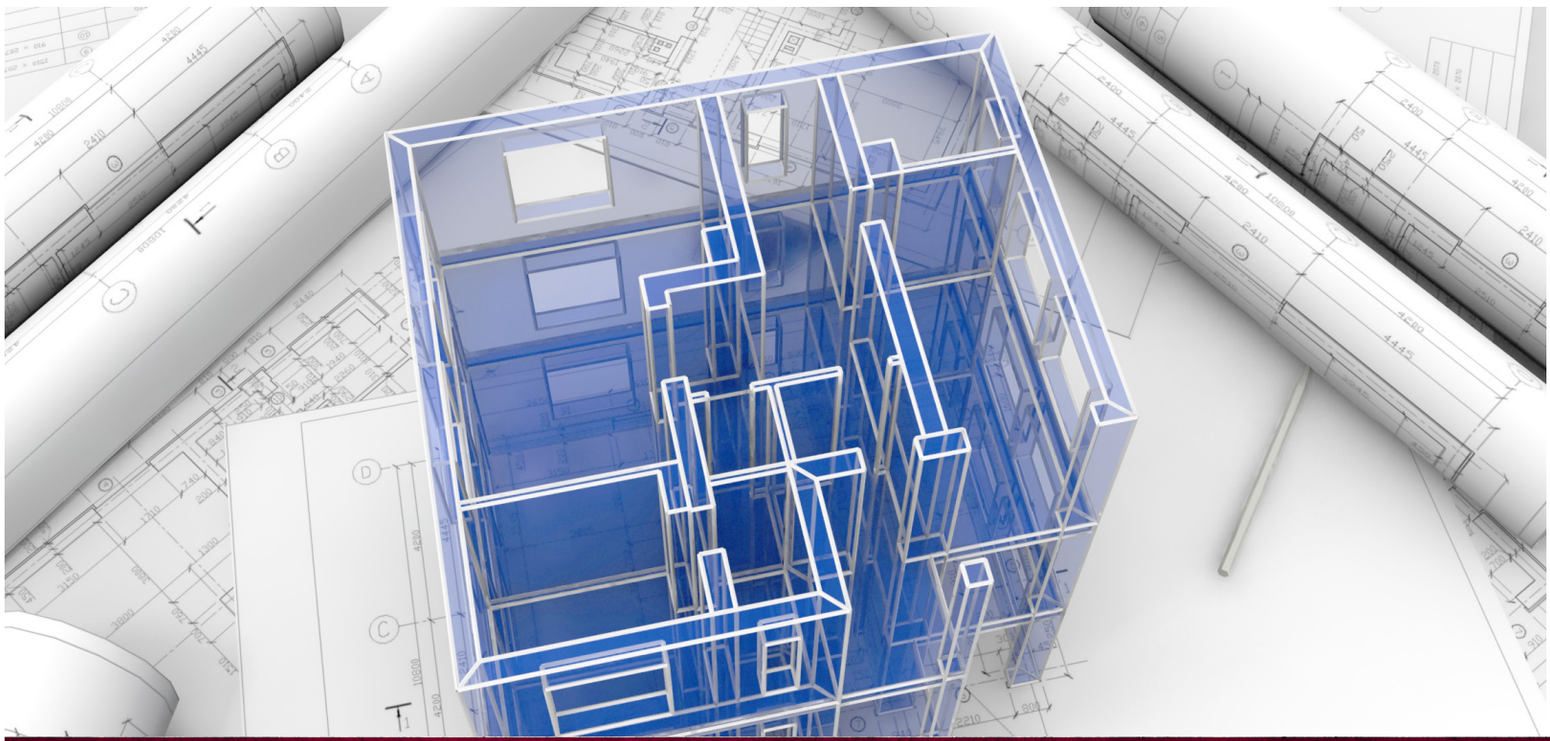
Learners could improve their understanding of scales of production by reviewing the production plan they created for a pre-production model. Production plans should be modified to encompass:

- batch production techniques
- mass production techniques.

The revisions should include detail on the challenges and advantages of each of these types of production.

Energy Transformation Project – related task

Learners could analyse the product information and create a production plan for the manufacture of the model of a fly wheel.



Module 3 - Computer Aided Manufacture

The delivery then follows through units R111 (LO1, LO2, 103 and LO4).

Contained within the following assessment criteria/LO(s)/ units:

Be able to plan the production of components on Computer Numerical Control (CNC) machines	LO1	R111
Be able to interpret information from CAD to manufacture components on CNC equipment	LO2	R111
Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components	LO3	R111
Know about applications of computer control processes used to manufacture products	LO4	R111

This will allow learners to develop the ability to interpret CAD information and use it to manufacture a range of components on a CNC machine.

Learners will gain a practical understanding of how computers are used in manufacturing.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

In order to give maximum exposure to this topic, learners should be given access to a CNC simulation (several are available with educational licences). Learners are then given a range of simple tasks and then programme the simulator accordingly. This may be delivered as a classroom or homework task, depending on access to the simulation software.

Activity 2

Learners develop their CNC programming skills by making virtual products from given information using a CAD package eg Siemens' 'Solid Edge Student Edition' (https://www.plm.automation.siemens.com/en_us/academic/resources/solid-edge/student-download.cfm?), which they import into the CNC simulation. Learners should evaluate the performance of the simulation activity.

Activity 3

Learners could develop the understanding gained in producing virtual products by selecting one product and creating a production plan to manufacture it using a CNC machine.

Learners could use the plan to manufacture the product on a CNC machine. They should reflect on how useful the plan was in supporting the activity.

Learners should be encouraged to record their progress and techniques throughout the activity, using suitable formats.

Activity 4

Learners could develop their understanding of 'methods of comparison' by creating a balanced scorecard for the product they made via manual methods and CNC production. The aspects of the scorecard should be: visual, dimensional, cycle time, consistency.

Videos demonstrating the Siemens use of the Balanced Scorecard are included in the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education).

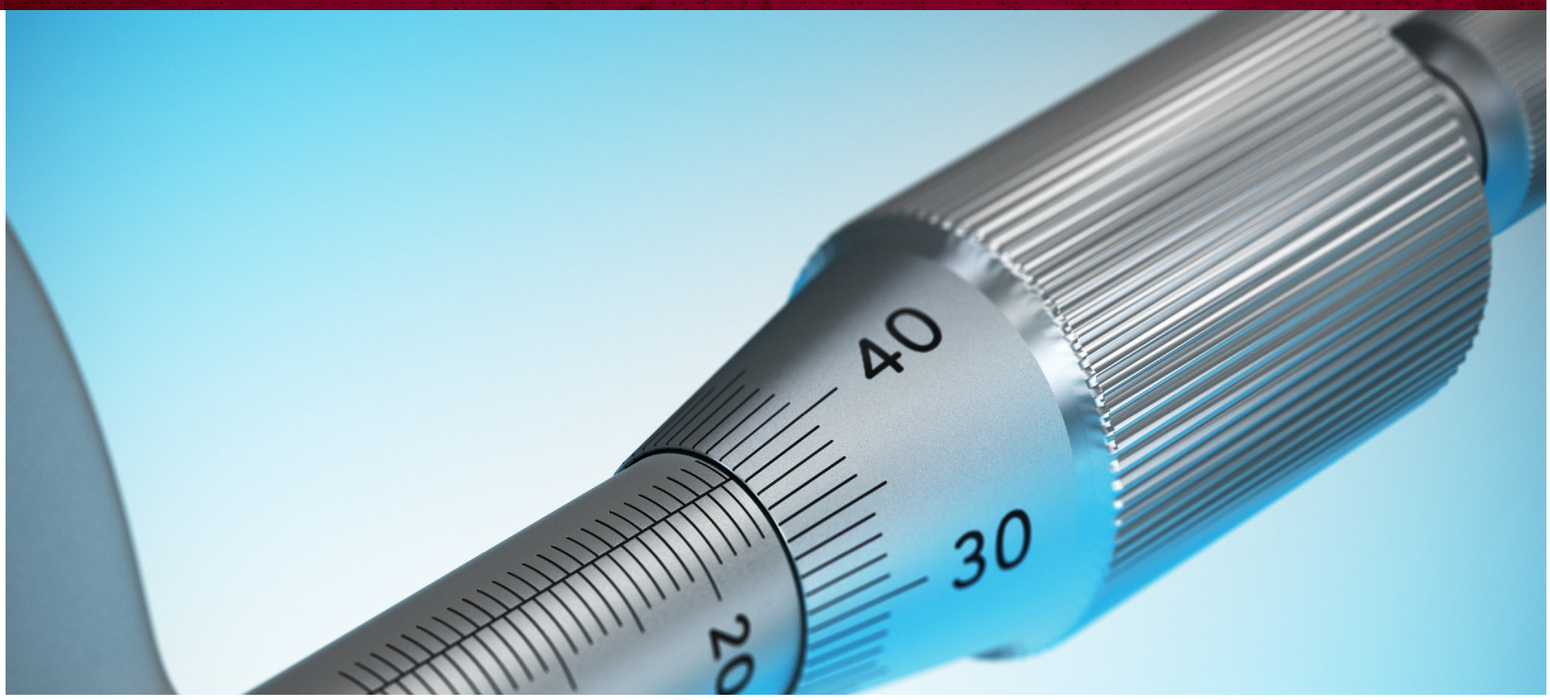
Activity 5

Learners could develop their understanding of the relationship between computer controlled processes and manufacturing by researching how Siemens use:

- rapid prototyping
- manufacturing processes
- robotics
- different scales of production.

