Cambridge **NATIONALS LEVEL 1/2**

ENGINEERING

A PROJECT APPROACH TO DELIVERY – VEX ROBOTICS

Version 1

Oxford Cambridge and RSA

Cambridge NATIONALS

ocr.org.uk/engineering

CONTENTS

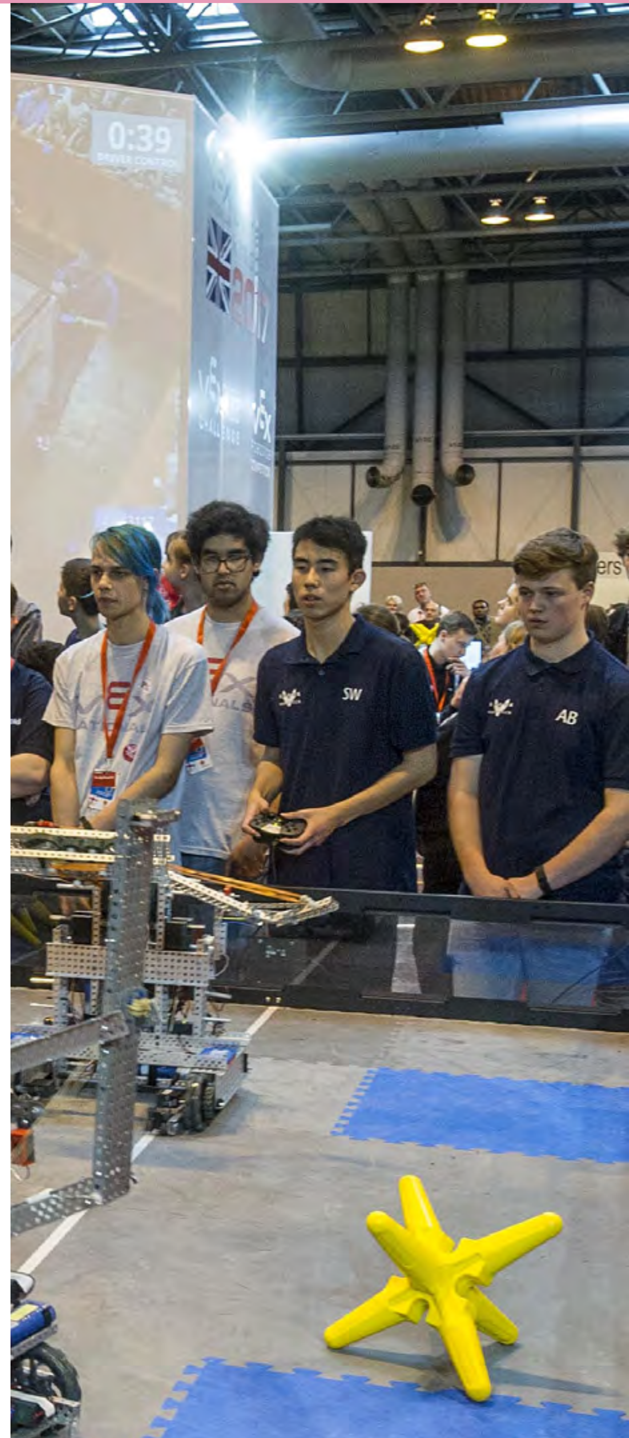
INTRODUCTION

Our world faces a growing problem. It's a problem that, without explicit and intentional action, could stagnate global progress and lead to a workforce that is unmotivated and ill-equipped to solve its future problems. As the world grows more technologically complex, the challenges we face every day will continue to escalate along with it. A mobile phone has more failure modes than a landline. The internals of an electric vehicle are more difficult to comprehend than a V8 combustion engine. Unmanned drone legislation is more nuanced than defining a maximum speed limit.

Dubbed 'the STEM problem', the situation is equally simple to understand, yet difficult to solve. In many cases, the traditional methods of teaching science, technology, engineering, and maths (STEM) will not be enough to adequately prepare students for this complex world. This is often coupled with the unfortunate reality that by the time they reach an age capable of grasping these critical topics, students may have already determined that they are 'not cool' or 'boring'. Without the skills or passion necessary to approach these problems in an educated manner, you cannot possibly expect to be productive in making forward progress or even sustaining the status quo.

The VEX Robotics Competition exists to solve this problem. Through its uniquely engaging combination of teamwork, problem solving, and scientific discovery, the study of competitive robotics encompasses aspects of STEM. You're not building VEX EDR robots because your future job will involve tightening shaft collars on a metal bar – you're executing an engineering design and problem-solving process that resembles the same mind-set used by rocket scientists, brain surgeons, and inventors around the world. The VEX Robotics Competition is not just a game that was invented because it is fun to play – it is a vehicle for teaching (and testing) teamwork, perseverance in the face of hardship, and provides a methodology to approach and solve new challenges with confidence.

We encourage you to keep in mind that a VEX Robotics Competition game is more than just a set of game objects worth varying amounts of points. It is an opportunity to hone the life-long skills that will characterise to the problem-solving leaders of tomorrow.



THE VEX ROBOTICS COMPETITION

In its simplest form, the VEX Robotics Competition (VRC), tasks teams of students with designing and building a robot to play against other teams in an engineering challenge wrapped in the form of a game. Classroom STEM concepts are put to the test as students learn lifelong skills in teamwork, leadership, communications, and more.

Aimed at students from 11 through to 18, the VEX Robotics Competition is a global STEM challenge held year-round at the local, regional and national levels. It culminates at the VEX Robotics World Championship each April where the top 1400 teams from over 30 countries around the world come together to see who will be crowned World Champions. Teams entering will spend weeks – or months – researching, designing, building, programming and iterating their robot along with developing CAD content and their Engineering Notebooks for judging.

Each year the challenge faced by the teams changes, though the format and structure of the competition itself remains constant. Full details of the current competition can be found at https://www.vexrobotics.com/vexedr/competition/vrc-current-game

VEX ROBOTICS IN THE CLASSROOM

VEX Robotics is used in the daytime teaching of Design and Technology, Computer Science, Robotics and Engineering lessons around the world. The simple and flexible platform allows students to understand complex theory and apply them in real world situations.

The VEX Robotics platform has hundreds of hours of free curriculum mapped to Key Stages 2 and 3 across Design and Technology and Engineering. These lessons, through scaffolded schemes of work, equip students with all the core skills and knowledge required to use the VEX Robotics platform. From there, this understanding can be used to develop open-ended, project-based solutions for the NEA elements of the OCR qualifications.

All of the free VEX Robotics curriculum can be downloaded from the National STEM Centres e-library here https://www.stem.org.uk/users/vex-robotics

VEX ROBOTICS AND OCR

Working with OCR, the VEX Robotics team have mapped the competition activities and the use of the VEX EDR platform as a prototyping system with a range of OCR qualifications. This mapping has produced this project approach document and provided additional suggested activities to support teachers in delivering using the platform against the required elements of the curriculum. A range of essential and optional competition elements can be developed and completed within the context of the school timetable, reducing the amount of extracurricular time required for the activity.

Schools taking part or considering taking part in the VEX Robotics Competition as part of the STEM agenda will find the project approach enables both the qualification and challenge can be delivered using the same programmed curriculum time.

HOLISTIC APPROACH TO DELIVERY

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

Suggest how the VEX Robotics Competition or the use of the VEX EDR robotics design platform could be used to support the delivery of the following OCR qualifications:

Cambridge Nationals in Engineering (Level 1/2):

- Principles in Engineering and Engineering Business, units R101 – R104
  Link to qualification http://www.ocr.org.uk/qualifications/cambridge-nationals-principles-in-engineering-and-engineering-business-level-1-2-award-certificate-j830-j840/

- Engineering Design, units R105 – R108
  Link to qualification http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-design-level-1-2-award-certificate-j831-j841/

- Engineering Manufacture, units R109 – R112
  Link to qualification http://www.ocr.org.uk/qualifications/cambridge-nationals-engineering-manufacture-level-1-2-award-certificate-j832-j842/

- Systems Control in Engineering, units R113 – R116
  Link to qualification http://www.ocr.org.uk/qualifications/cambridge-nationals-systems-control-in-engineering-level-1-2-award-certificate-j833-j843/

Note, learners can complete any of the 16 Cambridge Nationals in Engineering units, but must achieve the correct combination of units to achieve the appropriate certificate/diploma.

Cambridge Technicals in Engineering (Level 2):

Link to qualification http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-2-2016-suite/

Cambridge Technicals in Engineering (Level 3)

Link to qualification http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-engineering-level-3-certificate-extended-certificate-foundation-diploma-diploma-05822-05825/

GCSE Design and Technology (9–1).

Link to qualification http://www.ocr.org.uk/qualifications/gcse-design-and-technology-j310-from-2017/

VEX ROBOTICS AND OCR ENGINEERING QUALIFICATIONS

This guide is divided into six sections.

The first section explores the standard competition stages and suggests how the competition can be used to develop student understanding against specific learning outcomes in the qualifications.

Section 2 explains how the optional 'Design Your Own Part' element of the competition can be used to extend the range of learning outcomes covered through the activity.

Section 3 looks at using the VEX EDR platform in a project based approach. This section looks at classroom usage that may not be directly linked to the competition.

Section 4 gives unit level mapping of the different elements that make up the VEX Robotics Competition, Design Your Own Part and VEX EDR activities. This section suggests where each of the activities could support the qualification units. This section is supported by Appendix 1 which contains more detailed mapping of the activities to the specific unit learning outcomes.

Section 5 contains links to additional resources that could be used to support the delivery of the qualifications.

Section 6 contains suggestions on how the engineering activities can be integrated into the maths and science curriculum.

