



'BUILD YOUR OWN DIGITAL RAILWAY PROGRAMME'

Cambridge Nationals in Engineering Design and Creative iMedia



CROSSRAIL VALUES

Safety	 Create safety first culture Learn ways to make stay healthy and safe
Inspiration	Think creativitely and share ideasThink 'out of the box'
Respect	 Treat people as you'd like to be treated Appreciate the different skills, knowledges, and culture of each team member
Collaboration	See the bigger pictureWork effectively
Integrity	Keep promisesFocus on achieving team goals





Build Your Own Digital Railway

Student Design Brief

Have you ever been riding on a train and wondered, "What could I be doing with the time I'm sitting here?" Now is your chance to put those ideas into action. Your task, while working in a team of four, is to design a *Digital Railway* where you can carry out parts of your daily routine while you ride the train. You should be as creative as possible, butyou must keep the following factors in mind while developing yourrailway:

Cost – How much will your team's railway cost the public to build? Location – Where do you want your team's railway torun? Health and Safety Concerns – Is your rail accessible to people with disabilities? Isit safe to ride for the general public? Rail Traffic – How many people are going to ride your team's railway daily? City Planning – Is your team's railway going to disrupt existing structures?

You and your team will have ten weeks to provide the following deliverables:

Proposal – An outline of your team's idea for the Digital Railway and how yourteam plans to design and construct it.

Concept Model – A semi-completed physical representation of your idea. This is your time to test things out and see how they look before finalizing the design. Design Plans from Concept Model – A set of blueprints for your final structure. Final Model – A scale model of your structure based on your final design. Presentation – A final report to show off your digital railway in action and howyour team has collaborated effectively.

Two of you will be finishing this project to complete the requirements for an Engineering Design Level 2 qualification, while two will be attempting to complete the Creative iMedia Level 2 qualification requirements. The entire team will need to work as a unit, each member's strengths complementing another's weaknesses. **Collaboration** and proper **Data Management** is key to a successful *Digital Railway* project!





INTRODUCTION

Build Your Own Digital Railway

The purpose of this guide is to offer an overview of how you could deliver a project that emphasizes five Building Information Modeling (BIM) phases. The guide will give insight on how to deliver units from two Cambridge Nationals qualifications: Engineering Design Level 1/2 and Creative iMedia Level 1/2. The qualifications will deviate into two separate tracks (the Engineering Strand and the Creative Strand), allowing learners from both tracks to effectively collaborate.

This project approach will provide you with a plan to teach the learners how the Engineering and Creative Strands can link together during the project's five BIMrelated phases. It will provide an understanding of how data exists as an asset and can be used in a collaborative setting.

The guide looks at delivering the units from both the Engineering and Creative Strands:

The guide looks at delivering the units from both the Engineering and Creative Strands:

Engineering Strand:

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

Creative Strand:

Unit R081: Pre-production skills

Unit R082: Creating digital graphics

Unit R083: Creating 2D and 3D digital characters

Unit R085: Creating a multipage websites

OR

Unit R086: Creating a digital animation

OR

Unit R087: Creating interactive media products



The project requires the learners to collaborate in small teams while they design and build their "digital railway." The learners will study design and manufacturing from an engineering and/or creative approach. Teams will effectively engage themselves with a suite of resources and case studies to utilize similar project approaches in the team's project.

The intention of this project is to give learners a hands on appreciation and understanding of how effective data management and evaluation and collaboration is pivotal to designing a safe, cost-effective, transport system. Over the course of the project, learners will be taught a range of skills aligned to units within the Engineering and Creative Strands. Learners will be offered review activities after each module that apply similar design and manufacturing concepts. At the same time, learners will be taught how a mediafocused approach can translate the concepts into visual presentations.

Learners will be able to work towards the product for the final project while carrying out the activities at the end of each module, as not to restrict the teams' design choices, but offer helpful guides to handle example design and visual project briefs.

