Cambridge NATIONALS

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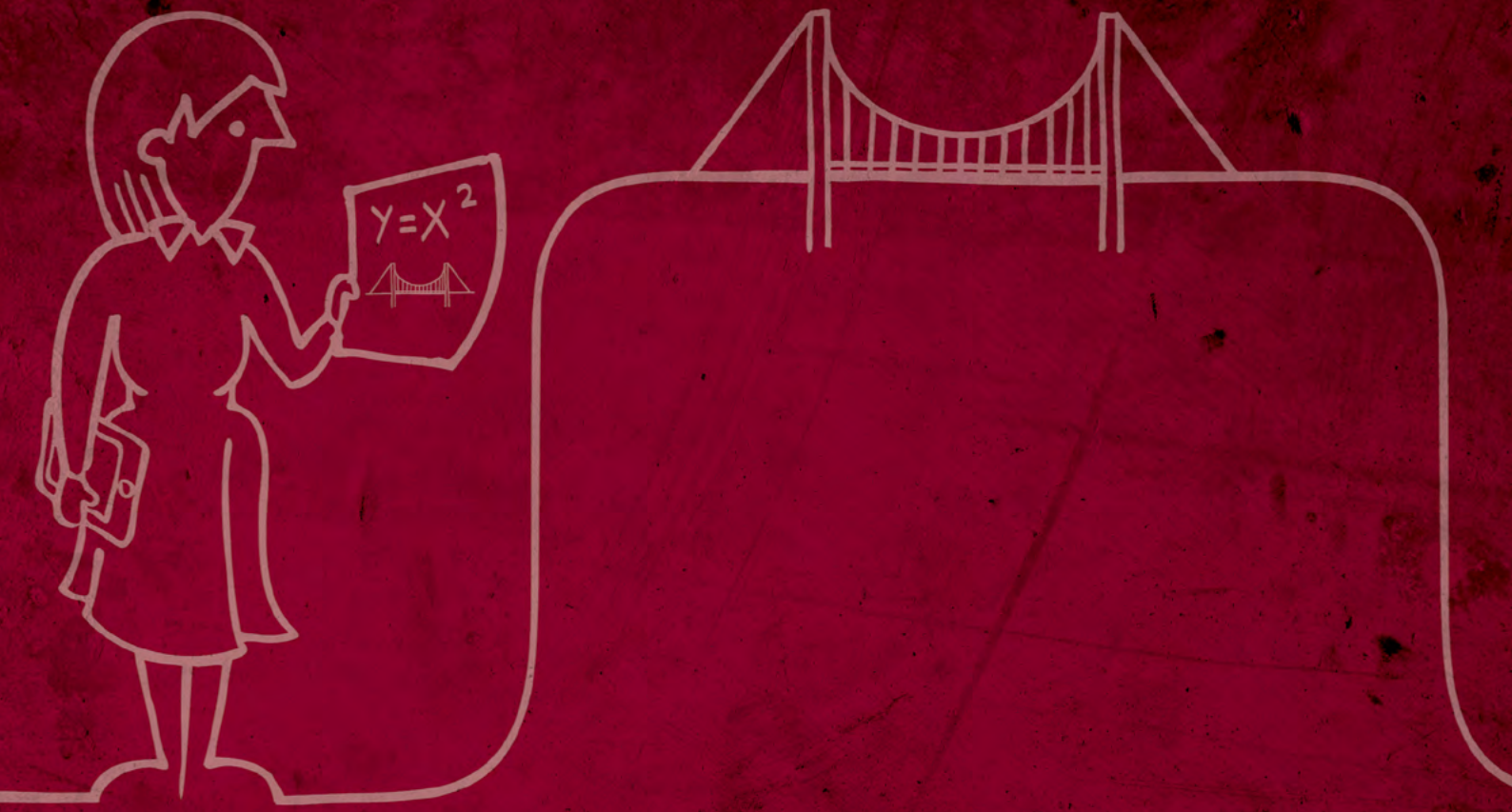


CAMBRIDGE NATIONALS IN ENGINEERING

ENGINEERING DESIGN

A PROJECT APPROACH TO DELIVERY – F1 IN SCHOOLS

VERSION 2

F1 IN SCHOOLS™

OCR
Oxford Cambridge and RSA

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 the F1 in Schools™ Technology Challenge. 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 – an 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 the F1 in Schools™ Technology Challenge.

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.

For the purpose of this guide, the intention is for the learners to undertake design and manufacturing tasks that should lead them to the production of a vehicle that will participate in the F1 in Schools™ Technology Challenge.