HOW TO USE THIS GUIDE

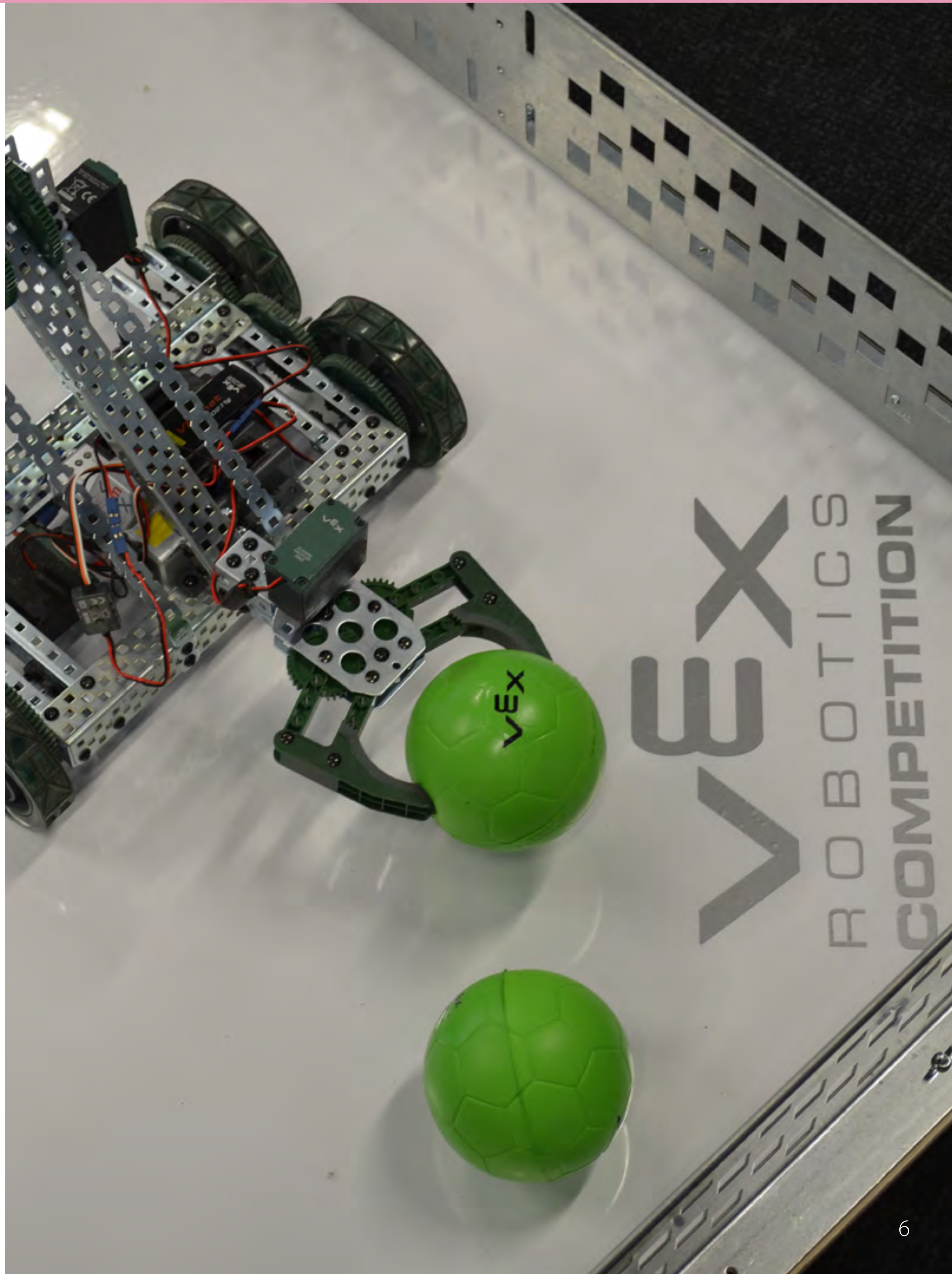
Sections one, two and three give an overview of the different broad activities that will be covered by a team taking part in the VEX Robotics Competition or in using the VEX EDR kit.

There are brief suggestions of things that tutors can bring into the classroom session related to the activity and some guidance and advice from teachers who have used VEX Robotics in the classroom.

Please note that this Project Approach MUST not be used directly for assessment purposes.

Each of the broad activities have been mapped to the units and learning outcomes for the stated qualifications. The qualification units are listed after the suggested activities in sections one, two and three. The tables in section four brings this information together by qualification. Once the units of interest have been identified, the tables in the appendix can be used to target specific learning outcomes.

Tutors can therefore use the unit lists in sections to identify the qualifications and units they are delivering. The tables in the appendix can then be used to develop the lesson plans based on the learning outcomes.



SECTION 1 VEX ROBOTICS COMPETITION STAGES

The main competition has three broad elements:

- Classroom based activities (preparation for the competition)
- Competition and judging (the competition)
- Stakeholder engagement (engaging with partners and sponsors of the competition)

Classroom Based Stages

Stage 1: Introduce the VEX Robotics Competition

To get the students enthusiastic about the competition and engineering in general, the tutor could run a session looking at previous years' competitions, exploring the challenges and winning designs. Using the resources on the VEX Robotics web site and through video sites such as YouTube, learners can explore and research the sorts of activities involved and the types of robot they might be expected to construct.

Understanding the design process and the strategic objectives are vital to a successful robot build. Part of this comes from the ability to analyse, in depth, the challenge put forward in the game. This will form the design brief for the build.

Resource: VEX Robotics Curriculum http://curriculum.vexrobotics.com/curriculum/the-game.html

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO3 Know about the wider influences on the design of new products
R106	LO2 Be able to research existing products

Activity 1

Analyse the challenges for the VEX Robotics Competition from the past four years. Try to identify the following:

- what is the main task of the game?

- what challenges are there adapting a Clawbot to meet the game requirements?

- what are the issues in collecting/moving/lifting the game elements?

- what strategy would you use to achieve a high scoring robot?

- how does the field layout affect robot design and game strategy?

- is the game style offensive, defensive or task driven?

Activity 2

Analyse the winning robot designs from the UK Nationals/World Championships by searching for their designs online on the VEX Forums, YouTube and team websites. Using images of the robot, annotate the features of the solutions, describing how they work. Try to identify any clever or unique applications of the VEX EDR parts.

Activity 3

Compare and contrast two different robotic solutions by two different teams competing in the same game. Make a list of positive and negative features of the design, considering the following features:

- size

- operation

- programming

- cost

- weight

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Stage 2: Allocation of team roles

Having informed the learners about the competition structure and challenges, the tutor could engage them in forming their own teams. Using the information from the competition overview page online, tutors should support the learners in outlining the different roles each team should have and then set them the task of detailing the responsibilities for each role, creating a basic job description and then allocating the roles within the team.

There may be some learners who take multiple roles and other roles which they determine are not required. Resource: Website detailing the roles and strategy when putting a team together http://curriculum.vexrobotics.com/appendices/appendix-4.html

This stage supports:

Cambridge Nationals Level 1/2 - Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R106	LO2 Be able to research existing products
Cambridge Nationals Level 1/2 - Engineering Manufacture	
R110	LO1 Be able to plan for the making of a pre-production
R111	LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines
Cambridge Technicals in Engineering Level 3	
Unit 24	LO1 Understand the stages of project management
	LO3 Be able to use project management tools

Activity 1

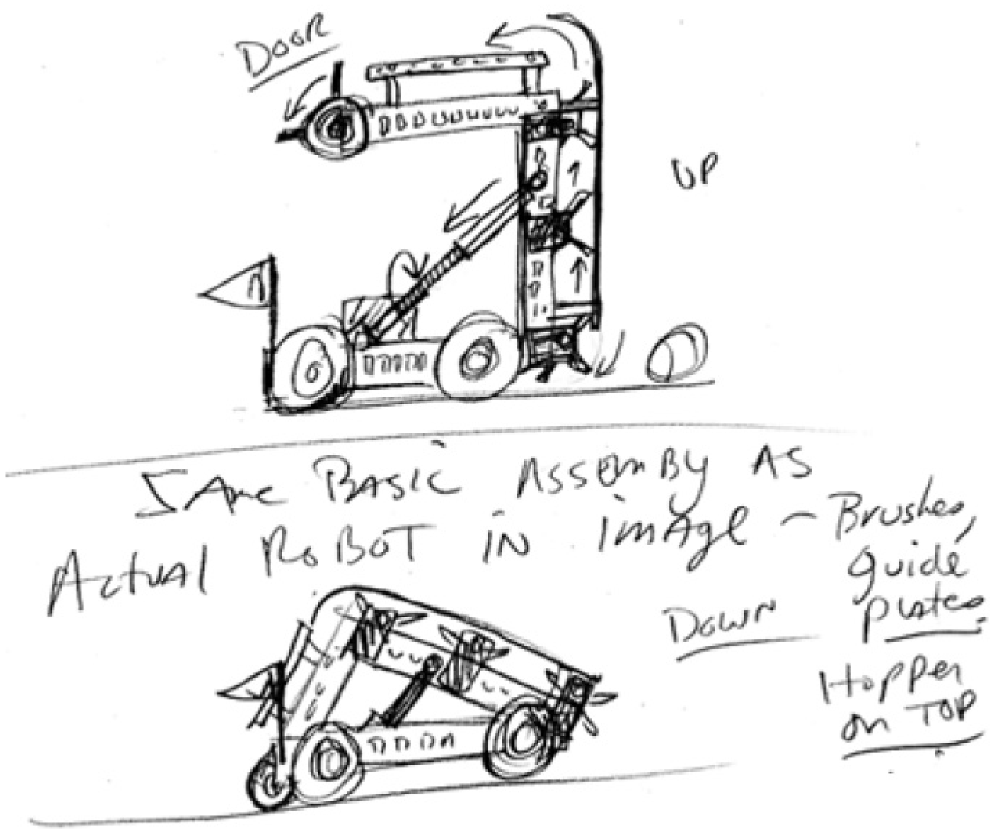
What are the industrial roles associated with robotics and mechanical engineering? Identify case studies of companies who develop robotic solutions, static or dynamic, and try to create a map of the individuals involved, from design to electrical to manufacture or shipping to operation and programming, to name just a few. Create a mind map for a specific application of robotics.

Activity 2

Role play a task. Using craft materials such as paper straws, tape and Blu Tack, the team are challenged with developing a structure that can achieve a specific purpose (height, reach, load, etc.). The team will need to identify roles for each member, and then carry out the engineering task. At the end, ask learners to reflect on the task and recommend how roles within teams should work for greater success next time.

Activity 3

Pitch a proposal for a new robotic solution. Using the scenario of bidding for funding for a new robotic research and development project, the team are tasked with putting a short presentation together that identifies the; need; aim; cost; outcome; benefactors. Learners will need job roles to prepare the presentation in a short time frame, and need to pitch the idea back to the class for critique and the decision to fund or not fund.



SECTION 1 VEX ROBOTICS COMPETITION STAGES

Stage 3: Equipment familiarisation

Before commencing on the design and construction of the competition robot, learners will need to be familiar with the range of tools and equipment they will be using and the product platform. This could be achieved with an upfront introduction to the range of equipment to be used or equipment could be introduced as it is needed. Learners could be asked to create documentation for the safe use of equipment with clear links to the health and safety aspects.

If the learners are undertaking the additional activity of designing their own components then the use of the additional equipment would be covered here. Learners could use research of past winners of the competition to gain knowledge whilst carrying out activities related to engineering materials that may be used in the competition. The tutor can introduce exercises with electronic circuits and controls systems, activators and sensors as part of the familiarisation.

The learners need to have a good understanding of the different subsystems of the VEX EDR system:

- Structure
- Motion
- Power
- Sensors
- Logic
- Control

Resource: The VEX EDR Clawbot gives learners the basic understanding of the system http://curriculum.vexrobotics.com/curriculum/intro-to-robotics/building-the-vex-clawbot.html

This stage supports:

Cambridge Nationals Level 1/2 - Principles in Engineering and Engineering Business	
R105	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
	LO4 Know about the systems used to transmit power in engineering
Cambridge Nationals Level 1/2 – Engineering Design	
R110	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly

Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
	LO3 Know about developments in engineering processes
	LO4 Understand the impact of modern technologies on engineering production
R110	LO2 Be able to use processes, tools and equipment safely to make a pre-production model
	LO3 Be able to modify a production plan for different scales of production
R111	LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines
	LO2 Be able to interpret information from CAD to manufacture components on CNC equipment
	LO3 Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO4 Understand commercial circuit construction methods
R114	LO1 Be able to use CAD for circuit simulation and design
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO2 Understand how computers are used for maintenance of engineering systems
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering Level 2	
Unit 1	LO1 Know what common SI units and their derivatives are and how to use them in engineering
	LO2 Know how to classify common engineering materials
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices
	LO3 Be able to programme an identified automated control system
Cambridge Technicals in Engineering Level 3	
Unit 7	LO1 Understand semi-conductor and programmable devices
	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
GCSE Design and Technology	
Topic Area 7	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes,
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods
	7.4 How do industry professionals use digital design tools when exploring and developing design ideas? a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions

Activity 1

Create a series of instructional materials. Using any media platform from one-to-one device to drawn or desktop published document, the learners are tasked with creating an easy to access and use instructional guide for younger children new to the robotics system. The learners can work individually on small task, or in teams. The task is to plan briefly, then create with rich media, a suitable guide that can be used to support others. Learners will need to research and understand the names of equipment and materials to reference these appropriately.