A treasure hunt style activity could be used where the learners work in teams to carry out the research and must complete the full range of identified elements.

Videos demonstrating the Siemens' scales of production at an electronics plant are included in the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education).



Module 4 - Quality control of engineered products

The delivery then follows through unitsR112 (LO1, LO2, LO3 and LO4).

Contained within the following assessment criteria/LO(s)/ units:

Understand the importance of quality control	LO1	R112
Be able to assess product quality from inspection and quality control techniques	LO2	R112
Know how modern technologies can be used in quality control	LO3	R112
Know the principles of lean manufacturing	LO4	R112

Learners will develop an understanding of quality control philosophy and techniques.

The will develop skills in applying the principles of lean manufacture to manufacturing processes.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could develop their understanding and appreciation of the different approaches to quality by working in teams to hold a balloon debate based on the different quality procedures:

- quality control
- quality standards
- quality assurance
- total quality management.

This will help the learners to prioritise and rank the different procedures.

Learners could create a comparison table for the four different quality procedures listed. This could be presented as a wall chart.

Videos demonstrating the Siemens' approach to quality control are included in the 'Project Approach Resource Bank' (http://www.siemens.co.uk/education).

Activity 2

Learners could develop an understanding of the importance of quality by taking a Siemens product (a train would be suitable) and writing a newspaper story based on what would happen if Siemens decided to abandon all quality procedures.

The story should cover issues such as production problems, waste, consistency, cost, safety, conformity and customer complaints.

'Rail Solutions' (http://w3.siemens.co.uk/MOBILITY/UK/EN/RAIL_SOLUTIONS/Pages/rail_solutions.aspx) has detail on Siemens' rail interests.

Activity 3

Learners could enhance their understanding of the relationship between quality and manufacturing by producing a diagram of a given production process and annotate it with details of which quality control techniques and equipment would be used at each stage and why. This activity could be effectively linked to a manufacturing visit or a visit to Siemens' Crystal Sustainable Cities Initiative (http://www.siemens.co.uk/education/en/teachers/the-crystal.htm).

Activity 4

Learners could improve their understanding of lean manufacturing by taking part in the Siemens' online manufacturing game, 'Lean Machines' (http://www.siemens.co.uk/education/en/students/interactives.htm) where they have to optimise the production of MINI cars using Lean principles.

http://www.dbda.net/clients/siemens/lean/

Glossary

Balanced Scorecard – a business technique used to focus on four different aspects of an operation. The four aspects can vary according to the operation being assessed, with each of the four aspects being assessed individually and then being combined to give an overall picture. For more information: http://www.businessballs.com/balanced_scorecard.htm

Treasure Hunt – teachers prepare a list of key elements that learners should find during their research. The learners are set up in teams and compete to find as many of the elements as possible within a given time. Collaboration between teams may or may not be encouraged depending on time and the objectives of the group

Balloon Debate – a small number of teams or individuals (no more than 6) are given different issues or approaches to debate. The scenario is that the teams are all in a hot air balloon losing height and needs to lose weight to stay afloat. The group, as a whole, vote to keep the most important teams in the balloon. The teams prepare an argument based on how important their issue or approach is. The teams present their arguments and then the whole group votes for the teams they wish to stay in the balloon. This works well with two rounds of debate. Depending on the number of teams, the first round of votes sees all but two or three teams thrown out of the balloon. The remaining teams then have a second, shorter debate, after which all but one team is thrown from the balloon.

Crystal - a sustainable cities initiative by Siemens exploring the future of cities. Home to the world's largest exhibition focused on urban sustainability and a world-class centre for dialogue, discovery and learning. http://www.thecrystal.org/

Delivering the project holistically

This project should be delivered in conjunction with other resources available on the OCR website. www.ocr.org.uk/cambridgenationals in the teaching and learning resources area.

Teaching and learning resources

Teaching and learning resources for each Cambridge National in Engineering are:

- the Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the delivery guide and lesson elements to enhance teaching and learning through each module in the project approach.

The example below shows how Unit R109: Engineering materials, processes and production LO1: Know about properties and uses of engineering materials can be delivered using these resources.

Learners could study relevant Siemens resources bank http://www.siemens.co.uk/education/en/. Learners could annotate engineering drawings or diagrams showing the different materials, classification and the properties of the materials. The drawings should cover a range of materials and learners could include descriptions of the properties and uses of the materials in the annotation.

Learners are required to interpret drawings that will include dimensions, tolerance and scale, which will require them to make comparisons of relevant data. In maths, learners are required to convert measurements from one metric unit to another and interpret scales on a range of measuring instruments. Learners could extract numeric values from any technical drawing to manipulate the dimensions and use simple proportion calculations to consider economies of scale or different production quantities of one off, batch and mass production.

They could for example, be taught in mathematics to use tables and graphs (both linear and non-linear) and apply this knowledge to inform a detailed and comprehensive conclusion.

Building up research skills and applying appropriate mathematics and science, learners could use resource links documents web sites such as (http://www.energy.siemens.com/br/en/energy-topics/videos/). provide useful background information on the different forms of energy production as part of their research.

Use the OCR guide to research to develop learners' research skills. http://www.ocr.org.uk/i-want-to/skills-guides/

Examples showing how the resources available from the OCR website can be used with this project approach

Unit R109: Engineering materials, processes and production

LO1: Know about properties and uses of engineering materials

	Unit	Learning Outcome (LO)
Module 1	R109	LO1 LO2 LO3 LO4

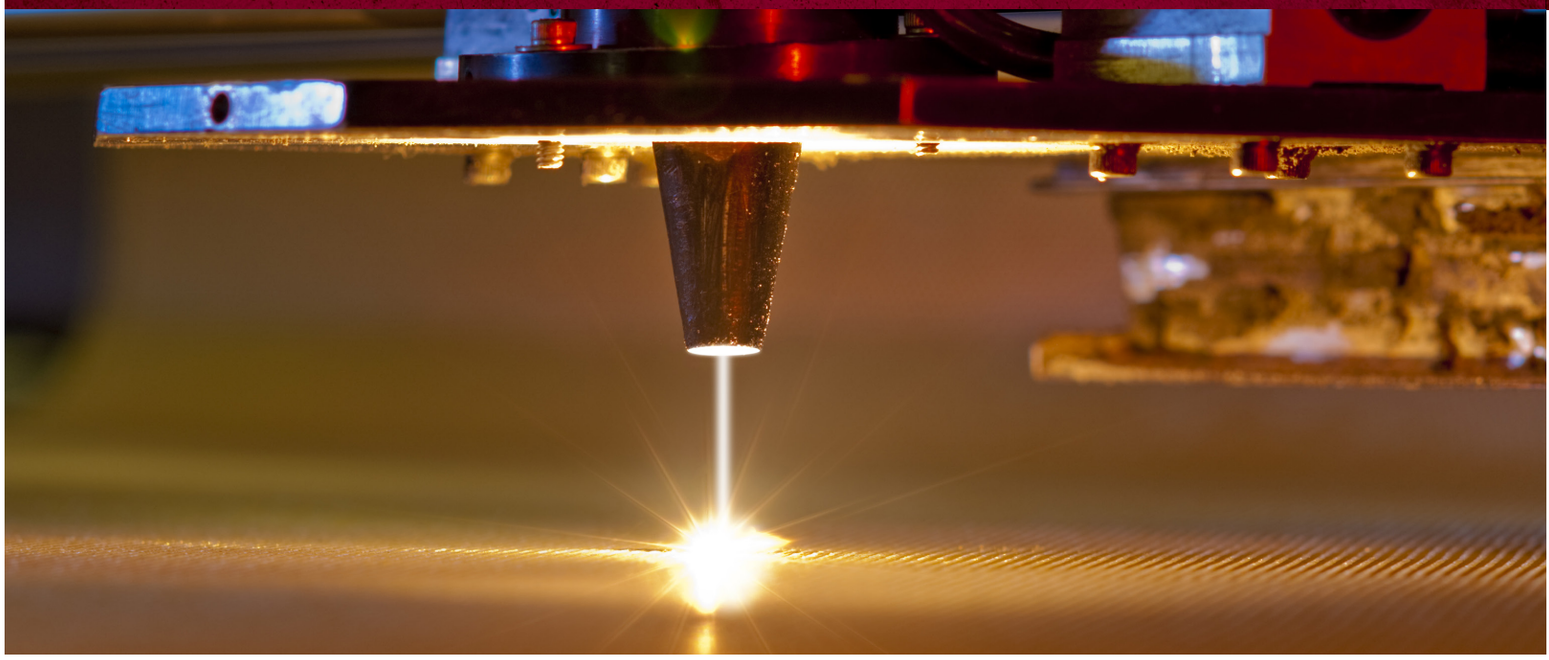
The Project Approach

Activity 1 (R109 – LO1)

To help learners relate to the range of engineering materials they have been studying, they could annotate engineering drawings or diagrams showing the different materials, classification and the properties of the materials. The drawings should cover a range of materials and learners could include descriptions of the properties and uses of the materials in the annotation. The given drawings or diagrams could be for a single product or a range of products depending on group size for the task. The 'Project Approach Resource Bank' (Link to be created) contains a number of suitable drawings for this purpose.