In this guide the objectives are to deliver are to:

- Deliver potentially all four units to achieve the Level 2 Cambridge National Certificate in Engineering Design or provide knowledge and understanding towards many of the learning outcomes.
- Deliver four units to achieve the Level 2 Cambridge National Certificate in Creative iMedia or provide knowledge and understanding towards many of the learning outcomes.
- Develop a program of lessons and review activities that engage team work and employability focus, while offering helpful guides to recognize and apply effective collaborative techniques to all stages of the project development.
- Provide the learners with an understanding of how the engineering and creative skills applied in the project can translate into career choices.





The guide will have learners from the Engineering and Creative Strands collaborating to design and build a transport system and then create a visual presentation that evaluates the individual learners' work and the team's work as a unit.

The guide is divided into five modules that may be taught for the recommended session with additional team working and researching time. Each session should be one hour long; however, students are expected to meet outside the scheduled sessions to compete their work.

Learners from either the Engineering or Creative Strand must be able to present evidence of individual work and impact on the final project for the respective assessed units.

Employability Skills Qualification

Learners may wish to attend two separate modules (0 and 00) that guide learners to assess a team's weaknesses and strengths, assess members' skills and attributes, and identify skills that will be needed for the project. These sessions will deliver three units from the OCR Employability Skills Level 2 Vocational qualification:

Unit 14: Assessing myself for a career

Unit 15: Learning how to manage finance

Unit 18: Planning for and reflecting on a work placement

Module Overview

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

	Unit	LO
Module 1	R081	LO1 LO2 LO3 LO4
Module 2	R083	LO1 LO2 LO3 LO4
Module 3	R085 R086 R087	LO1 LO2 LO3 LO4 LO1 LO2 LO3 LO4 LO1 LO2 LO3 LO4
Module 4	R082	LO1 LO2 LO3 LO4
Module 5		





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MODULE 0

Recommended one session

Engineering and Creative Strand

Learners from either the Engineering or Creative Strand will attempt to obtain credit for **Unit 14: Assessing myself for a career** and **Unit 15: Learning to manage finance**. The assessment criteria should be adapted for team-building exercises. Once teams are put together, the assessment criteria for Unit 15 should be modified for finance management activities to also assess effective teambuilding.

If all Unit 15 Learning Outcomes are not met in Module 0, learners may complete some recommended activities during Module 1 or where the instructor finds room in the curriculum plan.

Before the project begins, learners must come together as teams and execute team and individual evaluations.

Learners will be able to:

- audit own transferable skills, sector-specific skills and personal attributes
- obtain feedback in order to make a career choice
- identify own development needs for a chosen career and agree an action plan for the development

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

Understand how specific skills or personal attributes lead to success in a career	LO1	Unit 14
Be able to evaluate own skills or personal attributes to inform career choices	LO2	Unit 14
Understand specific skills or personal attributes that relate to a career	LO3	Unit 14
Be able to plan the development of own specific skills or personal attributes for a chosen career	LO4	Unit 14
Understand the purposes of financial documents	LO1	Unit 15
Be able to budget	LO2	Unit 15

Understand the consequences of getting into debt	LO2	Unit 15
Understand why credit rating is important	LO34	Unit 15

Practice Review Activities

Activity 1: Learners could research a person successful in their career and write a brief description on the skills and personality traits that make them successful.

Employability Skills Unit 14, LO1

Activity 2: Learners could take an online skills assessment test (ex.

https://www.iseek.org/careers/skillsAssessment) and reflect on their results. They could then browse through recommended careers for their skills. The results of this test could also be used to break up students into groups with a range of skills and identify which students will complete the Creative strand and which will complete the Engineering strand. *Employability Skills Unit 14, LO2*

Activity 3: Learners could select a career that is related to their skillset and/or program strand and identify what specific skills are necessary for that career. Learners could then identify what skills they already possess and which need to be developed, and form a plan for their development. *Employability Skills Unit 14, LO3 and LO4*

Activity 4: Learners could examine a bank statement and/or a wage slip. Learners could then identify and define the following information: National Insurance Number, Sort Code, Annual Percentage Rate, Income Tax Code, and Gross/Net pay. Employability Skills Unit 15, LO1