Activity 2

Simple system construction - Using any and all of the equipment in a VEX EDR kit, learners are tasked to be completely free and inventive and design/engineer an outcome. The outcome can be anything from an everyday product to a new solution to a structure or character. The class will need to guess and identify what it is without this being stated by the team creating it.

Activity 3

Build the EDR Clawbot, then set the learners the task of identifying the number of intentional design flaws built into it. Supported by the EDR Curriculum; Unit 2.0, learners can identify and 'design out' these flaws.

Resource: VEX EDR Curriculum – Unit 2.0 – Clawbot Build - https://www.stem.org.uk/resources/community/resource/162212/vex-robotics-edr-curriculum-unit-20-clawbot-build

Stage 4 Initial Design

This stage is quite lengthy and is where learners will have to interpret a design brief and use it to collaboratively come up with an initial design.

Tutors can include lessons on design stages, design briefs, client requirements and quality to support the stage. Learners could be expected to create a presentation detailing how the team interpreted the brief and how their initial design meets the brief. The presentation could also include a development plan.

At all stages throughout the process, the learners should use the 11-stage design process:

Step 1 – UNDERSTAND – Define the Problem

Step 2 – EXPLORE – Do Background Research

Step 3 – DEFINE – Determine Solution Specifications

Step 4 – IDEATE – Generate Concept Solutions

Step 5 – PROTOTYPE – Learn How Your Concepts Work

Step 6 – CHOOSE – Determine a Final Concept

Step 7 – REFINE – Do Detailed Design

Step 8 – PRESENT – Get Feedback and Approval

Step 9 – IMPLEMENT – Implement the Detailed Solution

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Step 10 – TEST – Does the Solution Work?

Step 11 – ITERATE

Resource: The Engineering Design Process http://curriculum.vexrobotics.com/curriculum/intro-to-engineering/what-is-the-engineering-design-process.html

There are a range of additional online curriculum resources that will support the underlying knowledge of the learners during this process:

Resource: A Guide to Drive Train Design http://curriculum.vexrobotics.com/curriculum/drivetrain-design.html

Resource: A guide to Object Manipulators http://curriculum.vexrobotics.com/curriculum/object-manipulation.html

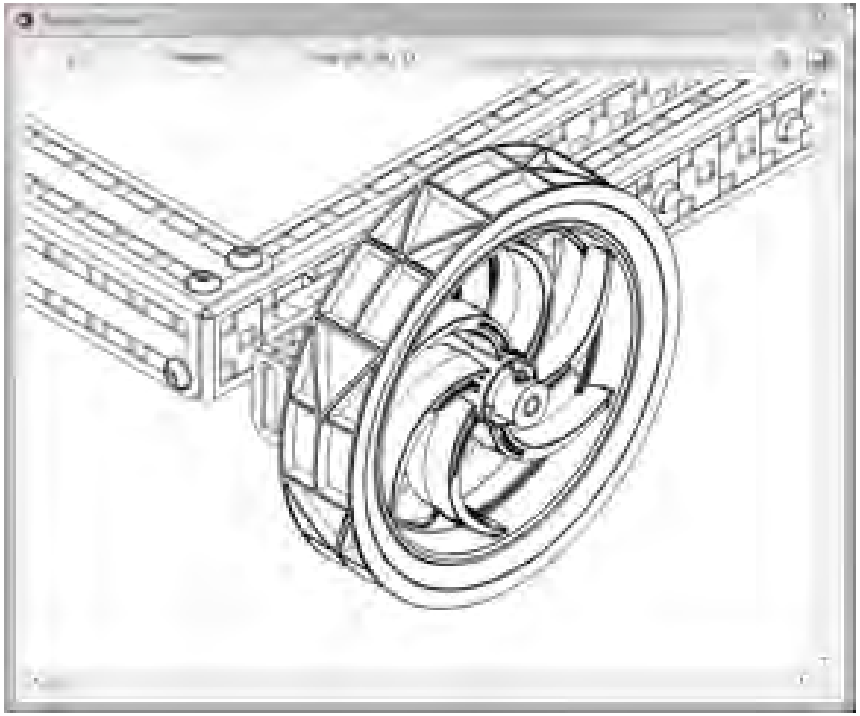
This stage also allows students to explore digital design tools, such as CAD software and create virtual models of robots. Resource: Autodesk Tutorials http://curriculum.vexrobotics.com/curriculum/intro-to-autodesk-inventor.html

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R106	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype

Cambridge Nationals Level 1/2 – Engineering Manufacture	
R110	LO1 Be able to plan for the making of a pre-production product
R111	LO3 Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system



SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering Level 2	
Unit 1	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
	LO4 Know how to calculate mechanical motion and force
	LO5 Know electrical and electronic principles for electronic control and electrical motion
Unit 2	LO2 Understand why engineering materials are suitable for specific engineering applications
	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Understand the operation and application of fluid power sources, actuators and valves
Unit 4	LO2 Be able to construct electronic circuits by interpreting circuit diagrams
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices
	LO3 Be able to programme an identified automated control system
Unit 6	LO1 Be able to create 2D and 3D drawings to present engineering components
	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software

Cambridge Technicals in Engineering Level 3	
Unit 5	LO2 Understand the application of electromagnetism in electrical design
	LO3 Be able to apply a systems approach to electrical design
	LO5 Understand the application of programmable process devices in electronic design
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards(PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely
Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
	LO4 Understand the application of smart and modern materials in electrical
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
	LO2 Be able to work safely with electricity
	LO3 Be able to construct electrical and electronic circuits
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
	LO3 Be able to design components that can be successfully manufactured
Unit 11	LO1 Understand material structure and classification
	LO4 Know the applications and benefits of modern and smart materials
Unit 12	LO3 Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components
	LO4 Be able to carry out Computational Fluid Dynamic (CFD)simulations to assess the operational performance of components
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
Unit 24	LO1 Understand the stages of project management
	LO3 Be able to use project management tools

SECTION 1 VEX ROBOTICS COMPETITION STAGES

GCSE Design and Technology	
Topic Area 1	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes? a. Considerations for exploring a context
	1.2 Why is usability an important consideration when designing prototypes? a. Considerations in relation to user interaction with design solutions
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
	2.2 How do developments in Design and Technology influence design decisions and practice? a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives
Topic Area 4	4.1 How can design solutions be communicated to demonstrate their suitability to a third party? a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations
	4.2 How do designers source information and thinking when problem solving? a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses
	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes.
Topic Area 8	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing? b. How to calculate the quantities, cost and sizes of materials and/or system components required in a design or product, being able to apply this to different applications

Activity 1

Commencing with a VEX EDR Clawbot or Tumbler, learners are tasked with refining the solution to design out flaws and improve its performance. This will require learners to test and critique the solution initially, then move to identify 3 clear areas to improve, and using materials and equipment available, design these out. The development of the robot solution can be directed towards a previous game, challenge, or new application set for the class by the teacher.

Activity 2

Virtually model a VEX Robotics solution using a CAD software package (Autodesk Inventor/ Fusion 360). Using the VEX parts library, learners are tasked with taking a design into the virtual world. This can centre on the reverse engineering of an existing solution, or the

SECTION 1 VEX ROBOTICS COMPETITION STAGES

design or new parts, sub-assemblies, or sections of a larger concept. The aim of the task is for learners to become familiar with the CAD platform, the use of libraries, assemblies and developing an understanding of how CAD might support the identification of issues and iteration opportunities in an existing solution.

Activity 3

Using images of previous or existing competition robot designs, learners are tasked with sketching and iterating improved versions of a robotic solution. This could see the improvement of a basic robot, the development of a new solution, or the re-engineering of a solution to a new game. The learners task will be to critique the initial design, on paper, using photographs to annotate the areas of concern, and then to sketch these improvements. A technique of drawing onto photographs of areas of re-engineering would make the process quick and provide a starting point for those weaker at drawing or sketching.

Stage 5: Test Design

Once the learners have created their initial design they will need to build it and then test the first prototype of the robot. Tutors can include specific testing methods and techniques for mechanical, electrical and electronic components and systems. Tutors could introduce an element of peer review and feedback to give learners different perspectives. Learners could be asked to create a team report to comment on the effectiveness of the initial design.

There are many questions to consider when reviewing the effectiveness of the initial design. The iterative design process should be followed at all stages.

Resource: Testing and Iteration http://curriculum.vexrobotics.com/curriculum/testing-iteration-and-continuous-improvement/testing-and-iteration.html

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R104	LO3 Understand factors that contribute to system/product failure
	LO4 Be able to perform simple procedures to optimise product/system performance
R108	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R110	LO3 Be able to modify a production plan for different scales of production

Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO3 Know test methods for electronic circuits
R114	LO3 Be able to test electronic circuits
R115	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO3 Be able to test control systems
Cambridge Technicals in Engineering – Level 2	
Unit 2	LO1 Understand the factors that determine efficiency in engineering systems
	LO4 Understand how to select electrical and electronic devices for engineering purposes
Unit 4	LO3 Be able to test electronic circuits for functionality
Unit 5	LO4 Be able to test the operation of an automated control system
Unit 8	LO1Understand the importance of maintenance to optimise performance
	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 2	
Unit 5	LO2 Understand the application of electromagnetism in electrical design
	LO3 .Be able to apply a systems approach to electrical design
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards (PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely LO4 Be able to test and perform fault-finding on electronic circuits
	LO4 Be able to test and perform fault-finding on electronic circuits
Unit 8	LO4 Be able to fault find in electrical and electronic equipment
Unit 9	LO4 Be able to optimise design to improve performance
Unit 11	LO2 Understand properties, standard forms and failure modes of materials
	LO5 Be able to test the suitability of materials for different applications
Unit 12	LO1 Be able to carry out simulations to establish reactions in moving mechanical assemblies
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
Unit 22	LO1 Understand sustainability in engineering
Unit 24	LO1 Understand the stages of project management
	LO3 Be able to use project management tools
	LO4 Be able to use information to support project management decisions
	LO5 Understand how and why projects are monitored
Unit 25	LO1 Be able to reflect on own performance and performance of systems, processes or artefacts
	LO2 Be able to develop a plan for improvements to a system, process or artefact

GCSE Design and Technology	
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses. b. Awareness of the processes that can be used to ensure the structural integrity of a product
	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes?
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes
Topic Area 8	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing? b. How to calculate the quantities, cost and sizes of materials and/or system components required in a design or product, being able to apply this to different applications

Activity 1

Prototyping in corrugated card. The learners work in teams and build their idea using corrugated card. The learners' task is to use the card flute to create bends or straight parts that can perform despite the material – the context can be open or VEX related. The learners can use the card with hot melt glue, rivets or tape, and create a to scale prototype that can establish key pieces of information like ergonomics, scale, cost, function and potential performance.