The Delivery Guide (R109 – LO1)

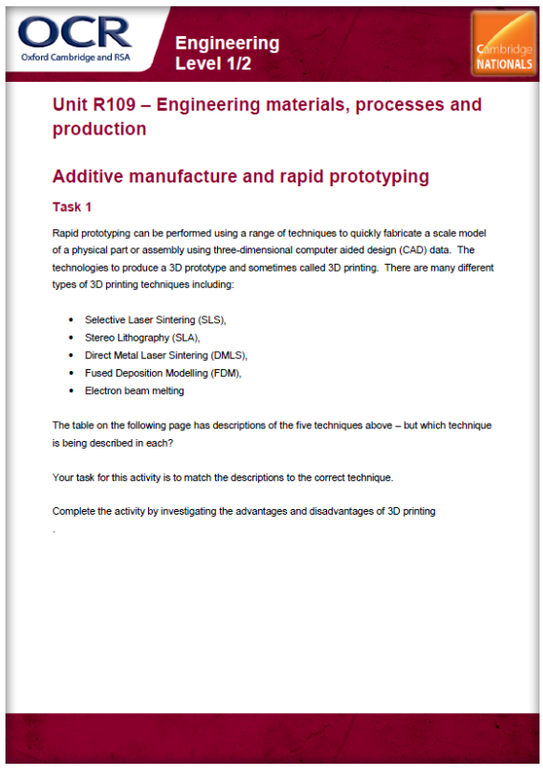
Suggested content	Suggested activities	Suggested timings	Possible relevance to
Engineering materials: metals	Teachers might develop an understanding of the properties of engineering materials through practical demonstrations or develop simple practical experiments for learners to perform. Learners could be given a range of metals to handle and tasked to research their properties including: Ferrous metals and alloys: iron, carbon steels, stainless steel, high speed steel Non-ferrous metals and alloys: copper, brass, bronze, aluminium alloys, zinc, tin, lead, titanium The use of internet sources to explain and explore properties of materials might be useful such as: http://www.bbc.co.uk/schools/gcsebitesize/design/electronics/materialsrev3.shtml which explains ferrous and non-ferrous metals.	2 hours	R103 (LO1) R106 (LO3, LO4)



Lesson Element (R109)
Additive manufacture and rapid prototyping

Learners are required to research 3D printing techniques used in rapid prototyping.

http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-manufacture-level-1-2-award-certificate-j832-j842/



OCR Oxford Cambridge and RSA

Engineering Level 1/2

Cambridge NATIONALS

Unit R109 – Engineering materials, processes and production

Additive manufacture and rapid prototyping

Task 1

Rapid prototyping can be performed using a range of techniques to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. The technologies to produce a 3D prototype and sometimes called 3D printing. There are many different types of 3D printing techniques including:

- Selective Laser Sintering (SLS),
- Stereo Lithography (SLA),
- Direct Metal Laser Sintering (DMLS),
- Fused Deposition Modelling (FDM),
- Electron beam melting

The table on the following page has descriptions of the five techniques above – but which technique is being described in each?

Your task for this activity is to match the descriptions to the correct technique.

Complete the activity by investigating the advantages and disadvantages of 3D printing

Cambridge Nationals in Engineering – Mapping to mathematics and science

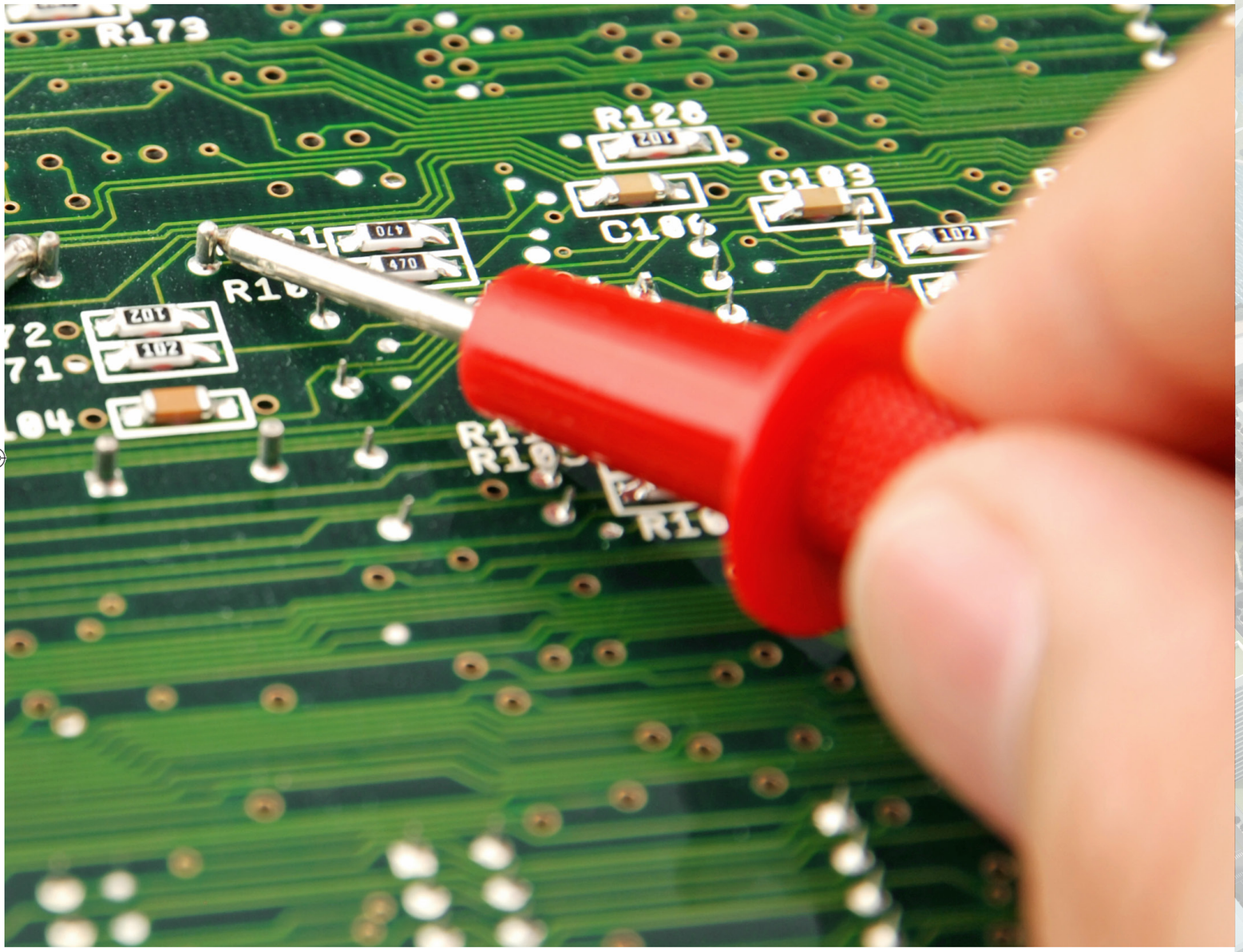
This document will help you plan your curriculum and assist you in delivering related subjects such as mathematics, science and ICT when teaching your Cambridge Nationals in Engineering.

The mapping of R110 LO1 to maths foundation – initial and bronze

The example below is an extract from this mapping document and suggests how GCSE mathematics could be taught and then applied to develop skills in evaluating market data necessary for LO1.

	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Drawings and views. Dimensions, tolerance, scale. Materials Production plans: sequence, time, QC	Be able to interpret engineering drawings including dimensions, tolerances and scale.	FIG1 Convert measurements from one metric unit to another Interpret scales on a range of measuring instruments. FIG2 Make sensible estimates of a range of measures in everyday settings.	FBN9 Use simple proportion, particularly in the context of recipes.

Learners are required to interpret drawings that will include dimensions, tolerance and scale, (R110) which will require them to make comparisons of relevant data. In maths, (FIG1) learners are required to convert measurements from one metric unit to another and interpret scales on a range of measuring instruments. Learners could extract numeric values from any technical drawing to manipulate the dimensions and use simple proportion calculations (FBN9) to consider economies of scale or different production quantities of one off, batch and mass production. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.


R173
R128
C103
C106
R1
R1
R1

CAMBRIDGE NATIONALS IN ENGINEERING

SYSTEMS CONTROL IN ENGINEERING

A PROJECT APPROACH TO DELIVERY – SMART HOMES

INTRODUCTION

The purpose of this guide is to give you an overview of how you could holistically deliver a range of units from the Cambridge National in Engineering Level 1/2 in conjunction with Siemens. When delivering any qualification it is always useful to be able to look at the variety of units and consider how they are or could be linked together – a holistic approach.

An holistic approach will provide you with a structured plan to teach the learners how a range of topics work together across a number of units, providing them with some understanding of how skills and knowledge could link together in a working environment.

This guide looks at the delivery and facilitation of learning of the following units:

Unit R113: Electronic principles

Unit R114: Simulate, construct and test electronic circuits

Unit R115: Engineering applications of computers

Unit R116: Process control systems

In this example, the objective is for learners to develop their knowledge of the way in which systems control is used in engineering through practical engagement with projects and activities designed and supported by Siemens.

The intention is that the learners will be taught a range of knowledge and skills within each of the units and then carry out relevant review activities at various stages. Each of the review activities (once successfully completed by the learner) will provide foundation knowledge for their final assessment. The practice review activities within the modules must not be used for Cambridge National final assessment purposes. Model assignment tasks for each of the Cambridge National qualifications can be found at www.ocr.org.uk.