This guide is divided into five 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.

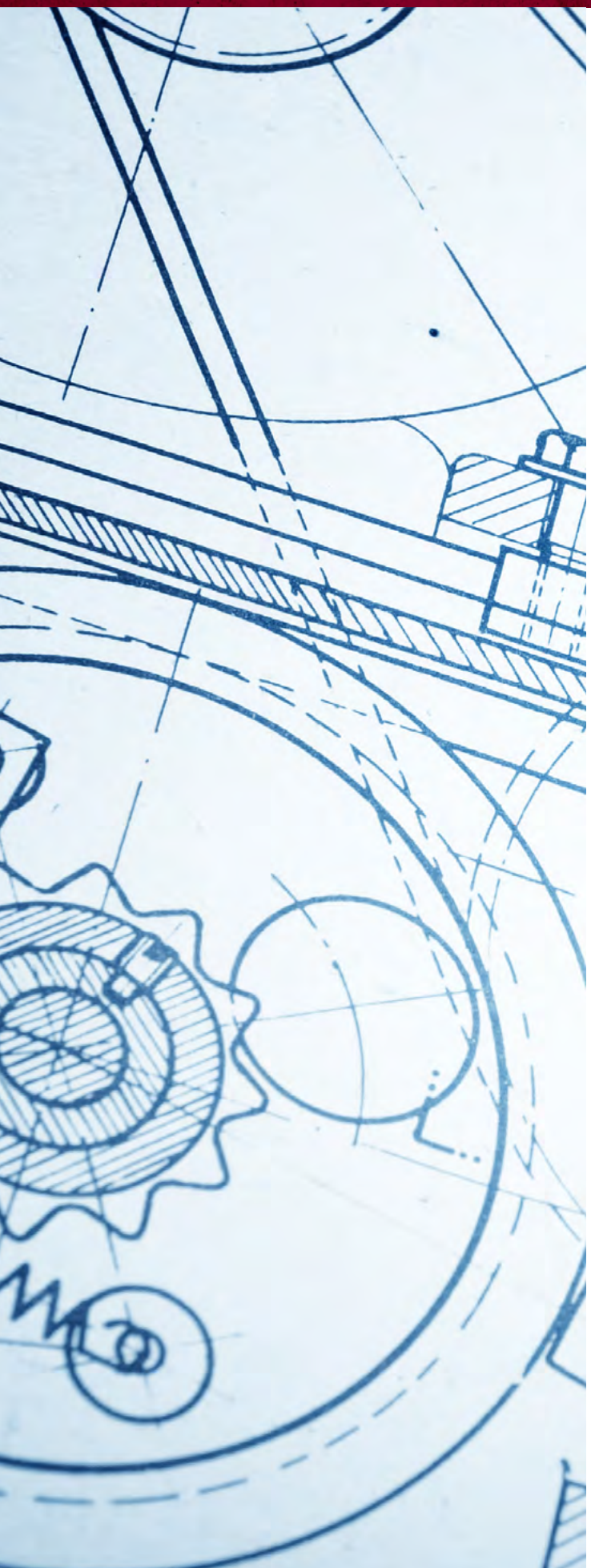
Please note that should final assessment be presented in a similar holistic way, learners must be able to present evidence for each of the centre assessed units R106, R107 and R108 independently.

By Unit/Learning Outcome (LO)

	LO1	LO2	LO3	LO4
Unit R105	Module 1	Module 2	Module 1 Module 2	
Unit R106		Module 1 Module 2	Module 2	
Unit R107	Module 3	Module 3	Module 3	
Unit R108				Module 5

By Module

	Unit	LO
Module 1	R105 R106	LO1 LO3 LO2
Module 2	R105 R106	LO2 LO3 LO2 LO3
Module 3	R107	LO1 LO2 LO3
Module 4	R108	LO1 LO2 LO3
Module 5	R108	LO4



The F1 in Schools™ Technology Challenge provides an exciting and challenging educational experience through the magnetic appeal of Formula 1®. Teams of learners deploy CAD/CAM software to collaborate, design, analyse, manufacture, test, and then race miniature compressed air powered balsa wood Formula 1® cars.

The challenge inspires learners to use IT to learn about physics, aerodynamics, design, manufacture, branding, graphics, sponsorship, marketing, leadership/teamwork, media skills and financial strategy, and apply them in a practical, imaginative, competitive and exciting way.