Activity 2

Comparative analysis of ideas - Based on sketches, prototypes or physical build and testing, the task is for learners to conduct a comparison analysis of solutions. Using a table, the column headings will be the key features or desired outcomes of the design. The row

SECTION 1 VEX ROBOTICS COMPETITION STAGES

headings will be the different solutions being considered. Using objective and subjective comments and scoring, learners rate the outcomes against each other and the headings, to identify strengths in one or more solution.

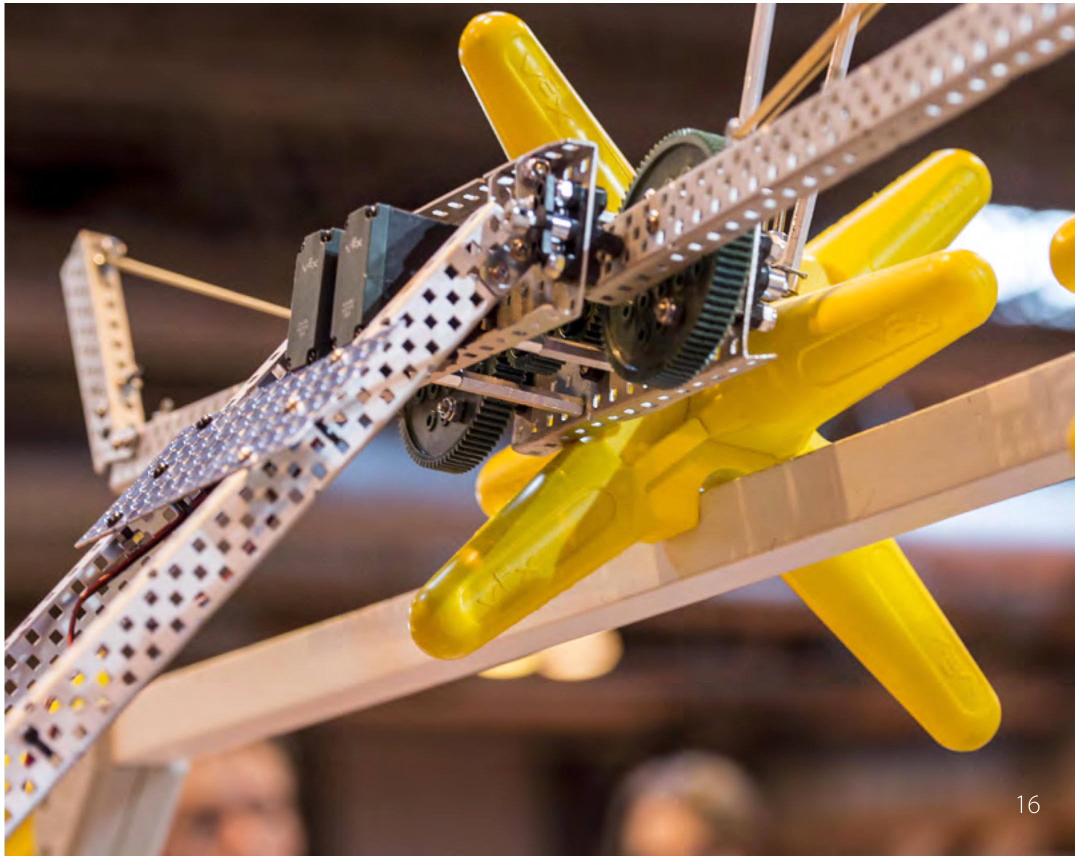
Activity 3
Analysis of mechanical systems - Using the mechanical systems within the VEX kit, learners are tasked with creating multiple solutions to the same challenge. This will involve exploring elements such as gears for aspects of torque or improved performance for example. Learners need to develop three different ways to achieve the same goal, for example lifting a heavy load off a surface or stopping a robot from tipping. Learners can critique the ideas using video and commentary.

Stage 6: Refine Design

Having tested the initial prototype and received feedback from other teams, learners can now refine the design and come up with the first iteration of the initial design. Learners can replace and adjust the components based on the results of the testing carried out. Tutors could ask the teams to produce a report detailing and justifying the modifications which should be done in the context of expected competition performance. This process can be repeated several times as timetabling permits.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R104	LO3 Understand factors that contribute to system/product failure
	LO4 Be able to perform simple procedures to optimise product/system performance
Cambridge Nationals Level 1/2 – Engineering Design	
R107	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R110	LO3 Be able to modify a production plan for different scales of production
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
R114	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R115	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems
Cambridge Technicals in Engineering – Level 2	
Unit 1	LO4 Know how to calculate mechanical motion and force
Unit 4	LO4 Understand how to select electrical and electronic devices for engineering purposes
Unit 5	LO4 Be able to test the operation of an automated control system
Unit 8	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations



SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 3	
Unit 5	LO3 Be able to apply a systems approach to electrical design
Unit 6	LO3 Be able to manufacture and construct electronic circuits safely
	LO4 Be able to test and perform fault-finding on electronic circuits
Unit 7	LO4 Understand the application of smart and modern materials in electrical
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
	LO4 Be able to optimise design to improve performance
Unit 12	LO3 Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components
	LO4 Be able to carry out Computational Fluid Dynamic (CFD)simulations to assess the operational performance of components
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
Unit 24	LO1 Understand the stages of project management
	LO3 Be able to use project management tools
	LO4 Be able to use information to support project management decisions
	LO5 Understand how and why projects are monitored
Unit 25	LO1 Be able to reflect on own performance and performance of systems, processes or artefacts
	LO2 Be able to develop a plan for improvements to a system, process or artefact
	LO3 Be able to implement a plan to make improvements

GCSE Design and Technology	
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses b. Awareness of the processes that can be used to ensure the structural integrity of a product
	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes
Topic Area 8	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing? b. How to calculate the quantities, cost and sizes of materials and/or system components required in a design or product, being able to apply this to different applications

Activity 1

Repeat testing - Learners take their existing solution, and repeatedly test on elements of the functional design. This could be movement of a motor, claw or arm etc. The learners will need to repeat the task over and over (between 10-20 times) and identify issues or patterns of operation that can be improved. If no improvement can be found, the learners test another aspect. For example the lowering of an arm and grabbing of an object could be tested with proposals for how to slow, speed up or improve the accuracy of the operation for the driver.

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Activity 2

Simulation using Robot Virtual Worlds - Using the virtual platform, learners are tasked with simulating operation of their robot in a virtual world. Learners can choose different robot options and programme this robot in the environment and conduct thorough testing of their programming in this environment. Learners can focus on elements of whole tasks.

Activity 3

CAD dry simulation - Using a CAD package (Autodesk Inventor/Fusion 360 for example), learners can create sub-assemblies of parts, and simulate their movement by not fully constraining parts in an assembly to allow for free movement through an axis. This will allow learners to establish areas where parts conflict, overlap, interact, or will not work in an assembly together.

Stage 7: Final Programming of Robot

Learners develop their programming skills with a range of controllers and programmable units. Tutors can develop the lessons around this activity to cover a range of programming activities and equipment. The VEX EDR Curriculum: Unit 1.0 – Tumbler has some introductory lessons looking at the use of the range of sensors available as part of the system. Programming options include the ROBOTC, VEX Coding Studio, Blockly, Python and Flowol software programs.

Resource: VEX EDR Curriculum: Unit 1.0 – Tumbler https://www.stem.org.uk/resources/community/resource/164397/vex-robotics-edr-curriculum-unit-10-tumbler

The programming task is centred around the competition game, but can be extended to include the optional Programming Skills Challenge for additional scope and depth. Learners can compare against other robots and give feedback and suggestions.

Resource: VEX EDR Sensor Overview http://curriculum.vexrobotics.com/appendices/appendix-1.html

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
	LO4 Know about the systems used to transmit power in engineering
R104	LO2 Know methods used in engineering sectors to maintain optimum performance
	LO3 Understand factors that contribute to system/product failure
Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
R106	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO2 Understand safe working practices used when making a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
	LO4 Understand commercial circuit construction methods
R114	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R116	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems
Unit 8	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 2	
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices
	LO3 Be able to programme an identified automated control system
Unit 8	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations
Cambridge Technicals in Engineering – Level 3	
Unit 5	LO3 Be able to apply a systems approach to electrical design
	LO5 Understand the application of programmable process devices in electronic design
Unit 6	LO4 Be able to test and perform fault-finding on electronic circuits
Unit 7	LO1 Understand semi-conductor and programmable devices
Unit 9	LO4 Be able to optimise design to improve performance
Unit 12	LO1 Be able to carry out simulations to establish reactions in moving mechanical assemblies
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO5 Know about maintenance in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 16	LO1 Understand programming techniques
	LO2 Be able to program embedded devices in a system
	LO3 Be able to program Programmable Logic Controllers (PLCs)
Unit 24	LO3 Be able to use project management tools
	LO4 Be able to use information to support project management decisions
	LO5 Understand how and why projects are monitored
Unit 25	LO1 Be able to reflect on own performance and performance of systems, processes or artefacts
	Be able to develop a plan for improvements to a system, process or artefact

GCSE Design and Technology	
Topic Area 6	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation

Activity 1

Experimentation with sensors - Using the range of sensors, learners can explore their performance and establish where sensing might enhance a mechanical system. Learners can explore digital or analogue sensors, or simply identify and fit sensors to areas of an existing build and explore how they perform. For example, learners could explore how limit and bump switches perform in application where different amounts of force might be applied.

Activity 2

Programme a VEX Tumbler or Clawbot to drive a specific route. Using the base of a robot build, learners can practice and refine their code by programming the drive to move to a specific location, travel a specific distance, or align to a certain object. This can centre around moving through a maze, around objects, or on a table where this is a drop.

Activity 3

Programming an arm to lift and move objects from one location to another - Using the concept of a production line, learners can programme a robotic arm to pick and move objects that arrive into a zone or space where the arm can reach. Depending on the complexity of the arm, the learners can design movement through one or more axis, and try to move objects into a container. The objects could be moving, or coloured, and using sensors, make the robotic arm perform more intelligently.

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Compete (Judging Criteria)

Whether or not the learners will be competing in the VEX Robotics Competition at a formal event, the tutor can still use the judging criteria as the basis for classroom lessons. Learners can be asked to act as judges and comment on the criteria of the robots of other teams. The comments can be compared with the feedback given by the competition judges.