It is assumed that the learners will be given the opportunity to carry out activities that will enable them to practice the skills they have learned within each module prior to being given final assessment activities.

When considering a holistic approach to delivery and learning it is important to consider the overall objectives. In this guide the objectives are to:

- Deliver all four units to achieve the Level 2 Cambridge National Certificate in Systems Control in Engineering.
- Structure a programme of learning and reviews which are exciting and engaging for the learners.
- Provide the learners with an overview of how the knowledge and skills gained in one unit, support the knowledge and skills used within other units.
- Provides the learners with an opportunity to consider how they would use their engineering skills holistically within the working environment.

This guide is divided into four modules which may be sub-divided or combined according to the teaching time available.

The tables below show where each module provides delivery approaches and learning opportunities to ensure a thorough review of skills and understanding prior to final assessment and evidencing by the learner.

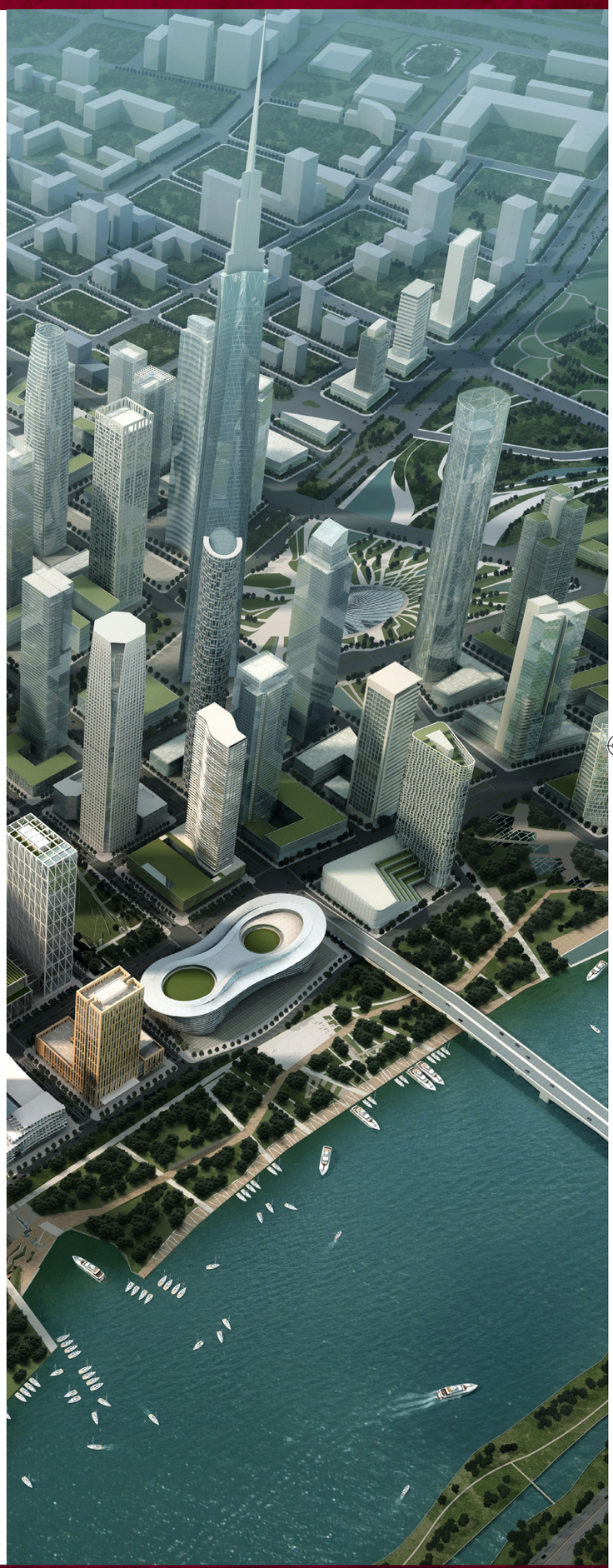
Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the controlled assessment units R114, R115 and R116 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R113	Module 1	Module 1	Module 1	Module 1
Unit R114	Module 2	Module 2 Module 1	Module 2 Module 1	
Unit R115	Module 3	Module 3	Module 3	
Unit R116	Module 4	Module 4	Module 4	

By Module

	Unit	LO
Module 1	R113	LO1, LO2, LO3, LO4
	R114	LO2,LO3
Module 2	R114	LO1, LO2, LO3
Module 3	R115	LO1, LO2, LO3
Module 4	R116	LO1, LO2, LO3



SMART Homes Project
The Project Brief

(Learner version of the Project Brief is available from www.ocr.org.uk/qualifications/cambridge-nationals-engineering-design-level-1-2-award-certificate-j831-j841/.

SMART Homes use a range of micro-generation technologies to provide power generation.

Any surplus power generated can be sold back to the national grid.

Learners have been asked to test and manufacture an electronic circuit that indicates the balance of energy generation and energy usage, suitable for use in a model SMART home for school use.

The circuit provide by Siemens is suitable for this application.

Task 1:

- Use CAD simulation to :
  - simulate and test the circuit operation
  - design the printed circuit board
- Use appropriate tools and techniques to:
  - manufacture the circuit board
  - assemble components to the circuit board
  - test and evaluate the operation of the constructed circuit

Task 2:

To ensure energy efficiency within a SMART house, an automatic control system is required to control lighting and heating.

The task is to:

- design a control system solution that will enable lighting and heating to be automatically adjusted considering elements such as:
  - external temperature
  - external light level
  - room usage (movement)
  - time of day
- Simulate the control system operation
- Transfer the control programme to a programmable device and test.

This work can be undertaken as an individual or as a team. If working as a team all learners are expected to contribute to each of the areas in order to gain the experience and knowledge required to successfully complete the Cambridge National in Systems Control.

The SMART Homes project explores the design challenges of designing an educational simulation that explains net energy production within a SMART Home.

Environmental issues and climate change are high on everyone's agenda, through this project learners will develop a balanced view of the challenges and opportunities for individuals who want to make a difference.

Learners will engage with a range of construction techniques and simulation software to design and test electronic circuits and automated control solutions, with learners using ICT to learn about physics, electronics, mathematics and systems design.

Module 1 – Electronic principles

The delivery begins with unit R113 (LO1, LO2, LO3 and LO4).

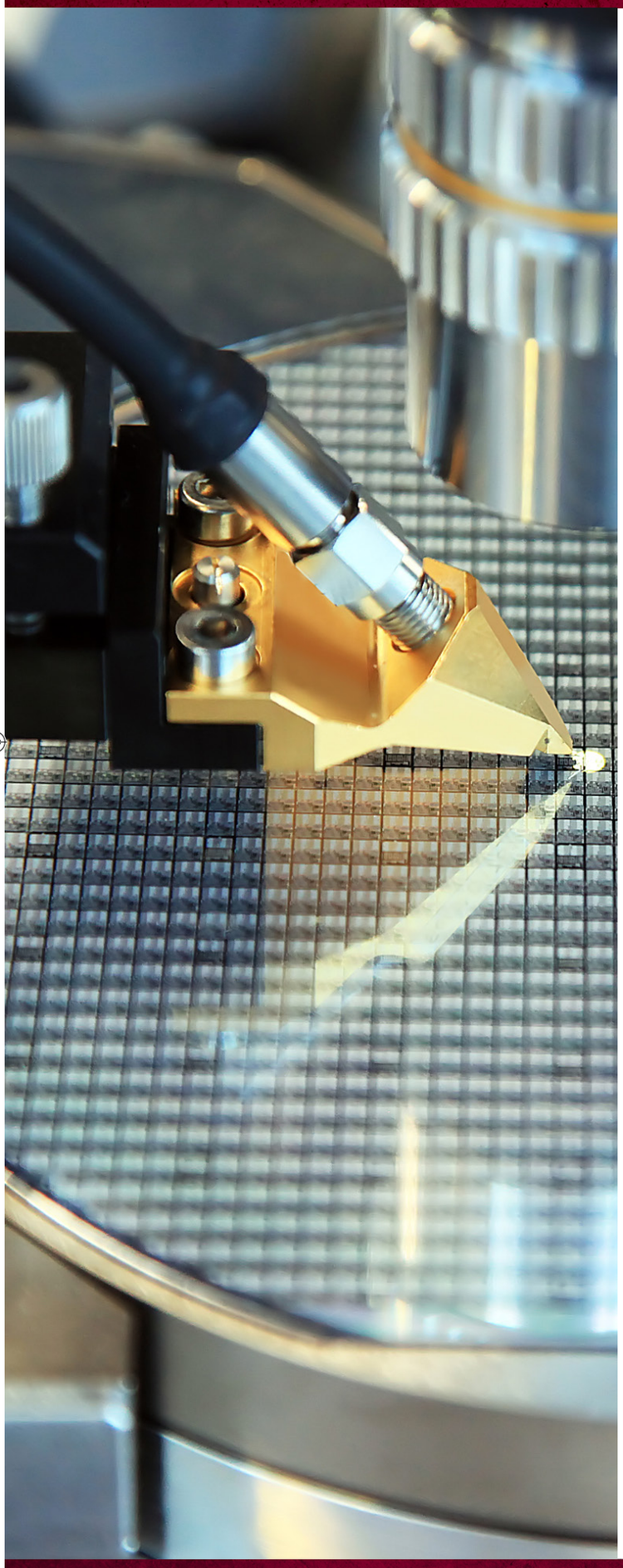
Before learners can start to design a control system for a SMART Home they need to have a good understanding of:

- electronic principles
- circuit simulation
- circuit construction
- circuit testing.