Learners will use computer aided design (CAD) software, data analysis using computational fluid dynamics (CFD) and drag calculation software, computer numerical control (CNC) machinery to manufacture the car and wind and smoke tunnels for testing. The challenge culminates in racing the cars on the 20 metre long F1 in Schools™ Technology Challenge race track to see who has designed and manufactured the fastest car. For those who wish to take the challenge further, there are opportunities for regional, national and international competitions.

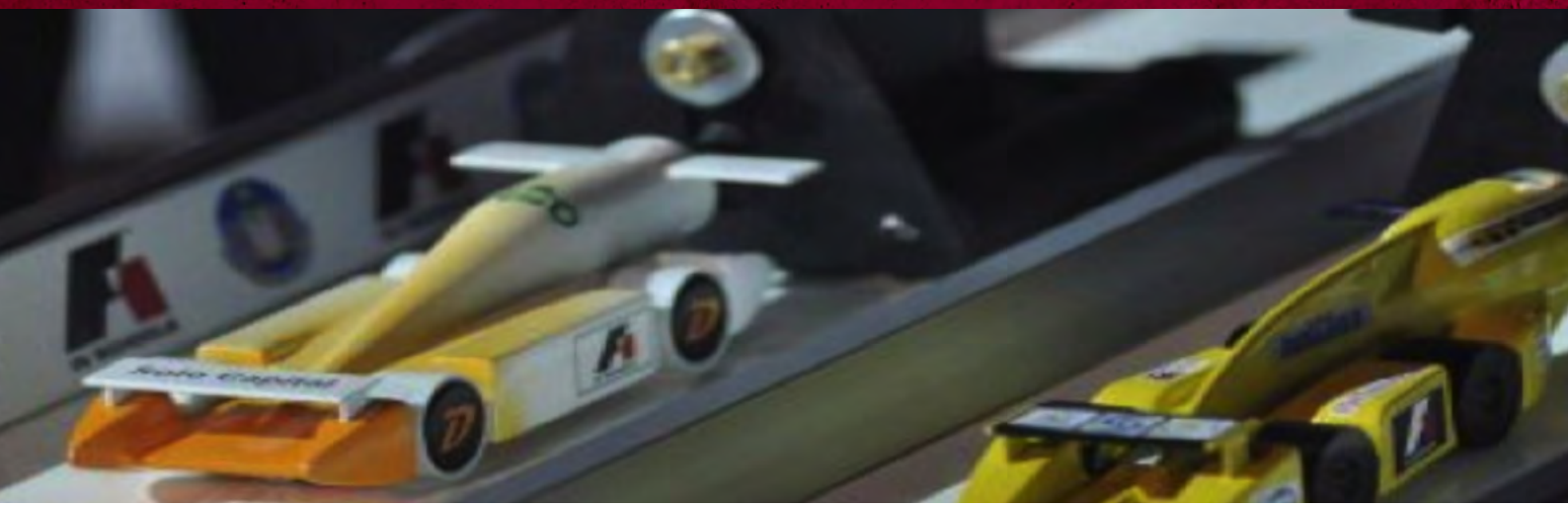
The F1 in School Learning Channel

The F1 in Schools Learning Channel offers a comprehensive range of web based audio/visual teaching and learning materials. Teachers and learners can access and view a set of over 50 short films focusing on the 8 key elements of The F1 in Schools™ Technology Challenge: Introduction to F1 in Schools, Business Planning, Design, Analysis, Manufacture, Test, Re-Test & Re-Make, Race and Review.

The F1 in Schools Learning Channel provides teachers with complete flexibility in how they deliver The F1 in Schools™ Technology Challenge, with relevance to their specific requirements and programmes of study, and learners will be able to tap into this resource at any time and on any device. The F1 in Schools Learning Channel also allows them to email fellow learners and teachers within their school or organisation, set favourite videos and keep track of those they've watched and those they haven't.

To gain free of charge access, teachers and learners will need to register via the F1 in Schools website www.f1inschools.co.uk

The F1 in Schools App is a promotional interactive tool for F1 in Schools™ Technology Challenge competitors, and a useful study and revision aid for learners. Active and available for immediate download for both platforms via Official App Store and Google Play Store.



Module 1 - Design cycle, design briefs and design specifications

The delivery begins with unit R105 (LO1 and LO3) and R106 (LO1).