Activity 5: Learners could develop a budget based on the design brief on their student resource sheet that includes money management and payment methods, contingency plans, and how they'll get themselves out of debt if they overspend. This activity may be completed during module 1 and revisited over the course of the program. *Employability Skills Unit 15, LO2 and LO3*

Activity 6: Learners could assess the credit rating for a fictional person using a free credit rating website. They could then identify whether the person has good, bad, or average credit and suggest ways to improve the credit rating. Employability Skills Unit 15, LO4



Recommended two sessions

Engineering Strand

This project begins with unit R105 (LO1 and LO2) and R106 (LO1).

Before learners can start the research phase for designing their own Digital Railway they must understand the following concepts:

- Four phases of the design cycle
 - o identify
 - o design
 - o optimise
 - o validate
 - Identification of design needs
 - o initial design brief from client vs. information researched for brief
- relationship between design brief and design specification
- requirements of design specification
 - o user needs
 - o product requirements
 - o manufacturing considerations
 - o production costs
 - regulations and safeguards
- Wider influences on the design of new products
 Economic vs. cultural vs. legislative pulls
- commercial production methods that impact product design
- impact of manufacturing processes on product design
- considerations for product end of life
- importance of conformity to legislation, quality and safety standards

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

Engineering Strand			
Understand the design cycle and 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 (talks about wider influences on products like tech push, legislative design requirements, life cycle analysis, etc.)	LO3	R105	
Know how commercial production methods, quality and legislation impact on the design of products and components	LO1	R106	

Creative Strand

This project begins with unit R081 (LO1, LO2, LO3, and LO4).

Before learners can start the pre-production phase for designing their own Digital Railway, they must understand the following concepts:

- the purpose, use, and content of preproduction brainstorming methods
 - o mood boards
 - o mind maps
 - o story boards
- understand target audience and client





- requirements
- determine production schedule and work plan

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

Creative Strand		
Understand the purpose and content of pre-production	LO1	R081
Be able to plan pre-production	LO2	R081
Be able to produce pre- production documents	LO3	R081
Be able to review pre-production documents	LO4	R081

Practice Review Activities

Activity 1: Learners could develop a story board that follows a popular engineered product through the design cycle. *Engineering Design Unit R105, LO1. Creative iMedia Unit R081, LO3 and LO4.*

Activity 2: Learners could critically analyze a client design brief and accompanying proposal and identify the logistics of the proposal, being able to answer the following questions: Has the proposal met all of the brief requirements? Have they given themselves enough time? Where might the proposal fall short? Engineering Design Unit R105, LO2. Creative iMedia Unit R081, LO2 and LO4

Activity 3: Learners could research existing railways and how they followed the design cycle, as well as identifying how they followed their time and budgetary constraints.

Engineering Design Unit R105, LO1, LO2, and LO3. Creative iMedia Unit R081, LO2 and LO4.

Activity 4: Learners could develop a mind map to graphically represent the design cycle. Engineering Design Unit R105, LO1. Creative iMedia Unit R081, LO3 and LO4.

Activity 5: Learners could research data management systems, how they fit into the design cycle/are used in industry, and current legislation on their use.

Engineering Design Unit R106, LO1. Creative iMedia Unit R081, LO2.

Crossrail Design Challenge Task 1.

Drawing inspiration from the design brief and resources listed on their *Student Resource Sheet*, students should identify design criteria for a *Digital Railway* that addresses the following:

- Cost
- Location
- Health and Safety Concerns
- Rail Traffic
- Potential disruption to existing structures

Students should then create a design proposal to address their design criteria. Students should also develop a plan to delegate responsibilities amongst the group members while maintaining a collaborative mindset.

After completing this task, students will be able to:

- organize and evaluate information such as cost, time, health and safety concerns, and location, as found in a design concept/brief and through their own research, to identify key elements of a design problem.
- develop and implement a plan for sharing information using a common data environment.
- create and defend a design proposal to solve the problem introduced in the design brief.