Contained within the following assessment criteria/LO(s)/ units:

Understand basic electronic principles	LO1	R113
Understand the operating principles of electronic components	LO2	R113
Know test methods for electronic circuits	LO3	R113
Understand commercial circuit construction methods	LO4	R113
Be able to construct circuits	LO2	R114
Be able to test electronic circuits	LO3	R114

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.



Practice Review Activities

Activity 1

Learners could develop their understanding of electronic principles by producing a series of teaching aids for the delivery of electronics to lower school pupils.

A number of the Siemens education resources can be used for reference.

Activity 2

Learners could apply their understanding of electronic components by creating an electronic component bingo game. The bingo cards could be different electronic circuits with electronic component symbols instead of numbers and the bingo balls would be the component names. This would help to introduce the concept of electronic components, the circuits they are linked with and linking the component name with the symbol.

The activity will help learners to match component symbols with the names and to recognise typical components in familiar circuits.

Activity 3

Learners' abilities to carry out electronic testing could be developed by presenting them with a circuit with known parameters. They should then obtain values at identified test points using the testing techniques they have been taught. The application of science and maths could be enhanced by asking them to calculate component values as part of the exercise.

The results should be entered onto a prepared table and compared with the correct figures at the end. Learners should revisit any tests where their values did not match the expected values.

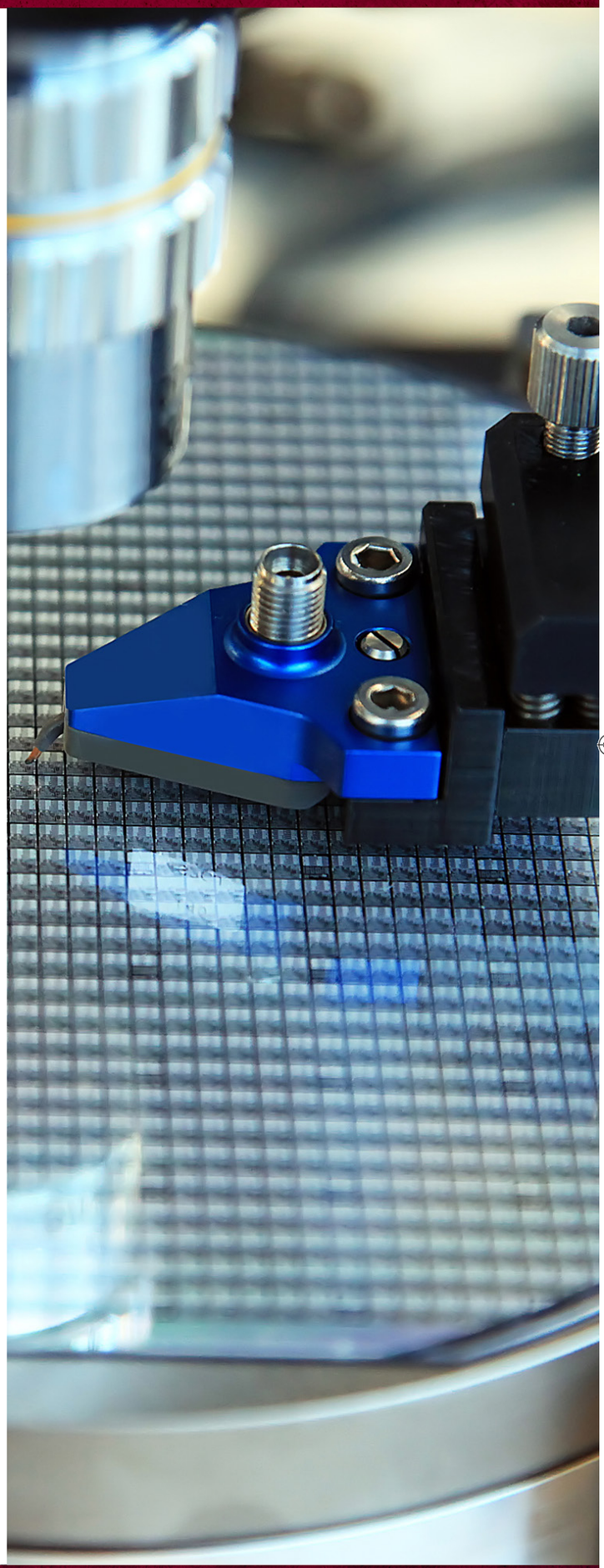
Activity 4

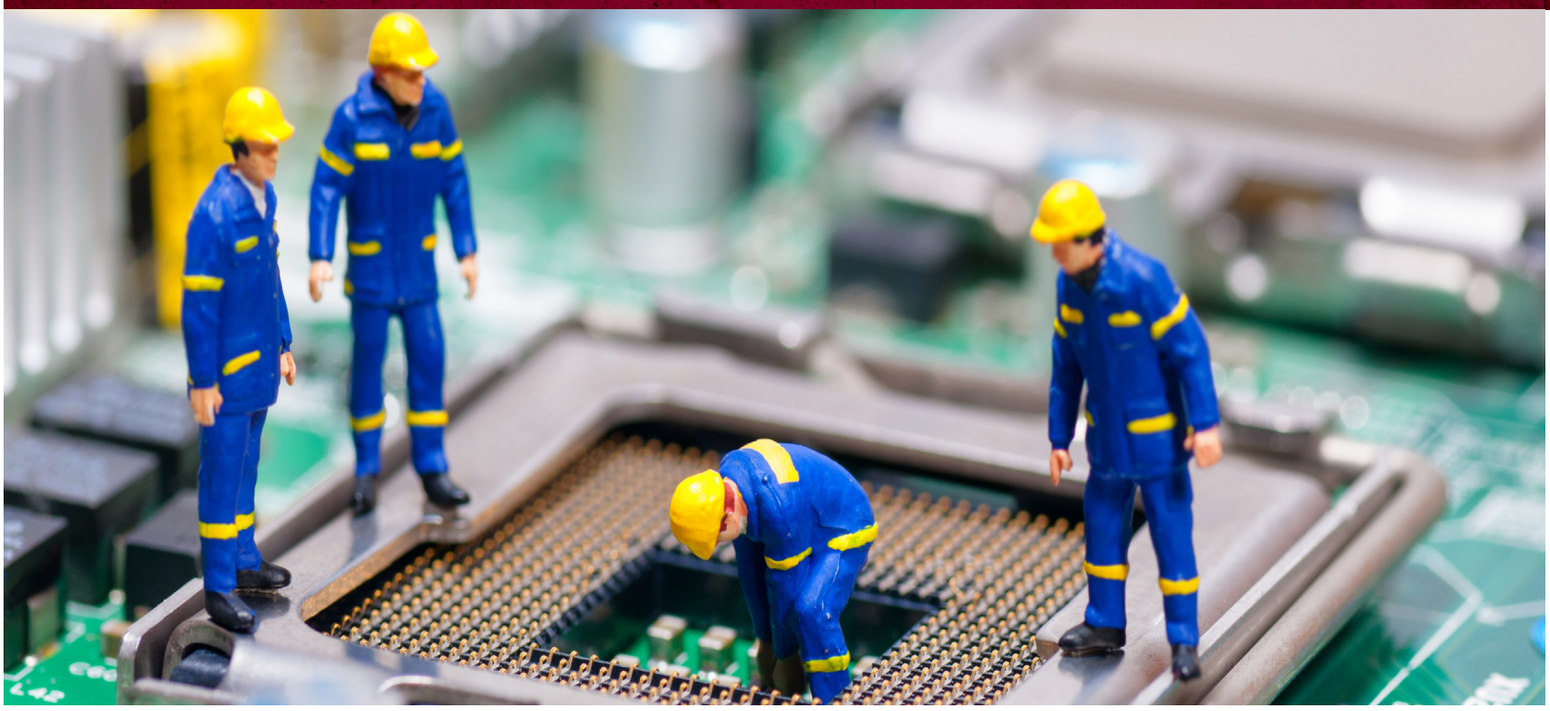
After being taught fault finding techniques, learners could consolidate their learning by working in teams to create a 'faulty circuit' (no more than two faults) for other teams to solve. Learners should construct a relatively simple circuit, or use one given, and introduce faults to the circuit. A circuit diagram and a description of the correct operation should be provided to the opposing team. The opposing team should then use fault finding techniques to identify the faults. Restrict the circuit to: low voltage operation only, 9v battery maximum.

Activity 5

Learners could confirm their understanding of circuit manufacturing methods in an exercise where they are presented with a series of pictures of circuits constructed using different commercial methods. 'Project Approach Resource Bank' (http://www.siemens.co.uk/education).

From the picture of the given circuit they should identify the likely construction method, considering pick and place robotic component placement, manual component placement, flow soldering and explain possible reasons why the method was selected.





Module 2 – Electronic Circuits

The delivery then follows through units R114 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Be able to use CAD for circuit simulation and design	LO1	R114
Be able to construct circuits	LO2	R114
Be able to test electronic circuits	LO3	R114

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

This will allow learners to develop their skill in using CAD to design, test and optimise circuits.