Before learners can start the design process for an Formula 1® in schools car or other engineered product they need to have a good understanding of:

- the four phases of the design cycle
  - identify phase
  - design phase
  - optimise phase
  - validate phase
- how commercial production methods, quality and legislation impact on the design of products and components
- the identification of design needs
  - initial design brief from client
  - information which may inform the design brief
  - 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
Know about the wider influences on the design of new products	LO3	R105
Know how commercial production methods, quality and legislation impact on the design of products and components	LO1	R106

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 improve understanding of the design cycle in learners joining a Key Stage 4 Engineering course.

Activity 2

Learners could produce a market research report examining the wider influences on the design/visual style of Formula 1® cars and associated team vehicles and clothing.

Activity 3

Learners could work from a given client design brief and explore the situation and context that has led to the brief, the needs of the client e.g. corporate branding, target audience, the purpose and functions of the product. Learners should consider other information which may inform the design brief, i.e. 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 4

Learners could undertake a case study exploring the four phases of the design cycle for a popular engineered product such as the Dyson vacuum cleaner.

Activity 5

Learners could examine the wider influences upon the design of products such as hybrid vehicles.

Activity 6

Learners could produce a presentation explaining the impact that developments in materials and production processes has had upon product design.

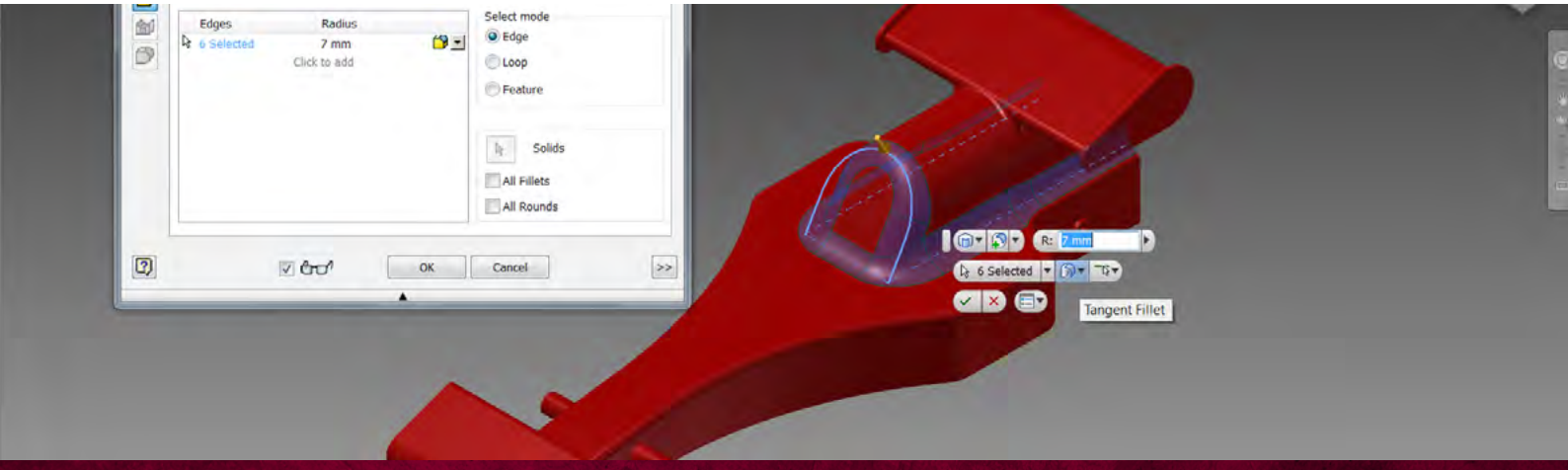
F1 in Schools Task

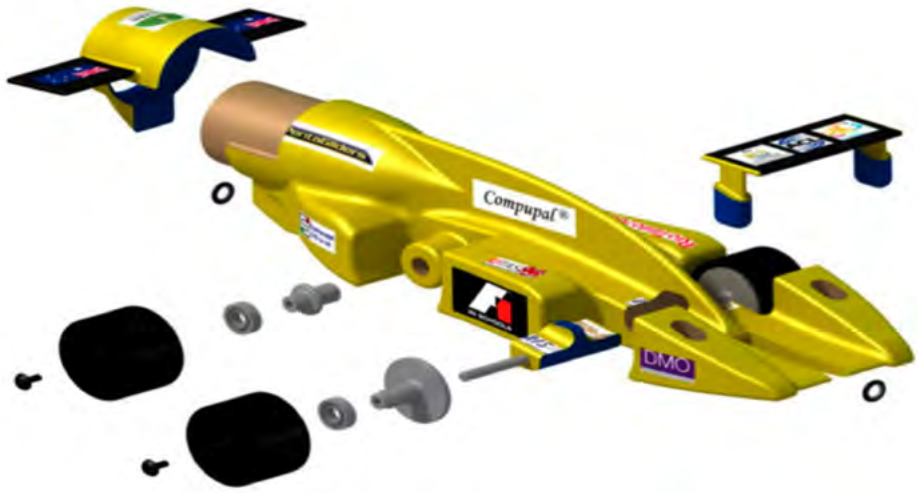
Learners should analyse the client brief (www.f1inschools.co.uk/). They should undertake research to establish key information that will affect their interpretation of the client brief and consider this prior to the development of a final design brief for the F1 in Schools™ Technology Challenge.