It is important that learners (competitors) are aware of the judging process before they start and they can use the resources created to support the delivery of events to build their knowledge. Resource: Judges Guide - http://www.roboticseducation.org/documents/2014/11/local-judges-guide-vex-robotics-competition-2.pdf

Innovative Engineering and Soundly crafted solution

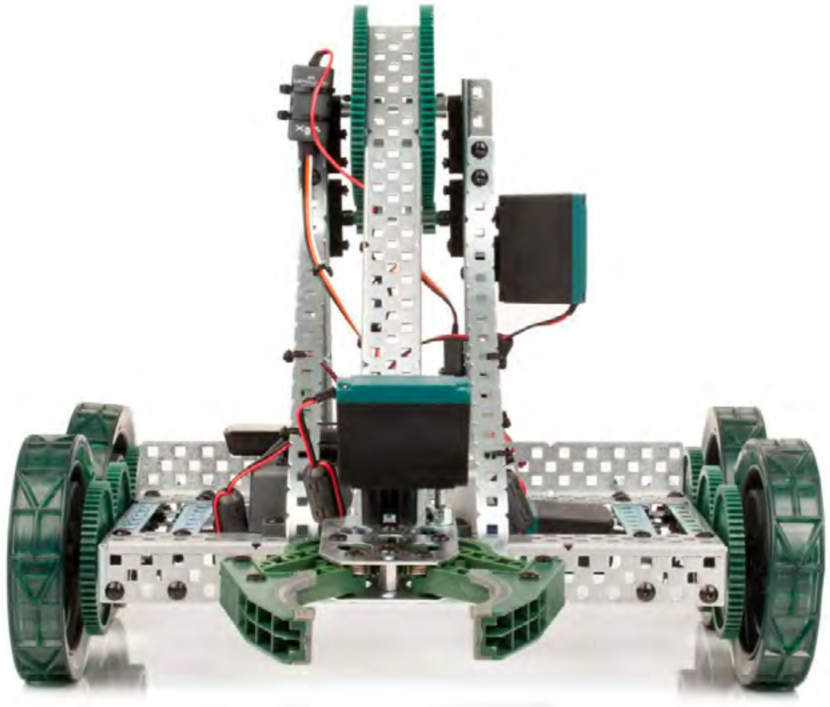
Learners comment and reflect on the extent to which:

- the construction is innovative
- the brief has been met in innovative ways
- innovative use of materials
- innovative control system
- strength and durability of the construction.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
	LO4 Know about the systems used to transmit power in engineering
R104	LO1 Understand why engineering systems and products are designed and maintained for optimum performance
	LO2 Know methods used in engineering sectors to maintain optimum performance
	LO3 Understand factors that contribute to system/product failure
	LO4 Be able to perform simple procedures to optimise product/system performance

Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R106	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO2 Understand safe working practices used when making a prototype
	LO4 Be able to evaluate the success of a prototype



SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
	LO3 Know about developments in engineering processes
R110	LO1 Be able to plan for the making of a pre-production product
	LO2 Be able to use processes, tools and equipment safely to make a pre-production model
R111	LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines
	LO2 Be able to interpret information from CAD to manufacture components on CNC equipment
	LO3 Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components
	LO4 Know about applications of computer control processes used to manufacture products
R112	LO1 Understand the importance of quality control
	LO2 Be able to assess product quality from inspection and quality control techniques
	LO3 Know how modern technologies can be used in quality control
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems

Cambridge Technicals in Engineering – Level 2	
Unit 1	LO3 Know physical properties of engineering materials in relation to
	LO4 Know how to calculate mechanical motion and force
Unit 2	LO3 Understand materials processing techniques
	LO4 Understand how to select electrical and electronic devices for e
Unit 3	LO2 Be able to work safely when performing engineering activities
	LO3 Be able to interpret engineering drawings to produce engineered
Unit 4	LO2 Be able to construct electronic circuits by interpreting circuit

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 3	
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards(PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely
Unit 7	LO1 Understand semi-conductor and programmable devices
	LO2 Understand electrical sensors and actuators
Unit 8	LO2 Be able to work safely with electricity
	LO3 Be able to construct electrical and electronic circuits
Unit 9	LO2 Be able to select appropriate engineering materials to achieve design solutions
	LO3 Be able to design components that can be successfully manufactured
Unit 11	LO3 Understand material processing techniques
	LO4 Know the applications and benefits of modern and smart materials
Unit 12	LO3 Be able to carry out Finite Element Analysis (FEA) simulations to assess the operational performance of components
	LO4 Be able to carry out Computational Fluid Dynamic (CFD)simulations to assess the operational performance of components
Unit 13	LO2 Be able to use bench processes, tools and equipment to produce quality components
Unit 14	LO6 Understand the application of robotics in automation control systems
Unit 21	LO5 Be able to undertake maintenance operations
Unit 22	LO1 Understand sustainability in engineering
	LO5 Know how innovation is making a difference to the way engineering interacts with the environment

SECTION 1 VEX ROBOTICS COMPETITION STAGES

GCSE Design and Technology	
Topic Area 1	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes? a. Considerations for exploring a context
	1.2 Why is usability an important consideration when designing prototypes? a. Considerations in relation to user interaction with design solutions
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
	2.2 How do developments in Design and Technology influence design decisions and practice? a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives
Topic Area 3	3.1 What are the impacts of new and emerging technologies when developing design solutions? a. Exploration of the impacts within different contexts
Topic Area 4	4.2 How do designers source information and thinking when problem solving? a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.
Topic Area 5	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components. b. An overview of the processes used to extract and/or convert the source material into a workable form. c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms.
Topic Area 6	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation.

Activity 1

Critique - Learners in the class are handed a list of criteria that the robotic solution must achieve for the stakeholders (e.g. must be lightweight, must achieve the outcome in 30 seconds, must fit inside a space x by y, etc.). The learners are then asked to watch a demonstration of the outcome, or conduct the activity themselves, and grade the performance of the solution.

Activity 2

Sign off - Using a list of strict design and engineering criteria, the learners must submit their robotic solution for sign off. This involves the measuring, costing, calculating and critique of the solution against criteria for sign off. Teams can write their own criteria or can be provided with generic terms that relate to the contextual application of their robotic solution.

Activity 3

Identifying manufacturing options - Using a completed solution, learners can be provided with the chance to explore the latest manufacturing technologies, and propose how parts and elements can be made. This could range from common 3D printing techniques to injection aluminium moulding and other more diverse production processes. The learners are tasked with presenting how the design could be made using 21st century techniques.

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Features integrated in a well-crafted robot

Learners comment and reflect on the range and functionality of the features in the robot.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
	LO4 Know about the systems used to transmit power in engineering
R103	LO1 Know about the sustainability of engineering materials and products
	LO2 Know about sustainable design for engineered products
R104	LO1 Understand why engineering systems and products are designed and maintained for optimum performance
	LO2 Know methods used in engineering sectors to maintain optimum performance
	LO3 Understand factors that contribute to system/product failure
	LO4 Be able to perform simple procedures to optimise product/system performance
Cambridge Nationals Level 1/2 – Engineering Design	
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R111	LO2 Be able to interpret information from CAD to manufacture components on CNC equipment
	LO3 Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components

Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered produces
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems
Cambridge Technicals in Engineering – Level 3	
Unit 7	LO3 Understand how to use signal conditioning techniques and signal conversion devices
	LO4 Understand the application of smart and modern materials in electrical
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 9	LO2 Be able to select appropriate engineering materials to achieve design solutions

SECTION 1 VEX ROBOTICS COMPETITION STAGES

GCSE Design and Technology	
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
	2.2 How do developments in Design and Technology influence design decisions and practice? a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives
Topic Area 5	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? b. The physical and working properties of specific materials and/or system components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components. b. An overview of the processes used to extract and/or convert the source material into a workable form. c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses. b. Awareness of the processes that can be used to ensure the structural integrity of a product

Activity 1

Learners use photographs of their robot and take it in turns to annotate areas of the solution with descriptions of how it is intended to perform. The team pass the photographs along, with each member of the team adding annotation. Once the photographs have been fully annotated, the full set are reviewed and discussed to make group decisions on improvements. This can include re-engineering solutions with the team, adjusting and moving parts, connections and assemblies to improve the solution.

Activity 2

Sketch the individual systems in a robotic solution. Using the whole solution as the example, learners are tasked with sketching only the unique systems that make it up. For example, learners might draw drive system for the base of the robot, with gears, motors and wheels, then separately draw the system that is the lifting arm, before finally drawing the claw or intake system that grabs the object as the actuator. For a Clawbot this would be the three individual systems that make the full robot work.

Activity 3

Alternative functionality - Using an existing solution, learners are tasked with designing out one system and replacing it with another to tests its performance. For example, using a simple Tumbler, learners would swap a wheel system for a tracked system and critique the new outcome. For a grabber or arm, learners could develop and swap in and out multiple alternative solutions to achieve the same desired outcome. This task could be centred on the Clawbot for ease of approach and opportunity to develop further.

Effective autonomous code with consistent autonomous code on the field.

Learners comment and reflect on the extent to which:

- the autonomous code works in meeting the design brief
- performs consistently during multiple operations

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R103	LO1 Know about the sustainability of engineering materials and products
	LO2 Know about sustainable design for engineered products
R104	LO2 Know methods used in engineering sectors to maintain optimum performance
	LO3 Understand factors that contribute to system/product failure
	LO4 Be able to perform simple procedures to optimise product/system performance

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Nationals Level 1/2 – Engineering Design	
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems
Cambridge Technicals in Engineering – Level 2	
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.
	LO3 Be able to programme an identified automated control system
	LO4 Be able to test the operation of an automated control system
Unit 8	LO1 Understand the importance of maintenance to optimise performance
	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations
	LO4 Be able to perform unscheduled repair procedures
Cambridge Technicals in Engineering – Level 3	
Unit 5	LO4 Be able to use semi-conductors in electrical and electronic design
	LO5 Understand the application of programmable process devices in electronic design
Unit 7	LO2 Understand electrical sensors and actuators

Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO5 Know about maintenance in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 16	LO1 Understand programming techniques
	LO2 Be able to program embedded devices in a system
	LO3 Be able to program Programmable Logic Controllers (PLCs)
Unit 21	LO1 Know about maintenance strategies and operations
	LO2 Understand failure modes
	LO4 Be able to plan maintenance operations
	LO5 Be able to undertake maintenance operations
GCSE Design and Technology	
Topic Area 6	3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation

Activity 1

Repeat testing of an autonomous program - Learners create a program for a robotic solution, and repeat the testing of it over and over, setting the robot up in the same way each time. Once imperfections are no longer evident, learners modify either the programme or the physical setup and repeat the testing until an improved outcome is achieved. This can include the introduction of new build elements, mechanical changes to the robot, or focus simply on the programming.

Activity 2

Scientific testing - Learners record using video the performance of a robot in an autonomous program. The learners need to repeat the program and film it until it can be analysed and observed by the learners or the team to identify where issues are occurring.

SECTION 1 VEX ROBOTICS COMPETITION STAGES

This could centre on the drive of a robotic solution through a maze, where fine adjustments in mechanical and programed elements result in a more accurate and efficient drive through the maze. Using scientific approaches, learners must make a hypothesis of how the solution will perform, record its performance, then reflect on how it performed and rate the success or failure, stating why.

Activity 3

Writing a design brief for an existing solution - As a practice activity, learners can write a design brief for an existing robotic solution and share these with the group. The task is to identify the specific elements, the context, and the stakeholders, which learners will be able to use their creativity to identify. The focus could be on converting the concept of one of the competition games into a contextual brief relating to industry, such as a packing or sorting company with automated robots in use, or the clearing of waste or debris in an accident.