Learners will practice the construction and testing of circuits.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could follow on from their introductions to circuits by being given a circuit diagram from a Siemens' product, 'Project Approach Resource Bank' (http://www.siemens.co.uk/education), naming the different components in the circuit and then describing the operation of the circuit.

Activity 2

Learners then develop their understanding by being given access to a circuit simulation CAD package (a number are available for educational use). They are provided with a range of simple circuits, 'Project Approach Resource Bank' (http://www.siemens.co.uk/education), which they then create and test using the simulation software.

Activity 3

To develop their construction skills, learners are given a simple circuit design, maybe an audio amplifier for a portable music device, which they then construct.

The finished circuits are then tested and the learners write a short report evaluating the method they used, procedures followed, equipment used and any fault finding techniques applied.

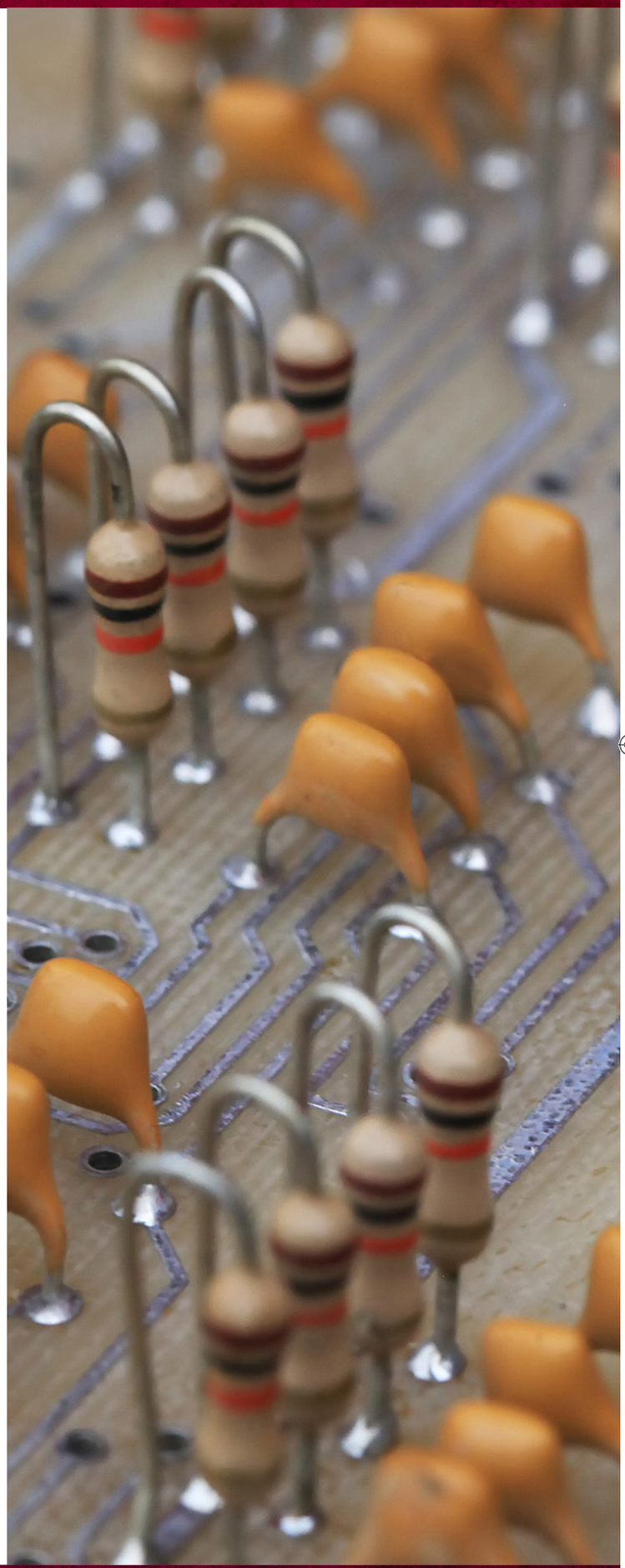
Activity 4

Learners could practice their fault finding techniques by locating a fault on a given circuit. The learners should devise a plan to test the circuit, noting down what tools, processes and approaches they could take and the results they could expect to see.

Learners then carry out the fault finding exercise according to their plan and then evaluate the effectiveness of the plan.

SMART Home Task links

Learners could use CAD simulation to design the SMART Home demonstrator circuit and construct elements of the circuit. Learners completing just the Award can undertake Task 1 of the SMART Homes Project.



Module 3 – Engineering applications of computers

The delivery then follows through units R115 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Understand how computers are used in engineering design, manufacture and process control	LO1	R115
Understand how computers are used for maintenance of engineering systems	LO2	R115
Know how computers are used to communicate and use data for production and maintenance	LO3	R115

This will allow learners to develop an understanding of how computers are integral to all areas of the product life cycle, from design and manufacture to operation and maintenance.

Learners will experience the integration of HMI (Human Machine Interface) control and remote computer communication.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could embed their understanding of the integration of computer control through a visit to the Siemens' Crystal Sustainable Cities Initiative (www.Siemens.co.uk/education/en/teachers/the-crystal.htm) experience in London to see one of the most sustainable buildings in Europe and understand how it was designed.

www.thecrystal.org/

Learners could explore the use of computer control through the Siemens' 'Totally in Control' (www.Siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) activity exploring the use of electronic communication for fairground rides and pedestrian crossings.

Activity 2

Learners could develop their practical understanding of the relationship between computer control and manufacturing by visiting a manufacturing facility. During the visit, learners create a flow diagram showing all the stages where computers are used in the process. They should identify the extent to which the computer is controlling each process. A SWOT (Strengths Weaknesses Opportunities Threats) analysis based on how computer control was used at the facility could be produced.

Activity 3

Learners could explain the functions of a HMI (Human Machine Interface) and an Expert System. Learners could be encouraged to imagine the HMI and the Expert System as people and describe an operational discussion the two people might have.

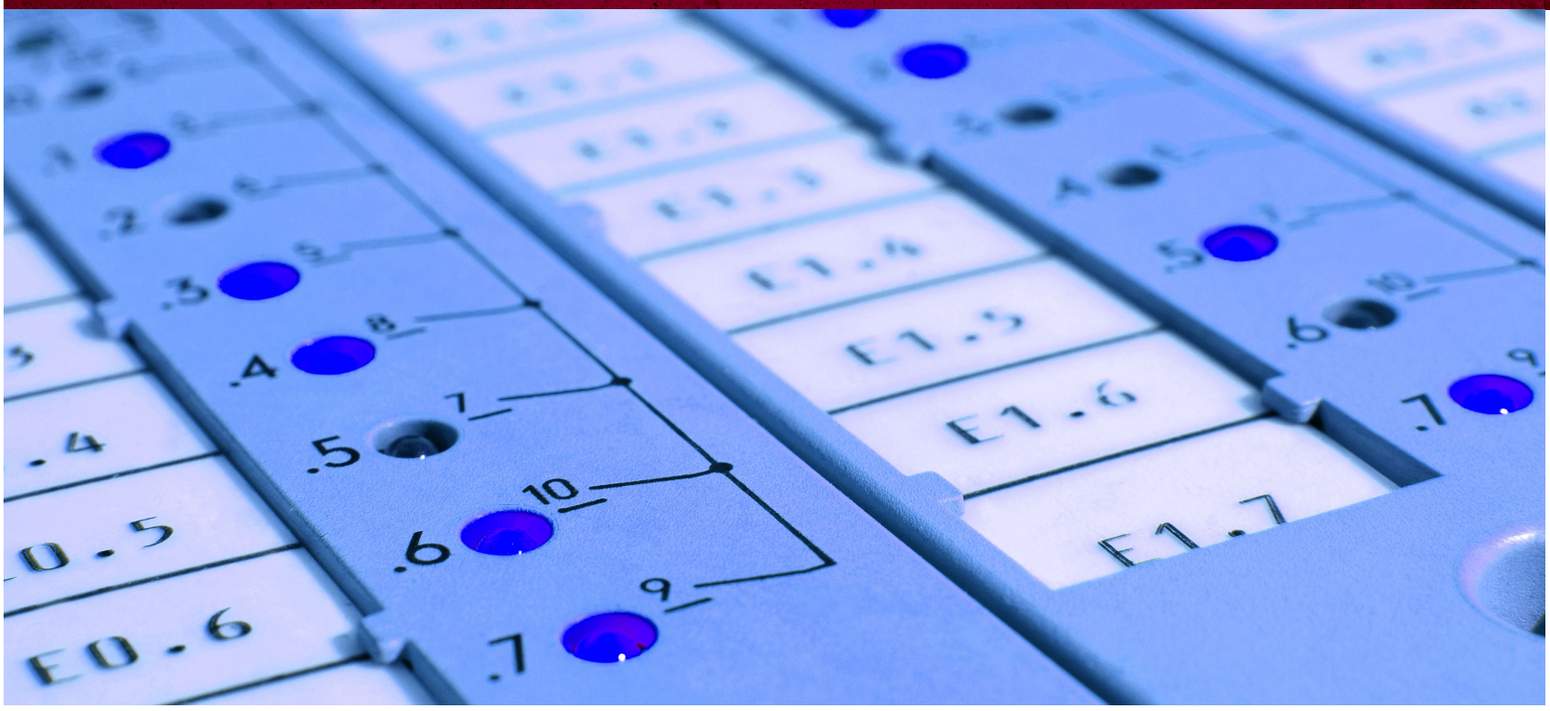
This is an opportunity for role play in the classroom, depending on the group, the teacher may ask some of the learners to act out their discussion for the group.