Learners should:

- analyse the client brief:
  - read the technical and competition regulations
  - develop their understanding of the challenge
  - establish the objectives of the challenge
  - analyse what the design must do
  - establish what they would like the design to do
- develop a final design brief
- consider and allocate team roles. Who is the best person to be the lead each of the key areas to successfully complete all the areas of the F1 in Schools™ Technology Challenge? Learners will need to select a team of three to four people. Who will be the team leader, design engineer, manufacturing engineer, resources manager and graphic designer?
- create a project time plan
- create a project financial plan and budget
- seek sponsorship.

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 Engineering Qualification.





Module 2 Research, Product Analysis and Design Specifications

The delivery then follows through units R105 (LO2 and LO3) and R106 (LO2 and LO3).

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

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
Be able to research existing products	LO2	R106
Be able to analyse an existing product through disassembly	LO3	R106

This will allow learners to develop their understanding of both formulating and interpreting design specifications. They will develop their critical analysis skills through product analysis using both primary 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

Learners could reverse engineer a product to establish the initial 'justified' product specification.

Activity 2

Learners could develop a 'justified' specification for a new product considering:

- user needs
- product requirements
- manufacturing considerations
- production costs
- regulations and safeguards.

Activity 3

Learners could undertake a product disassembly exercise following manufacturer's instructions and establish how manufacturing was considered in the product's design. The learner should consider aspects such as:

- materials availability/supply chain
- ease of manufacture
- use of standard components
- use of pre-manufactured components
- design for manufacturing assembly (DFMA)
- design for disassembly
- scale of production
- durability and reliability
- tolerances
- product safety
- sustainability
- maintenance.

Activity 4

Learners could undertake a product analysis exercise of an engineered product using both primary and secondary research methods. They could critically review their outcomes to establish which method has produced the most useful data.

F1 in Schools Task

Learners should undertake research to establish the key data that will influence their design specification and their design ideas. They should review the technical and competition regulations (www.f1inschools.co.uk/), analyse previous entries to the competition and consider the wider influences that will impact upon the design of their F1 in Schools™ Technology Challenge car.

Learners should analyse and review the data obtained prior to writing a final product specification for their vehicle.

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 undertake an exercise to interpret a 'commercial' engineering drawing. They could produce a parts list to accompany the drawing.

Activity 2

Learners could draw 2D and 3D representation of an engineered product. Use different techniques to render the object and evaluate the rendering techniques used.

Activity 3

Learners could use hand sketching techniques to develop designs for an engineered product using appropriate design annotations.

Activity 4

Learners could use 'exploded drawing' to show an engineered product assembly.

Activity 5

Learners could produce a working drawing for an engineered product using 2D CAD software.

Activity 6

Learners could produce design drawings for an engineered product using 3D CAD software.

F1 in Schools Task

Learners should create a team identity (name, logo, colours etc). They should generate three/four different design concepts for their F1 in Schools™ Technology Challenge car. Learners should analyse their designs against the design brief and specification and use this analysis to develop their initial concept designs further. (www.f1inschools.co.uk/)

The developed concept ideas should be analysed using virtual wind tunnel testing. Learners should investigate fluid dynamics and identify stress and drag points within their design.

Learners should develop their optimum final design. A final design drawing should then be produced that should give all details with regard to finish and final dimensions.

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

This 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 could undertake a 'critical review' of a production plan to establish improvements to production sequencing, risk assessment and the appropriateness of the planning tool.

Activity 2

Learners could follow a pre-produced production plan to manufacture an engineered product. They could undertake risk assessment prior to the manufacturing process and add this detail to the production plan. Learners could keep a production diary to record their manufacturing activity.

Activity 3

Learners could manufacture an engineered product using a supplied engineering drawing and production plan. They could then carry out testing to establish the manufacturing quality against given tolerances.

Activity 4

Learners could consider the implications of large quantity production upon production planning. They could modify the production plan for the manufacture of a one-off prototype product assuming that batch quantities of 1000 of the product will be made.