Recommended two sessions

Engineering Strand

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

Before learners can start the design phase for designing their own Digital Railway, they must understand the following concepts:

- techniques to hand draw designs
 - o 2D and 2D sketches using shades, toning, and textures
 - o use of annotations and labels to identify different design features
 - use of ICT software to enhance drawn 0 design proposal
- techniques to produce technical drawings o 2D vs. 3D
- familiarity of CAD applications to produce design proposals
- techniques to effectively communicate design proposals
 - o display boards
 - models 0
 - PowerPoint 0

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

Engineering Strand

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 (possible for schools with CAD capabilities)	LO3	R107

Creative Strand

This project begins with unit R083 (LO1, LO2, LO3, and LO4).

Before learners can start the construction phase for designing their own Digital Railway they must understand the following concepts:

- when to use 2D and 3D digital characters and ways to create them
- how to interpret client requirements for 2D and 3D characters



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

Creative Strand		
Understand the properties and uses of 2D and 3D digital characters	LO1	R083
Be able to plan original 2D and 3D digital characters	LO2	R083
Be able to create 2D and 3D digital characters	LO3	R083
Be able to review 2D and 3D digital characters	LO4	R083

Practice Review Activities

Activity 1: Learners could disassemble a simple engineered product, identify the methods of manufacture, and (using CAD or hand drafting techniques) produce a set of design drawings for the product.

Engineering Design Unit R106, LO3; Unit R107, LO1, LO2, LO3. Creative iMedia Unit R083, LO1, LO2 and LO4.

Activity 2: Learners could develop a set of design drawings from a simple design proposal. Engineering Design Unit R107, LO1, LO2, and LO3. Creative iMedia Unit R083, LO2, LO3.

Activity 3: Learners could interpret a set of commercial design drawings, identifying the client, tolerancing, materials, etc.

Engineering Design Unit R107, LO1, LO2, LO3; Unit R105, LO2. Creative iMedia Unit R083, LO1 and LO4.

Activity 4: Learners could analyze a "customer" description of an engineered part and create a 3D representation (CAD or physical) of the part. Engineering Design Unit R107, LO2 and LO3. Creative iMedia Unit R083, LO2 and LO3.

Activity 5: Learners could analyze a set of engineering drawings and identify missing information (dimensions, part description, customer, material, etc.) Engineering Design Unit R105, LO2; Unit R107, LO1. Creative iMedia Unit R083, LO1 and LO4.

Crossrail Design Challenge Task 2.

Working from their design proposal, students should create a 3D model – using Computer Aided Design software (CAD)* or paper and tape/glue – of their design that incorporates multi-level information. Students should take note of where they deviate from their design proposal and be able to justify these changes, and begin forming a preliminary budget. Students should also begin to investigate which types of careers would be working on each aspect or "layer" of the model.

After completing this task, students will be able to:

- create a conceptual/prototype 3D model of a structure/building/system to incorporate multi-level information.
- visualize a 3D model as a 4D multifaceted database.
- identify which type of engineer would be working on each "layer" of the model.

*CAD knowledge is required for students to achieve the Cambridge Nationals Engineering Design Certificate. See Unit R107 in the Cambridge Nationals Engineering Design Specification.



Recommended three sessions

Engineering Strand

The delivery follows through with R108 (LO1, LO2, LO3, and LO4) and returns to R105 (LO2).

Before learners can start the construction phase for designing their own Digital Railway, they must understand the following concepts:

- key considerations when making a prototype
 - product specification
 - o process of making prototype
 - o use of planning tools and planning stages
 - o resources when making a prototype
- identify and assess safety risks to take precautions against potential hazards
- produce prototype using appropriate materials, tools, and processes
 - o use of preparation and assembly methods
 - o recording key stages of prototype production
- methods for evaluating the prototype and one's own performance

Learners must also understand the concepts from R105 LO2 (Module 1).