Effective use of mechanical and electrical components

Learners can comment and reflect on how effective the uses of components were.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
	LO4 Know about the systems used to transmit power in engineering
R103	LO1 Know about the sustainability of engineering materials and products
	LO2 Know about sustainable design for engineered products
R104	LO1 Understand why engineering systems and products are designed and maintained for optimum performance
Cambridge Nationals Level 1/2 – Engineering Design	
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype

Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
R110	LO1 Be able to plan for the making of a pre-production product
	LO2 Be able to use processes, tools and equipment safely to make a pre-production model
R111	LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines
	LO2 Be able to interpret information from CAD to manufacture components on CNC equipment
	LO3 Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components
R112	LO1 Understand the importance of quality control
	LO2 Be able to assess product quality from inspection and quality control techniques
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
	LO4 Understand commercial circuit construction methods
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 2	
Unit 1	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
	LO5 Know electrical and electronic principles for electronic control and electrical motion
	LO6 Know how to recognise fluid power components and their symbols and calculate fluid power
Unit 2	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Understand the operation and application of fluid power sources, actuators and valves
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices
	LO3 Be able to programme an identified automated control system
Cambridge Technicals in Engineering – Level 3	
Unit 5	LO2 Understand the application of electromagnetism in electrical design
	LO3 Be able to apply a systems approach to electrical design
Unit 6	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards(PCBs)
Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
	LO4 Understand the application of smart and modern materials in electrical
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and device
	LO3 Be able to construct electrical and electronic circuits
Unit 9	LO2 Be able to select appropriate engineering materials to achieve design solutions
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
	LO3 Understand material processing techniques
	LO5 Be able to test the suitability of materials for different applications
Unit 12	LO3 Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components
	LO4 Be able to carry out Computational FluidDynamic (CFD)simulations to assess the operational performance of components
Unit 13	LO2 Be able to use bench processes, tools and equipment to produce quality components
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems

SECTION 1 VEX ROBOTICS COMPETITION STAGES

GCSE Design and Technology	
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components b. An overview of the processes used to extract and/or convert the source material into a workable form c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms
Topic Area 6	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation

Activity 1

Learners are tasked with identifying components from each of the five elements of a VEX Robotics solution, and stating their appropriate selection for the solution. The elements are:
- Structure
- Movement
- Gearing
- Control
- Sensing

For each element, learners must state why the material, production technique, finish, design and application are appropriate for the robotic solution.

Activity 2

Peer review - Learners work in pairs, with each taking it in turns to present their robotic solution to their partner for review. The learners can offer the opportunity to test the solution without instruction, and then receive critique, or learners can demonstrate their solution and receive observational critique.

SECTION 1 VEX ROBOTICS COMPETITION STAGES

A unique design able to cope with hazards and competition rigors using creative and innovative design process

Learners can comment and reflect on the design process used and the extent to which the design:

- is unique
- deals with competition hazards

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R103	LO1 Know about the sustainability of engineering materials and products
	LO2 Know about sustainable design for engineered products
R104	LO1 Understand why engineering systems and products are designed and maintained for optimum performance
Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R106	LO1 Know how commercial production methods, quality and legislation impact on the design of products and components
	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype

Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
R111	LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines
	LO2 Be able to interpret information from CAD to manufacture components on CNC equipment
R112	LO1 Understand the importance of quality control
	LO2 Be able to assess product quality from inspection and quality control techniques
	LO3 Know how modern technologies can be used in quality control
	LO4 Know the principles of lean manufacturing
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
	LO4 Understand commercial circuit construction methods
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Cambridge Technicals in Engineering – Level 2	
Unit 1	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
Unit 4	LO2 Be able to construct electronic circuits by interpreting circuit diagrams
Unit 5	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.
	LO3 Be able to programme an identified automated control system
Unit 8	LO1 Understand the importance of maintenance to optimise performance
	LO2 Be able to plan maintenance to optimise performance
	LO3 Be able to perform maintenance operations
	LO4 Be able to perform unscheduled repair procedures
Cambridge Technicals in Engineering – Level 3	
Unit 5	LO1 Be able to apply AC and DC circuit theory to circuit design
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) tod esign printed circuit boards(PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely
Unit 7	LO4 Understand the application of smart and modern materials in electrical
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
Unit 10	LO1 Be able to produce 3D models using Computer Aided Design (CAD)
	LO2 Be able to create 3D assemblies of components within a CAD system
	LO3 Be able to produce 2D CAD engineering drawings
Unit 11	LO2 Understand properties, standard forms and failure modes of materials
	LO4 Know the applications and benefits of modern and smart materials
Unit 12	LO3 Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components
	LO4 Be able to carry out Computational Fluid Dynamic (CFD)simulations to assess the operational performance of components

Unit 14	LO5 Know about maintenance in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 21	LO1 Know about maintenance strategies and operations
	LO2 Understand failure modes
	LO4 Be able to plan maintenance operations
	LO5 Be able to undertake maintenance operations
Unit 22	LO1 Understand sustainability in engineering
	L05 Know how innovation is making a difference to the way engineering interacts with the environment
GCSE Design and Technology	
Topic Area 3	3.1 What are the impacts of new and emerging technologies when developing design solutions? a. Exploration of the impacts within different contexts
	3.2 How do designers choose appropriate sources of energy to make products and power systems? a. The generation of electricity and how energy is stored and transferred b. The appropriate use in products and systems of renewable and non-renewable sources
Topic Area 4	4.1 How can design solutions be communicated to demonstrate their suitability to a third party? a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations
	4.2 How do designers source information and thinking when problem solving? a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries
Topic Area 5	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? c. Other factors that influence the selection of materials and/or components
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses b. Awareness of the processes that can be used to ensure the structural integrity of a product

SECTION 1 VEX ROBOTICS COMPETITION STAGES

Activity 1

The learners are tasked with creating a competition field, test area, or simulation area using materials available to them in a workshop, and testing their solution in context. Learners will need matching time restrictions, access arrangements, and the setup of the field will need to match the real version in dimensions. Learners can critique their approach, film it for review, and upload to a blog for critique by others in the school.

Activity 2

Star analysis of the project approach - Using a star diagram, learners are tasked with critiquing the following elements of the project out of 5 (1 being least successful, 5 being most):

1 – UNDERSTAND – Define the Problem

2 – EXPLORE – Do Background Research

3 – DEFINE – Determine Solution Specifications

4 – IDEATE – Generate Concept Solutions

5 – PROTOTYPE – Learn How Your Concepts Work

6 – CHOOSE – Determine a Final Concept

7 – REFINE – Do Detailed Design

8 – PRESENT – Get Feedback and Approval

9 – IMPLEMENT – Implement the Detailed Solution

10 – TEST – Does the Solution Work?

11 – ITERATE

Non-competition stage

Sponsor and Partner Information

The VEX Robotics Competition has a range of sponsors and partners who provide significant resources and information about their businesses. Resource: REC Foundation Sponsors - http://www.roboticseducation.org/support-us/rec-foundation-sponsors/ In addition the competition teams may well engage with local organisations to raise sponsorship.

Tutors can utilise the contacts and information to support the learners in their understanding of the business side of engineering and opportunities.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R102	LO1 Know about engineering sectors, their products and services
	LO2 Understand how engineering companies operate
	LO3 Know about employment in engineering
	LO4 Understand innovation and technical advances in engineering
Cambridge Technicals in Engineering – Level 3	
Unit 20	LO1 Know how size, ownership and key stakeholders can influence engineering businesses
	LO4 Understand influences on innovation and entrepreneurship in engineering
	LO5 Understand key financial terms and documents for engineering businesses
GCSE Design and Technology	
Topic Area 8	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing? a. The significance of the cost of specific materials and/or system components in relation to commercial viability, different stakeholder needs and marketability

Activity 1

Engage with local internal parties. Learners are tasked with writing letters requesting support for their robotic and engineering activities. These letters will be drafted and written for internal school use, such as for the head of school or parents association. The aim is to seek support in growing the programme as the school.

Activity 2

Similar to activity 1, except learners are tasked with engaging local external business in developing opportunities to support the school programmes for robotics. Learners will need to learn how to write appropriately with professional focus and with specific aims and objectives in mind.

Activity 3

Engaging with national companies - Moving beyond local support and engaging with national companies, learners will need to take appropriate steps to ensure the school is represented in the highest regard when in contact with national companies, press or business sponsors.

SECTION 2 DESIGN YOUR OWN PART

This is an optional activity that adds to the core challenge of the VEX Robotics Competition.

The learners will use the following skills whilst designing their own parts for the competition robot:

- Parametric Modelling - Basic Inventor Skills
- Free Form Modelling – Basic Fusion
- Designing a Battery Clip - Parametric Modelling using Autodesk Inventor
- Designing a Wheel – Free Form Modelling using Autodesk Fusion

VEX Robotics have provided specific curriculum support materials covering the design of the battery clip and the wheel. Specifically designed for use with the free Autodesk package, tutors can use the materials provided in the context of designing two components for the competition robot.

Resource: Design Your Own Part Module - http://curriculum.vexrobotics.com/curriculum/design-your-own-part.html

By allowing all components of the design system to be released digitally, VEX is actively encouraging all aspects of design. Learners should consider the implications of final production and manufacture, not just the theoretical design. To support this, resources are available for the design and make of new parts.

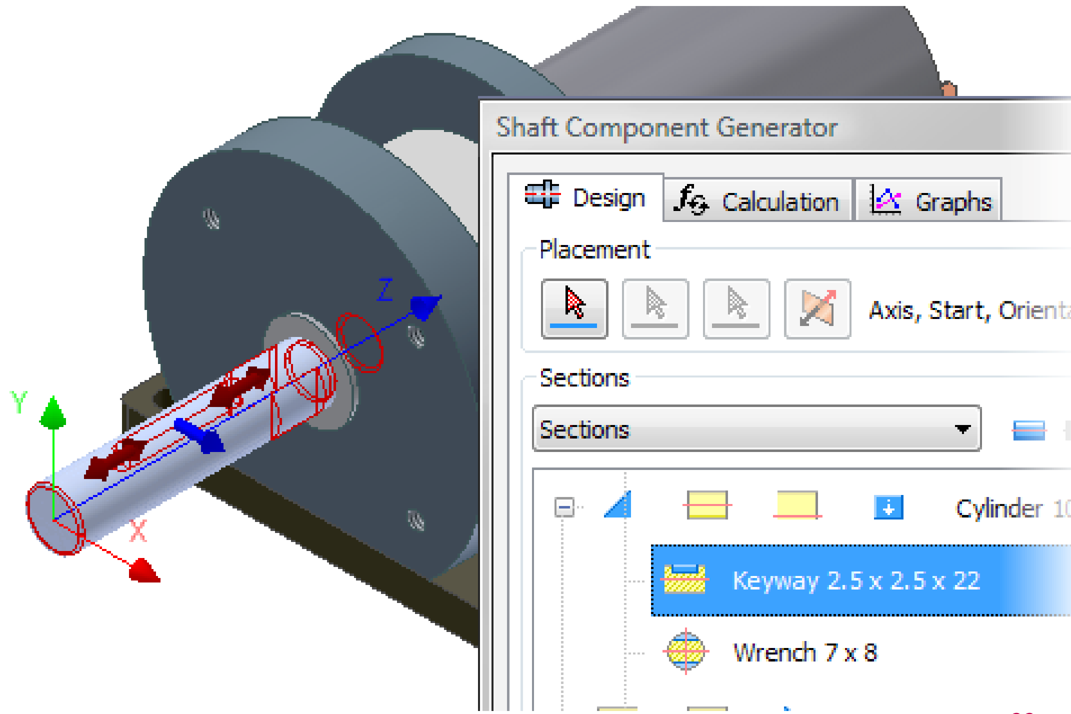
Resource: 3D Printing VEX Parts - https://www.stem.org.uk/resources/community/resource/162299/vex-robotics-edr-curriculum-unit-31-3d-printing

Resource: Laser Cutting VEX Parts - https://www.stem.org.uk/resources/community/resource/162228/vex-robotics-edr-curriculum-unit-32-laser-cutting

Resource: CNC and Plasma Cutting VEX Parts - https://www.stem.org.uk/resources/community/resource/162343/vex-robotics-edr-curriculum-unit-33-cnc-and-plasma-cutting