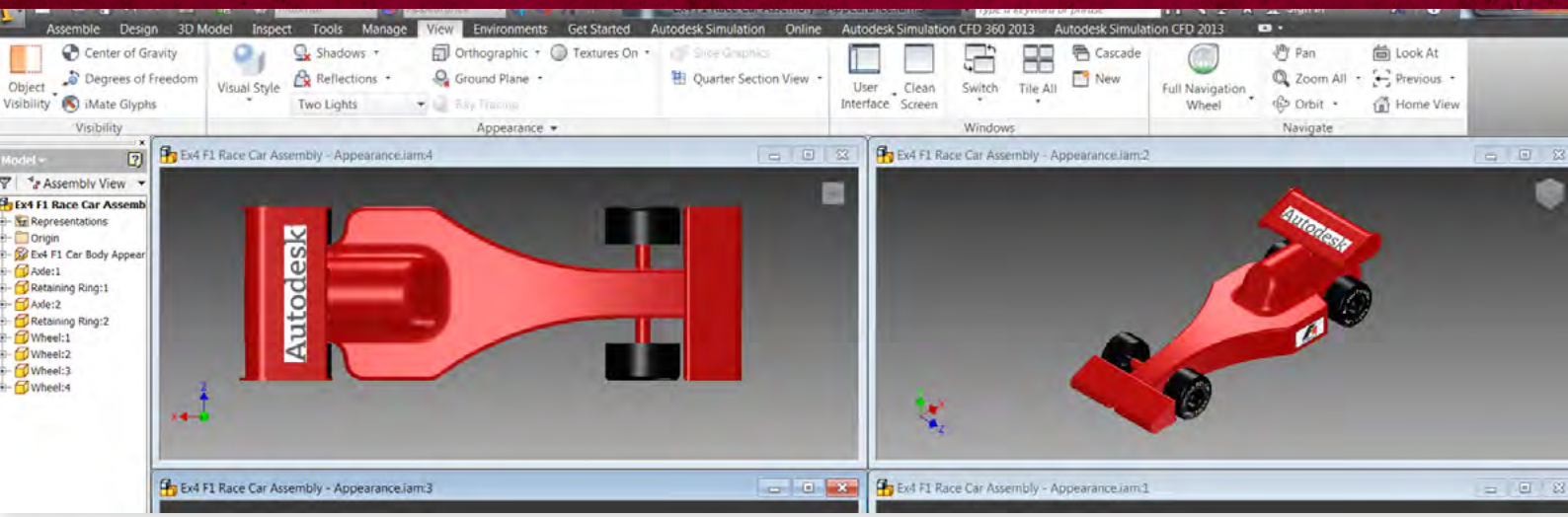
Activity 5

Learners could identify and suggest appropriate materials and manufacturing processes for production of a prototype engineered product from a given design drawing.

F1 in Schools Task

Learners should research manufacturing techniques and develop a production plan for the manufacture of the F1 in Schools™ Technology Challenge car (www.f1inschools.co.uk/). As part of the planning process they should consider how different construction methods affect the ability to carry out repairs or design updates to the car.

Learners should sand and finish off the car body. They should paint the car in chosen team colours and add on graphics/ logos prior to final assembly with axles and wheels. Tether line guides should then be added.



Module 5 Design evaluation and test

The delivery then follows through units R108 (LO4).

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

Be able to evaluate the success of a prototype	LO4	R108

This will allow learners to develop techniques for production planning and manufacture of prototype products. Additionally, learners will develop their evaluation skills through the analysis of prototype products against product specifications and briefs.

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 undertake a 'critical review' of a production plan that they have used to manufacture a product.

Activity 2

Learners could undertake an evaluation of a prototype engineered product against a product specification and client brief to establish strengths and weaknesses in the design and areas for design improvement.

Activity 3

Learners could undertake a review of an existing product and identify possible areas for aesthetic or functional improvement. The design modifications should be clearly communicated.