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

Engineering Strand		
Understand the requirements of design specifications for the development of a new product	LO2	R105
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





Creative Strand

This project begins with unit R085 (LO1, LO2, LO3, and LO4), R086, R087.

Before learners can start the pre-production phase for designing their own Digital Railway they must understand the following concepts:

- the purpose, use, and content of pre-production brainstorming methods
 - o mood boards
 - o mind maps
 - o story boards
- understand target audience and client
- determine production schedule and work plan requirements

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

Creative Strand		
Understand the properties and features of multipage websites	LO1	R085
Be able to plan a multipage website	LO2	R085
Be able to create multipage websites using multimedia components	LO3	R085
Be able to review a multipage website	LO4	R085
OR		

Understand the properties and features of animation	LO1	R086
Be able to plan a digital animation	LO2	R086
Be able to create a digital animation	LO3	R086
Be able to review a digital animation	LO4	R086
OR		
Understand the uses and properties of interactive multimedia products	LO1	R087
Be able to plan interactive multimedia products	LO2	R087
Be able to create interactive multimedia products	LO3	R087
Be able to review interactive multimedia products	LO4	R087

Practice Review Activities

Engineering Strand:

Activity 1: Learners could create a presentation on safe prototyping practices. *Engineering Design Unit R108, LO1 and LO3.*

Activity 2: Learners could develop a step-by-step plan of how they would create a prototype from a given design drawing.





Activity 3: Learners could create a prototype evaluation sheet for evaluating features, function, materials, aesthetics, ergonomics, construction processes, and alternative manufacture techniques. This evaluation sheet can later be used to evaluate their constructed project model.

Engineering Design Unit R108, LO4.

Creative Strand:

Unit R085:

Activity 1: Learners could create a presentation on different mediums for web access and how they access the internet.

Creative iMedia Unit R085, LO1

Activity 2: Learners could create a layout for a website based on a client brief. Creative iMedia Unit R085, LO2 and LO3.

Activity 3: Learners could critically assess a popular social media website (Facebook, Tumblr, Twitter, etc.) and identify potential areas for improvement. Creative iMedia Unit R085, LO4.

Unit R086:

Activity 1: Learners could develop a storyboard for an advertisement for their digital railway. *Creative iMedia Unit R086, LO1 and LO2*.

Activity 2: Learners could review an animation against its original brief and identify areas for improvement. Creative iMedia Unit R086, LO4.

Activity 3: Learners could create a simple animation (using Adobe Flash or a similar program) to highlight some aspect of their railway's design. Creative iMedia Unit R086, LO2 and LO3.

Unit R087:

Activity 1: Learners could create a presentation on different interactive multimedia products, identifying where such products are used, design consideration, required hardware, software, and peripherals, and limitations to such products. *Creative iMedia Unit R087, LO1.* Activity 2: Learners could design an app to highlight the functions of their digital rail. *Creative iMedia Unit R087, LO2, and LO3.*

Activity 3: Learners could critically assess a popular social media app (Facebook, Tumblr, Twitter, Instagram, etc.) and identify potential areas for improvement. *Creative iMedia Unit R087, LO4*.

Crossrail Design Challenge Task 3.

Students should translate their 3D model into a set of design drawings. These need not be exceedingly detailed, but should serve as instructions for how they'll develop their final construction model. Students in the engineering strand should critically analyze the logistics of their build plan, and proceed with construction of their final model. Students in the creative strand should begin layout for the "digital" aspects of the digital railway and should be assigned one of the three Creative iMedia qualification units listed for this module based on their design from the previous module. All students should create a spreadsheet of the cost of their constructed model.

After completing this task, students will be able to:

- translate their conceptual model into a set of building plans to construct their final model.
- critically analyze the logistics (structural stability, cost of materials, construction processes, etc.) of the build plan.
- tabulate "costs" of materials used in their model to make budgetary decisions.



Recommended three sessions

Engineering Strand

The delivery follows through with R108 (LO1 and LO2).