This stage supports:

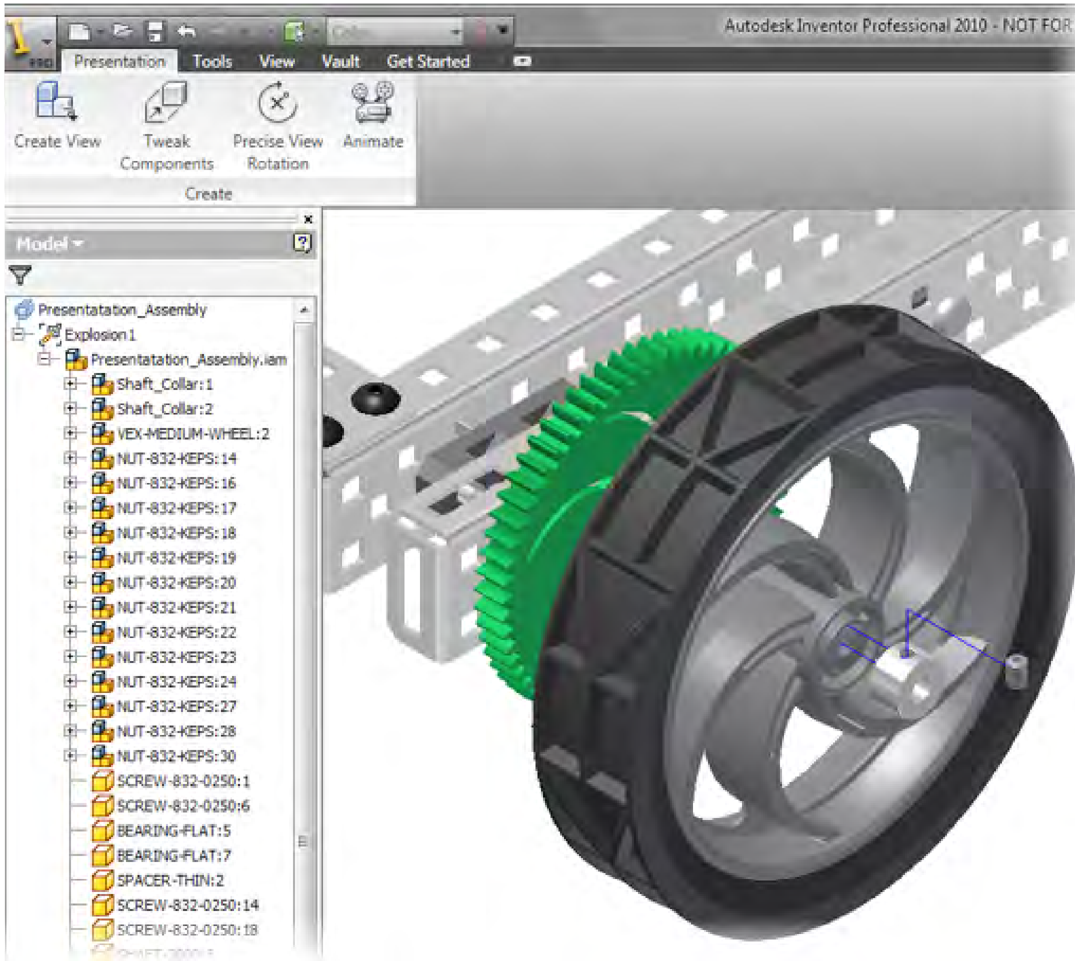
Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R106	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
R110	LO1 Be able to plan for the making of a pre-production product
	LO2 Be able to use processes, tools and equipment safely to make a pre-production model
	LO3 Be able to modify a production plan for different scales of production



SECTION 2 DESIGN YOUR OWN PART

Cambridge Technicals in Engineering – Level 2	
Unit 3	LO2 Be able to work safely when performing engineering activities
	LO3 Be able to interpret engineering drawings to produce engineered component(s)
	LO4 Be able to prepare and mark out materials to produce engineered component(s)
	LO5 Be able to select and use tools, and work-holding devices to create machined component(s)
	LO6 Be able to perform machine operations to create machined component(s)
Unit 6	LO1 Be able to create 2D and 3D drawings to present engineering components
	LO2 Be able to save, store, organise and retrieve engineering drawings
	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software
	LO4 Be able to produce 3D solid model(s) using Computer Aided Design (CAD)
	LO5 Be able to produce 2D CAD engineering drawing from a 3D solid model
Unit 7	LO1 Be able to prepare and plan for product assembly and manufacture
	LO2 Be able to follow efficient and safe working procedures for product assembly and manufacture
	LO3 Be able to produce an engineering product using product assembly and manufacturing techniques
	LO4 Be able to apply quality control checks to product assembly and manufacture
Cambridge Technicals in Engineering – Level 3	
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
	LO3 Be able to design components that can be successfully manufactured
	LO4 Be able to optimise design to improve performance

Unit 10	LO1 Be able to produce 3D models using ComputerAided Design (CAD)
	LO2 Be able to create 3D assemblies of components within a CAD system
	LO3 Be able to produce 2D CAD engineering drawings
	LO4 Understand the use of simulation tools within CAD systems
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
	LO3 Understand material processing techniques



SECTION 2 DESIGN YOUR OWN PART

GCSE Design and Technology	
Topic Area 1	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes? a. Considerations for exploring a context
	1.2 Why is usability an important consideration when designing prototypes? a. Considerations in relation to user interaction with design solutions
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
Topic Area 4	4.1 How can design solutions be communicated to demonstrate their suitability to a third party? a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations
	4.2 How do designers source information and thinking when problem solving? a. Awareness of different design approaches b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials.
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses
Topic Area 7	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods
	7.4 How do industry professionals use digital design tools when exploring and developing design ideas? a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions

SECTION 3 VEX EDR USE IN SCHOOLS

The VEX EDR Curriculum is designed to help students explore the fundamentals of robotics and the engineering design process while learning to use industry-leading CAD and programming software. Through the curriculum available learners can walk through the design and build a robot to play a sport-like game, while also learning key STEM principles, and robotics concepts.

There are extensive lesson plans and resources available at: https://www.stem.org.uk/users/vex-robotics this guide gives a simple overview of how these resources could be used as the knowledge base to deliver a range of engineering qualifications through nine different approaches to how VEX EDR can be applied in the classroom:

1. Reflective analysis of existing VEX EDR solutions
2. Deconstruction of EDR Clawbot
3. Industrial Context task
4. Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts.
5. EDR component analysis
6. Creation of EDR systems
7. Use fabrication techniques to prototype for the EDR platform
8. Using VEX EDR as a context for mathematical considerations

Reflective analysis of existing VEX EDR solutions

To engage in identifying how a VEX EDR robotic solution could be developed to meet a contextual need, learners will want to consider what a robotics solution is designed to achieve, which stakeholders connect to the solution either through direct use or through the wider solution lifecycle, and will need to identify how the solution is useable for different lifestyles with inclusivity in mind.

Example: For this context based task, learners could analyse existing robotics in society, such as autonomous cleaners for the home. A teacher can either prototype an EDR solution for analysis, or make direct links between the EDR platform and the commercial product. Learners can take a mapping approach to consider all factors that include:

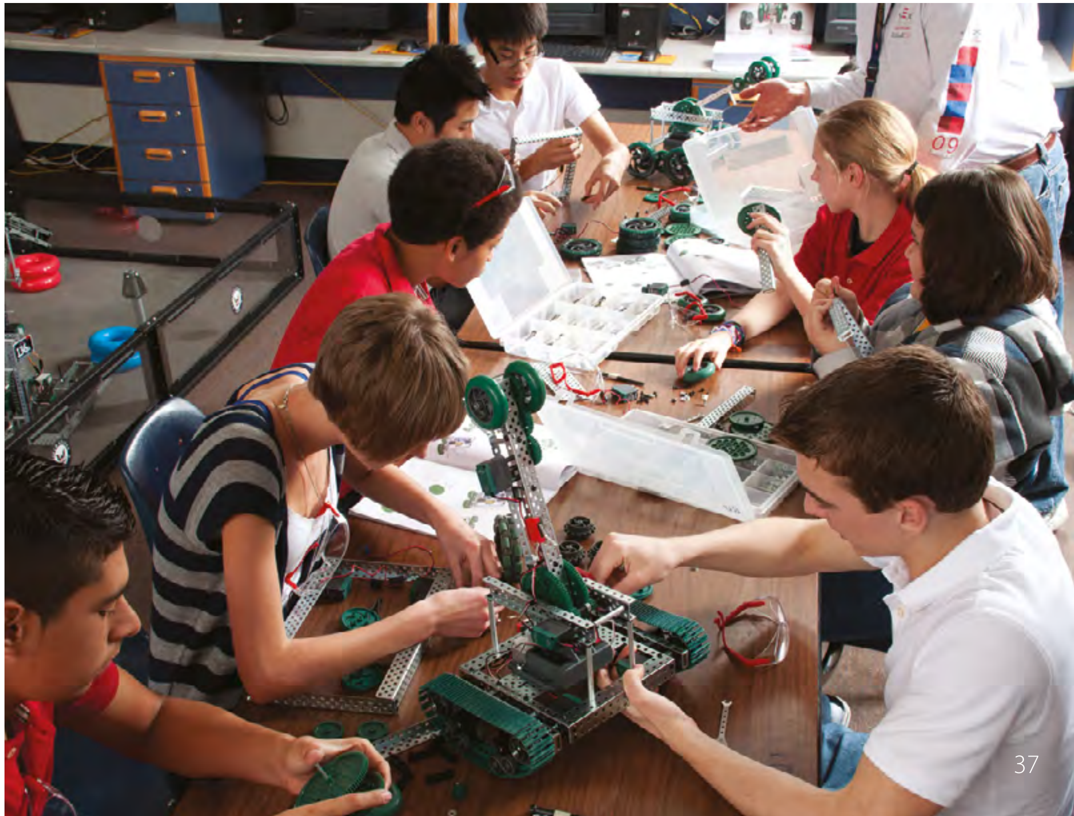
- where and how
- stakeholders
- social, cultural, moral and economic influences
- user lifestyle
- ease of use
- ergonomics and anthropometrics
- aesthetics

This stage supports:

Cambridge Nationals Level 1.2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
Cambridge Nationals Level 1/2 – Engineering Design	
R106	LO2 Be able to research existing products
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
Cambridge Technicals in Engineering – Level 2	
Unit 1	LO2 Know how to classify common engineering materials
	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
	LO5 Know electrical and electronic principles for electronic control and electrical motion
Unit 2	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Understand the operation and application of fluid power sources, actuators and valves
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/transducers, actuators and mechanical devices.
	LO3 Be able to programme an identified automated control system

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Technicals in Engineering – Level 3	
Unit 5	LO1 Be able to apply AC and DC circuit theory to circuitdesign
	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
Unit 16	LO1 Understand programming techniques
	LO2 Be able to program embedded devices in a system
	LO3 Be able to program Programmable Logic Controllers (PLCs)
	LO4 Understand commercial testing and validation strategies



SECTION 3 VEX EDR USE IN SCHOOLS

GCSE Design and Technology	
Topic Area 1	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes? a. Considerations for exploring a context
	1.2 Why is usability an important consideration when designing prototypes? a. Considerations in relation to user interaction with design solutions
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials.
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms d. The lifecycle of specific materials and/or system components when used in products
Topic Area 6	6.2 How can materials and products be finished for different purposes? a. The processes used for finishing and adding surface treatments to materials and products for specific purposes
	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
Topic Area 6	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods

Deconstruction of EDR Clawbot

In order for learners to be able to analyse and learn from existing solutions and approaches, they will need to take a consistent approach to analysis which can subsequently be applied to any other commercial product. This requires learners to critique solutions using a framework that relates to all of the products opportunities and constraints, and will see learners identifying factors ranging from materials, components and processes through to the environment and lifecycle assessment.