The objective is for learners to understand the different roles and impacts of HMI and Expert Systems.

Learners could use the Siemens"London Underground' (w3.Siemens.co.uk/smartgrid/uk/en/Services/mcs/smb/Pages/Case-Studies.aspx) case study to better understand Expert Systems.

Activity 4

Learners could develop their understanding of computers in collecting data and communicating by creating a map of communication and data collection for a given process (possibly from a manufacturing visit). Learners should be given a list of approaches and encouraged to use as many as possible as part of the plan. Learners create a diagram of the manufacturing process and then add in lines of communication with annotations to show where data is travelling and the purpose for the data. They could complete the exercise with a short reflection on how the process would continue if all computer communication was banned for some reason and had to revert to non-electronic control.



Module 4 – Process control systems

The delivery then follows through units R116 (LO1, LO2 and LO3).

Contained within the following assessment criteria/LO(s)/ units:

Understand the application and operation of microcontrollers and microprocessors in engineered products	LO1	R116
Be able to design, develop and simulate a control system	LO2	R116
Be able to test control systems	LO3	R116

This will allow learners to develop an understanding of control systems and how they operate, they will develop a skill in programming of PLC and/or PIC controllers and use a range of components in building a simple control system.

They will also develop the skills associated with risk assessment and contingency planning.

During the delivery of the units, the learners should carry out a range of activities to demonstrate and check their knowledge and understanding. They should also undertake review activities as they work through the programme of learning.

Practice Review Activities

Activity 1

Learners could be introduced to the idea of control systems by using the Siemens' 'Totally in control' (www.Siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) activity focused on the use of circuits in modern life. The activity focuses on how sequential process control operates in the context of fairground rides and pelican crossings.

Activity 2

Learners could develop their skills in testing control systems using a control system with a given fault condition. The learners should devise a plan to test the system, noting down what procedures would be followed, what equipment would be used and the fault finding technique. They should then follow the plan they set out and evaluate how effective the plan was at identifying the fault. They should be given the opportunity to revise the plan to see if it could be made more efficient.

Activity 3

Learners could develop their understanding of microprocessor control through access to PLC or PIC simulation software (there are a number available). Simple operation sequences of domestic products, such as Siemens washing machines, can be simulated by learners using the software. 'Siemens' Product and Technology Videos' (www.energy.Siemens.com/br/en/energy-topics/videos/)

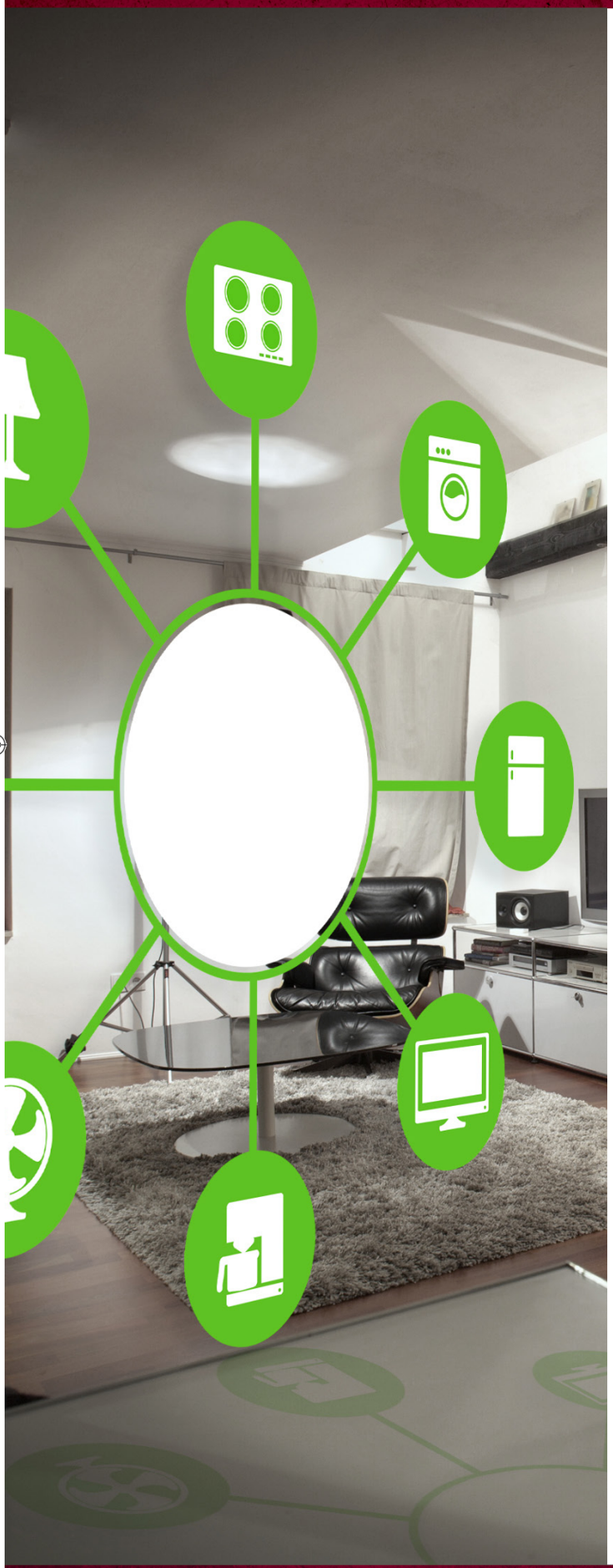
'Living Energy e-magazine' (www.energy.Siemens.com/br/en/energy-topics/publications/living-energy/).

Activity 4

Learners could take part in the Siemens' 'A case to resolve' (www.Siemens.co.uk/education/en/teachers/teaching-resources/schemes-of-work-ks4.htm) activity where they will learn how systems are developed to meet certain requirements and use logical reasoning to analyse the outcomes from a process within the context of the baggage handling system at an airport.

Activity 5

Learners could develop their programming skills by being given access to a PIC programmer or PLC programmer and set the task of writing a suitable programme. The task could be related to the functionality of the SMART home simulator in Task 2 of this project.



Delivering the project holistically

This project should be delivered in conjunction with other resources available on the OCR website. www.ocr.org.uk/cambridgenationals in the teaching and learning resources area.

Teaching and learning resources

Teaching and learning resources for each Cambridge National in Engineering are:

- the Delivery Guide
- Lesson Elements
- Resource Links
- Sample assessment materials
- Cambridge Nationals in Engineering – Mapping to Mathematics and Science
- Skills Guides www.ocr.org.uk/i-want-to/skills-guides/.

Use the delivery guide and lesson elements to enhance teaching and learning through each module in the project approach.

The example below shows how Unit R113: Electronic principles LO1: Understand basic electronic principles can be delivered using these resources.

Learners could study relevant Siemens resources bank http://www.siemens.co.uk/education/en/. Learners will understand the fundamentals of electronic circuits and be able to calculate resistor and capacitor values applying them to a range of electronic circuits. Learners will use techniques to identify potential electrical hazards and apply fault-finding procedures using multi-meter for voltage, current, resistance and continuity.

Learners are required to calculate values of power, voltage, current, resistance, capacitance, inductance, electromagnetism and frequency. In maths, learners are required to add and subtract three-digit numbers, multiply and divide any number by 10, 100 and 1000 without the use of a calculator. They should also be able to round numbers to the nearest integer or to any given number of significant figures or decimal places

Building up research skills and applying appropriate mathematics and science, learners could use resource links documents web sites such as (www.siemens.co.uk/education/en/teachers/the-crystal.htm) experience in London to see one of the most sustainable buildings in Europe and understand how it was designed.

Use the OCR guide to research to develop learners' research skills. www.ocr.org.uk/i-want-to/skills-guides/

Examples showing how the resources available from the OCR website can be used with this project approach

Unit R113: Electronic principles

LO1: Understand basic electronic principles

	Unit	Learning Outcome (LO)
Module 1	R113 R114	LO1 LO3 LO2 LO4 LO2 LO3

The Project Approach

Activity 1 (R113 – LO1)

Learners could develop their understanding of electronic principles by producing a series of teaching aids for the delivery of electronics to lower school pupils.

A number of the SIEMENS education resources can be used for reference.