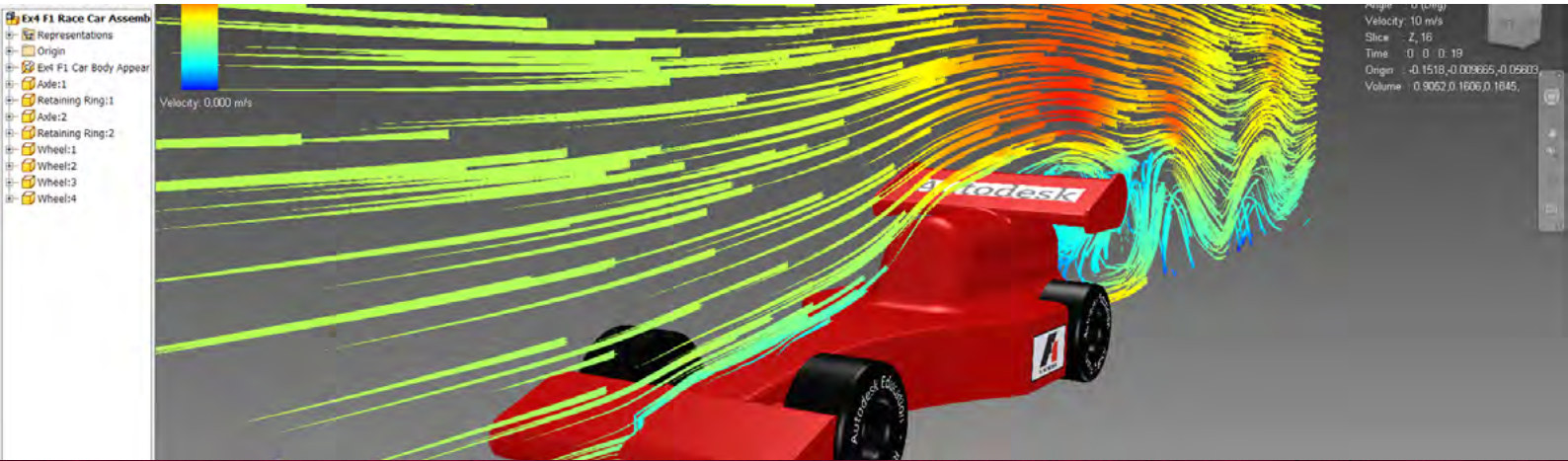
Activity 4

Learners could consider the precision and accuracy of an engineered product through comparison with an engineering drawing for the product.

F1 in Schools Task

Learners should consider the tests required to evaluate the success of the car. They should assess the performance of the vehicle and identify areas where improvements could be made. Based upon the outcomes of the testing learners may wish to re-make and re-test the car (www.f1inschools.co.uk/).

Learners should review their designs, their manufactured outcomes and the processes they have used during design and manufacture. They should prepare and deliver a presentation relating to their experience and the process of designing and developing the F1 in Schools™ Technology Challenge car. They should prepare their final portfolio and artefacts for assessment.



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 F1 racing products as part of the F1 challenge, 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 the resource links document as part of their research to explore web sites such as www.technologystudent.com/designpro/despro1.htm
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.