Before learners can start the handover/commission phase for designing their own Digital Railway, they must understand the following concepts:

- how to evaluate a prototype
 - compare and contrast prototype and production plan against product specification
 - o identify areas to improve design
 - how to evaluate own performance

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

Engineering Strand			
Be able to evaluate the success of a prototype	LO4	R108	

During the delivery of the units, learners should carry out the project to demonstrate and check their knowledge and understanding.

Creative Strand

This project begins with unit R082 (LO1, LO2, LO3, and LO4).

Before learners can start the handover/commission phase for designing their own Digital Railway they must understand the following concepts:

- purpose and properties of digital graphics
 - where are why digital graphics are used
 - what techniques are involved in digital graphics

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





Creative Strand			
Understand the purpose and properties of digital graphics	LO1	R082	
Be able to plan the creation of a digital graphic	LO2	R082	
Be able to create a digital graphic	LO3	R082	
Be able to review a digital graphic	LO4	R082	

Practice Review Activities

Engineering Strand:

Activity 1: Learners could critically analyze an existing product and identify the product's strengths and weaknesses. They could then suggest areas for improvement. Engineering Design Unit R106, LO2; Unit R108, LO4.

Creative Strand:

Activity 1: Learners could edit the current London Underground map to include their digital railway. Creative iMedia Unit R082, LO1, LO2, and LO3.

Activity 2: Learners could create a concept graphic of their digital railway in operation. Creative *iMedia Unit R082, LO2 and LO3.*

Activity 3: Learners could compare a concept graphic or advertisement to the physical entity it represents.

Creative iMedia Unit R082, LO1 and LO4.

Crossrail Design Challenge Task 4.

Students should reflect on their construction, and begin formulating their final reports. Students in the Engineering strand should be able to describe and defend any design changes that arose during construction, and critically analyze their final model to evaluate its success. Students in the Creative Strand should begin developing graphics for the final report. Students in both strands should assemble a detailed cost report of their model, showing any deviation from the initial budget.

After completing this task, students will be able to:

- provide a detailed cost report for their constructed model.
- describe and defend any design changes made during construction.
- assemble a detailed report on their design processes, from conceptualization to final construction.

Recommended one session

Crossrail

Engineering and Creative Strand

The learners have completed the designated units for this project. At this time, learners should collaborate with their teammates to prepare a final presentation that will demonstrate how to "operate and maintain" their digital railways to other learners. Each team should demonstrate a clear understanding of each objective, and each learner should demonstrate how his/hers individual work contributed to the group's success.

Crossrail Design Challenge Task 5.

Students should deliver a final presentation of their entire design process, from the design proposal to the final construction.

After completing this task, students will be able to:

• show peers how to operate and maintain their final product.





Recommended one session

Engineering and Creative Strand

Learners from either the Engineering or Creative Strand will attempt to obtain credit for **Unit 18: Planning for and reflecting on a work placement**. The assessment criteria should be adapted for independent activities and exercises to identify personal goals.

Now that the project has been completed, learners may take part in this post-project evaluation.

Learners will:

- reflect at the end of the work placement (in this case, the Digital Railway project) on their performance
- establish if personal goals have been achieved, to identify improvement in skills and attributes
 - and how the experience might influence future job choices

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

Be able to plan for a specific work placement	LO1	Unit 18
Understand the importance of exhibiting the behaviour expected during the work placement	LO2	Unit 18
Be able to complete tasks independently during the work placement	LO3	Unit 18
Understand how to assess own performance during the work placement	LO4	Unit 18

Practice Review Activities

Activity 1: Learners could reflect on their performance during the program, identify whether they met their personal goals for the project, where their skillset helped or hindered them, what skills they've developed through the program, and whether they were able to work independently within the group.

Employability Skills Unit 18, LO4

Activity 2: Learners could research work placements based on their post-project skills, and identify how their learned and pre-existing skills could benefit them in the work placement. *Employability Skills Unit 18, LO1*

Activity 3: Learners could identify the workplace behavior expected for the work placement they researched, identifying necessary communication skills, acceptable dress, PPE requirements, etc. *Employability Skills Unit 18, LO2*