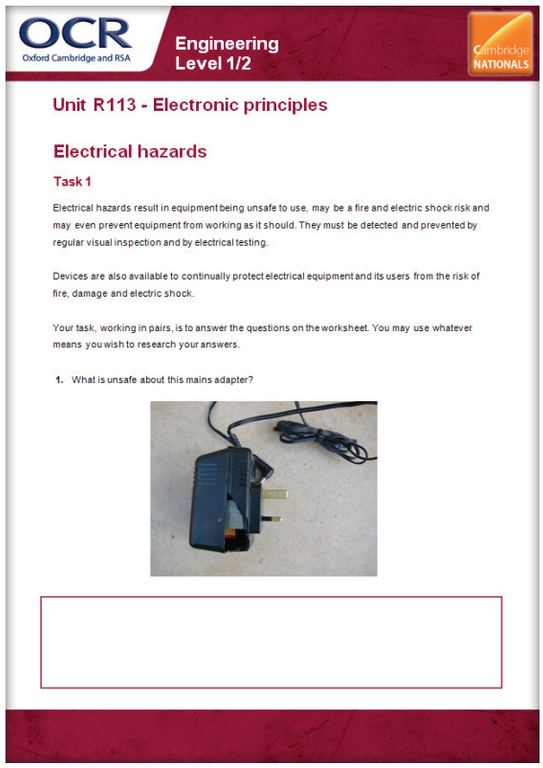
The Delivery Guide (R113 – LO1)

Suggested content	Suggested activities	Suggested timings	Possible relevance to
1 Components and Circuits	Learners could be given real electrical components to handle, and worksheets may be developed with pictures and circuit symbols of components to identify. The learners could be asked in groups or individually to research (using catalogues, data sheets and supplier websites such as http://uk.rs-online.com/web/) various aspects of different electrical components such as size and cost. Teachers might show circuit diagrams to learners for them to identify various components and to encourage them to research components not yet recognised. An outcome of the activity could be an expectation that learners could develop their skills in identifying a range of electrical components alone and as part of circuits.	1 hour	R101 (LO2) 2 Principles, Units and R114

Lesson Element (R113) Electrical Hazards

In this lesson element the students are tasked with identifying unsafe devices and wiring practices in a variety of appliances.

www.ocr.org.uk/qualifications/cambridge-nationals-systems-control-in-engineering-level-1-2-award-certificate-j833-j843/



OCR Oxford Cambridge and RSA

Engineering Level 1/2

Cambridge NATIONALS

Unit R113 - Electronic principles

Electrical hazards

Task 1

Electrical hazards result in equipment being unsafe to use, may be a fire and electric shock risk and may even prevent equipment from working as it should. They must be detected and prevented by regular visual inspection and by electrical testing.

Devices are also available to continually protect electrical equipment and its users from the risk of fire, damage and electric shock.

Your task, working in pairs, is to answer the questions on the worksheet. You may use whatever means you wish to research your answers.

1. What is unsafe about this mains adapter?

Cambridge Nationals in Engineering – Mapping to mathematics and science

This document will help you plan your curriculum and assist you in delivering related subjects such as mathematics, science and ICT when teaching your Cambridge Nationals in Engineering.

The mapping of R113 LO1 to maths foundation – initial and bronze

The example below is an extract from this mapping document and suggests how GCSE maths could be taught and then applied to develop skills in evaluating market data necessary for LO1.

	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Calculations: ohms law and potential divider. Power law. Voltage, current, resistance, capacitance, inductance, electromagnetism, frequency.	Fundamental electrical calculations e.g. Using ohms law, power law.	FIN2 Add and subtract three-digit numbers, without the use of a calculator. FIN3 Multiply and divide numbers with no more than one decimal digit by an integer between 1 and 10, without the use of a calculator. Multiply and divide any number by 10, 100 and 1000 without the use of a calculator.	FBN2 Round numbers to the nearest integer or to any given number of significant figures or decimal places. Estimate answers to one-stage calculations, particularly calculations involving measurement or money. FBN3 Use the terms square and square root (positive square roots only) and the correct notation.

Learners are required to calculate values of power, voltage, current, resistance, capacitance, inductance, electromagnetism and frequency. In maths, (FIN2) learners are required to add and subtract three-digit numbers, multiply and divide any number by 10, 100 and 1000 without the use of a calculator. They should also be able to round numbers to the nearest integer or to any given number of significant figures or decimal places (FBN2). Learners could apply the knowledge they acquire from their maths studies to use when calculating electrical units. Joining these two requirements together makes the learning experience much more relevant to learners and should ultimately increase their interest.

The Skills Guides

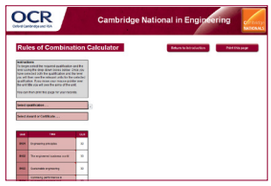
Learners could use the OCR guide to research skills and the OCR guide to presentation skills to help them develop these skills.
www.ocr.org.uk/i-want-to/skills-guides/

RESOURCE MENU

Below is a selection of the resources we provide for the Cambridge Nationals Engineering qualifications...

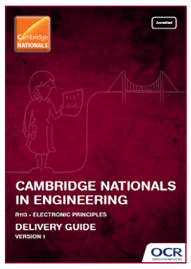
Qualifications Calculator

An Excel based tool to help the teacher ensure that their learners achieve the required number of credits for their chosen qualification and meet the mandatory requirements. Teachers also have the option to generate a personal print-out for learner portfolios or other records.



Delivery Guide

Each guide contains a range of lesson ideas with associated activities that teachers can use with their learners. The guide is structured by learning outcome so the teacher can see how each activity helps them cover the specification.



Project Approach to Delivery

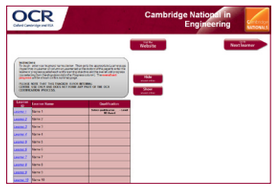
The Project Approach to Delivery shows how by setting learners a project, they could achieve a number of units. Learners could improve their interest in engineering by studying through projects such as the F1 in Schools™ Technology Challenge, Siemens' Energy Recovery, Energy Transformation, Powering the Future and SMART Homes.

Unit Introduction Presentations

Short PowerPoint presentations introducing each unit. Each will look at the skills and knowledge that the learner will gain from the unit and give some content (like real life examples or questions) to introduce the learner to the unit's content.

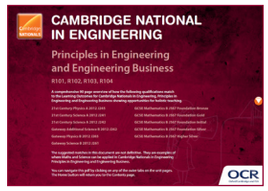
Progress Tracker

An Excel based tracking document to help the teacher monitor their learners' progress throughout the qualification both individually and as a cohort.



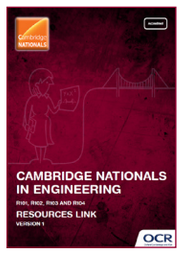
Maths, Science and ICT in Engineering

Maths, Science and ICT in Engineering can show you how GCSE Maths, GCSE Science and Cambridge Nationals in ICT units relate to Cambridge Nationals in Engineering units, indicating how themes for teaching, eg, force x distance.



Resources Link

An e-resource that provides teachers with links to a range of teaching and learning websites and materials, including videos, data sets and other online content to support the teacher with the delivery of their subject.

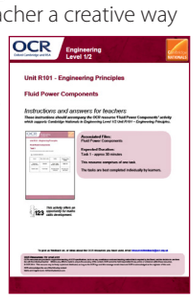


Skills Guide

Skills guides are not specific to a particular qualification, but cover topics that could support a range of qualifications, for example Communication, Legislation or Research Skills.

Lesson Element

Task sheets with accompanying teacher instructions. Each offers the teacher a creative way of encouraging their learners to engage with the topic, with individual and group exercises, research activities and the opportunity to develop English and maths skills.



A quick guide to explain when and how the Cambridge Nationals Resources could be used

CPD
Advice and Guidance on Specification/Qualification including:
- face to face events
- online training available from Professional development site (whenever needed)

Admin Tools (AT)
- Qualification calculator (QC)
- Progress Tracker

Teaching Support Tools (TST)
- Delivery Guide
- Maths and Science in Engineering
- Project Approach to Delivery
- Resources Links
- Skills Guides

Classroom Tools (CT)
- Unit Introduction Presentation
- Lesson Element
- Skills Guides

CPD

Start with the QC (AT)
Excel tool to ensure the correct units are selected for the learners, including any barred combinations.

Set up the Progress Tracker (AT)
Excel tool to record learners' names and ensure the correct units are selected for the learners, ready to start recording their progress.

Update the Progress Tracker (AT)
Record the teacher's grade per Learning Outcome as the learners progress through their units. Overall grade is automatically calculated. OCR Moderators must confirmed the learners' grade following moderation.

Plan delivery (TST)
Use the **Delivery Guide** to plan lessons. **Delivery Guides** are structured by Learning Outcome and give suggested timings for a range of activities. English and maths skills development opportunities are also identified.

Maths and Science in Engineering can show you how GCSE Maths and GCSE Science units relate to Cambridge Nationals in Engineering units, indicating how themes for teaching, eg, force x distance.

Project Approach to Delivery suggests how learners could achieve a number of units by setting them a specific project such as the FI in Schools™ Technology Challenge, Siemens' Energy Recovery, Energy Transformation, Powering the Future and SMART Homes

Use the **Resources Links** to check out some other resources which teachers might find useful.

Skills Guides can help review/refresh skills in a variety of topics areas. See any Cambridge Nationals web page to see the **Skills Guide** pdf portfolio. More **Skills Guides** currently in production.

In the classroom (CT)
Show the learners the **Unit Introduction Presentation**. This will 'set the scene' for the learner and let them know what to expect. These presentations could also be used at Open or Parents' Evening.

Lesson Elements are identified to a specific unit and offer activities which help the learners to understand various concepts or build on their existing knowledge. **Lesson Elements** are in two parts; Teacher Instructions/answers and Learner Task sheet. Most **Lesson Elements** are pdf and printable, some are on-screen interactive as well.

Skills Guides can help review/refresh skills in a variety of topics areas. See any Cambridge Technicals web page to see the **Skills Guide** pdf portfolio. More **Skills Guides** currently in production.

Further information:

To see examples of these resources for Cambridge Nationals go to: http://www.ocr.org.uk/qualifications/by-type/cambridge-nationals/

To see the Professional Development website, go to: http://www.ocr.org.uk/i-want-to/find/professional-development/

We'd like to hear your views about these resources, email to: Resources.Feedback@ocr.org.uk

Contact us

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

Telephone 02476 851509

Email cambridgenationals@ocr.org.uk