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

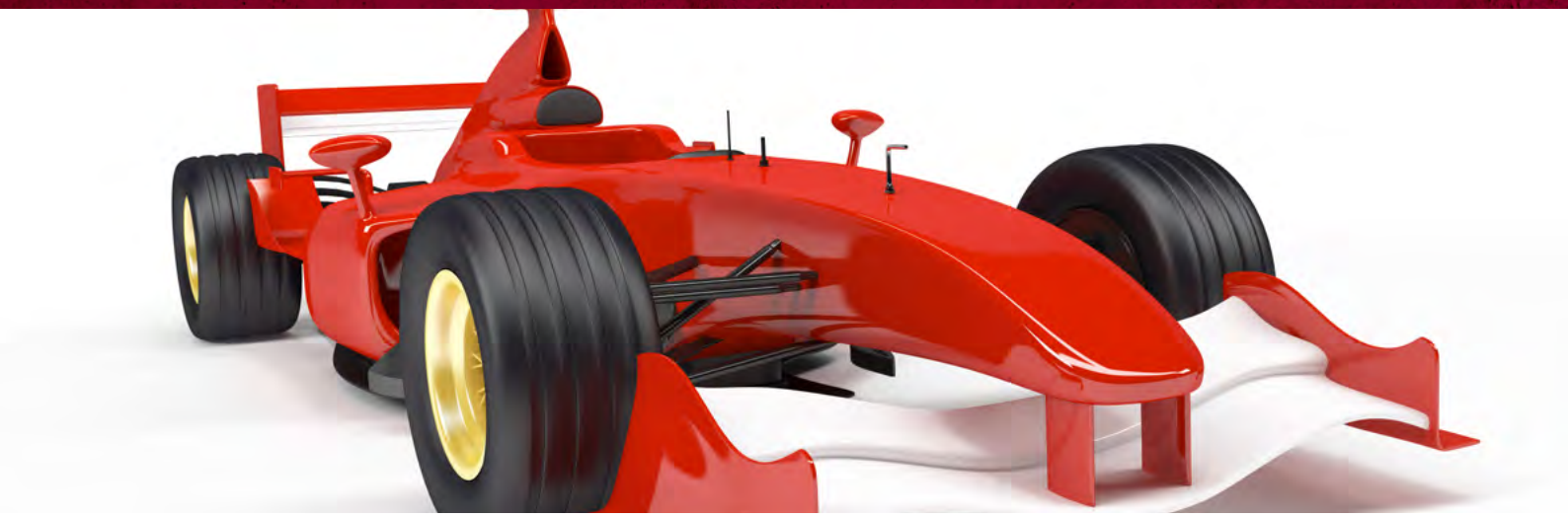
The Project Approach

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 : www.bbc.co.uk/schools/gcsebitesize/design/systemscontrol/designevaluationrev1.shtml	2 hours	



The Lesson Element (R105 LO1)

Identifying design needs: information informing design

Activity 1:

Market research is often used as a starting point when producing a design brief for a new or improved product. There are many forms of market research including surveying potential users, and looking at the strengths and weaknesses of competitors products.

Your client has asked you to produce a design brief for a new MP3 player and wants to know what features are good and bad about competitor's products.

Your task is to research a range of MP3 players currently available (no more than 5) and to compare a number of features across them. A tabulated approach will prove useful to do this, where you score each feature on a scale of 1 to 10 (with 1 being poor and 10 being excellent). The table has been started below (you can add more features):

Feature:	Player 1	Player 2	Player 3	Player 4	Player 5
Size					
Weight					
Ease of Use					
Appearance					
Battery Life					
...					
...					
Total					

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

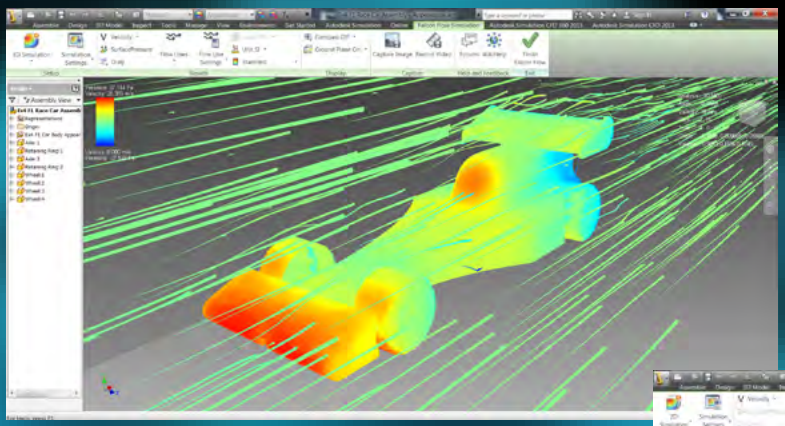
The example below is an extract from this mapping document and suggests how GCSE mathematics could be taught and then applied to develop skills in evaluating market data necessary for LO1.

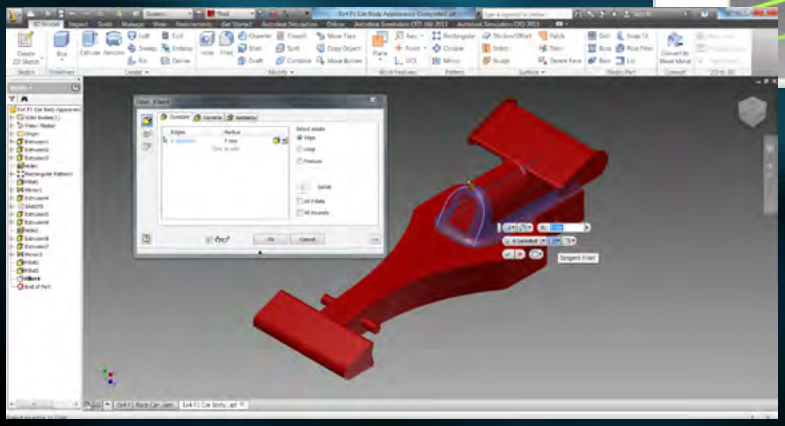
	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Market research (surveys) Improvements in materials Budgets	Be able to interpret data (market research) used to influence the design process.[Direct]	FIA5 Construct and interpret simple graphs, including conversion graphs. FIS4 Draw and interpret 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.





Contact us

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