Example: Using an assembled EDR Clawbot, Tumbler, Protobot or similar, learners are challenged to handle, test and disassemble the robot in order to develop full understanding of the areas through which robotics are designed, namely:
- structure
- control
- movements
- sensing
- gears

The task for learners is then to establish, with guidance or support, the following information:
1. What materials can be identified, their properties and characteristics
2. What components are evident under the 5 headings for all robotic solutions
3. What processes have been employed to manufacture each component
4. What aesthetic properties do components require
5. How has brand identity been applied across all components
6. How are parts designed for the user and broader stakeholders
7. What is the impact on the environment of each components features
8. What ethical issues relate to new and emerging technologies

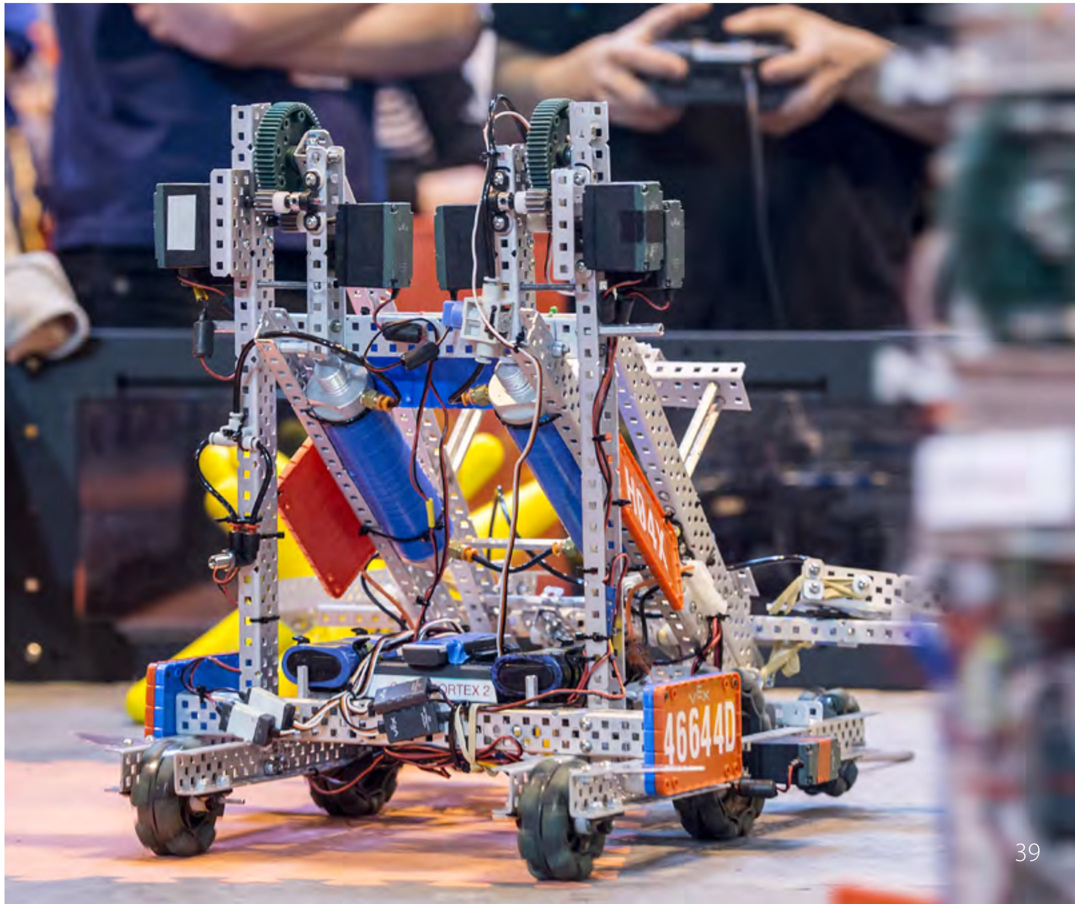
SECTION 3 VEX EDR USE IN SCHOOLS

Only question 2 will apply specifically to VEX EDR, whilst all others will ensure learners can critique a product from any area of commercial product design.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
Cambridge Nationals Level 1/2 – Engineering Design	
R106	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to research existing products
	LO3 Be able to analyse an existing product through disassembly
Cambridge Technicals in Engineering – Level 2	
Unit 1	LO2 Know how to classify common engineering materials
	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Know electrical and electronic principles for electronic control and electrical motion
Unit 2	LO2 Understand why engineering materials are suitable for specific engineering applications
	LO3 Understand materials processing techniques
	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Understand the operation and application of fluid power sources, actuators and valves
Unit 4	LO1 Be able to work safely when undertaking electrical operations
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.
	LO3 Be able to programme an identified automated control system
Cambridge Technicals in Engineering – Level 3	
Unit 5	LO1 Be able to apply AC and DC circuit theory to circuit Design

Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
Unit 15	LO1 Understand mechanical elements of control systems
Unit 16	LO1 Understand programming techniques
	LO2 Be able to program embedded devices in a system
	LO3 Be able to program Programmable Logic Controllers (PLCs)
	LO4 Understand commercial testing and validation strategies



SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Nationals Level 1.2 – Principles in Engineering and Engineering Business	
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
	2.2 How do developments in Design and Technology influence design decisions and practice? a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials.
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components d. The lifecycle of specific materials and/or system components when used in products
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses. b. Awareness of the processes that can be used to ensure the structural integrity of a product
	6.2 How can materials and products be finished for different purposes? a. The processes used for finishing and adding surface treatments to materials and products for specific purposes
Topic Area 6	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes.
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods
	7.4 How do industry professionals use digital design tools when exploring and developing design ideas? a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions.

Industrial Context task

Though VEX EDR is a prototyping platform for education use, its design is a direct reflection of how industrial robotics are designed and built. In order to engage learners in the wider issues that relate to industrial practice, the EDR platform can be used as a scaled example of an industrial application. This will provide a visual and hands on resource for debate and discussion.

Example: Using technical data from the VEX website, along with the physical equipment, learners are tasked with the critical review of the technical equipment that powers the EDR platform. Learners are tasked with researching how battery systems work, how they store energy and transfer it throughout the system, and where electrical energy is sourced if it is provided through National Grid. The EDR platform as a modular and upgradable system will

SECTION 3 VEX EDR USE IN SCHOOLS

then allow learners to discuss the implications of such a system on the environment, factors that influence sustainable approaches, and the impact of new and emerging technologies on society.

This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R102	LO1 Know about engineering sectors, their products and services
	LO2 Understand how engineering companies operate
	LO4 Understand innovation and technical advances in engineering
R103	LO2 Know about sustainable design for engineered products
Cambridge Nationals Level 1/2 – Engineering Design	
R106	LO2 Be able to research existing products
Cambridge Technicals in Engineering – Level 3	
Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO4 Know about industrial network systems
	LO5 Know about maintenance in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
GCSE Design and Technology	
Topic Area 2	2.1 What are the opportunities and constraints that influence design and making requirements? a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations
	2.2 How do developments in Design and Technology influence design decisions and practice? a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives
Topic Area 3	3.1 What are the impacts of new and emerging technologies when developing design solutions? a. Exploration of the impacts within different contexts
	3.2 How do designers choose appropriate sources of energy to make products and power systems? a. The generation of electricity and how energy is stored and transferred. b. The appropriate use in products and systems of renewable and non-renewable sources
	3.3 What wider implications can have an influence on the processes of designing and making? a. Consideration of environmental, social and economic influences
Topic Area 6	6.1 What gives a product structural integrity? b. Awareness of the processes that can be used to ensure the structural integrity of a product
	6.2 How can materials and products be finished for different purposes? a. The processes used for finishing and adding surface treatments to materials and products for specific purposes
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing

Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts.

Where EDR has the most important impact in the new Design and Technology specification is in approach to design. EDR provides a modular system that can frame sketching approaches in perspective or in 2D. EDR can also support learners in how to sketch model using materials in ways that reference to subsequent fabrication considerations.

Through CAD, EDR can support learners in the creation of technical drawings and documents, using libraries of EDR components ready to assemble, that are able to be edited for new applications. Learners can also design easily for the EDR system, creating unique components that can provide unique functionality.

Using a choice of programming software packages, learners can conduct real systems thinking to design the functional performance of an EDR solution, and simulate performance using a VEX virtual environment (used to assess the performance of robotic solutions for the National competition).

SECTION 3 VEX EDR USE IN SCHOOLS

EDR finally will help learners engage with mathematical modelling, using the principles of physics to predict performance, gather data that can provide insight in to trends in performance and allow learners to critique aspects of the design, iterate the design guided solely by output data rather than other factors like aesthetics, and remain focused on optimal performance achievement through iterative design.

EDR provides a testable platform for engaging with stakeholders also, so that learners can test performance in context, role play activities to provide live feedback to inform better design, all the while allowing stakeholders to see the progress of a solution towards its final solution.

Example 1: Using sketching strategies that represent the EDR platform, learners are instantly required to design with the following:
- perspective, form, scale and detail
- fabrication methods for parts identified (or identifiable)
- relationships between components considered
- a functional focus over aesthetic
- a realistic sketch that represents a feasible concept to prototype

Example 2: Using Autodesk Fusion 360 (or similar platform), learners can pull from a library all VEX EDR parts into an assembly, where aesthetics, material properties, and component relationships are already assigned. Learners can then reverse engineer solutions, design new parts, adapt existing components, and produce a virtual prototype that can be:
- tested using simulation applications within the software
- iterated through editing following feedback
- shared with other designers for collaboration
- displayed on mobile devices for presentations
- exported by parts or as an assembly for digital fabrication
- rendered or used to create general arrangement drawings for the technical specification
- used to generate parts lists for 3rd party fabrication

Example 3: After prototyping using VEX EDR, learners will be able to produce an autonomous program designed to achieve an outcome (for example a movement of the system to carry out a task). The programme will repeat without bias again and again. This allows the learner the opportunity to focus on iteration of the physical solution, changing the assembly until the outcome that is desired is achieved. Likewise, learners can also focus on iterating the program that powers a solution, and change this to make a finished physical prototype conduct a task.

Where either program or physical build, or both are in iteration, the learner will be able to document easily these activities until a specific desired outcome is achieved.

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
	LO4 Understand commercial circuit construction methods
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R115	LO1 Understand how computers are used in engineering design, manufacture and process control
	LO2 Understand how computers are used for maintenance of engineering systems
	LO3 Know how computers are used to communicate and use data for production and maintenance
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Technicals in Engineering – Level 2	
Unit 1	LO4 Know how to calculate mechanical motion and force
Unit 4	LO2 Be able to construct electronic circuits by interpreting circuit diagrams
Unit 6	LO1 Be able to create 2D and 3D drawings to present engineering components
	LO2 Be able to save, store, organise and retrieve engineering drawings
	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software
	LO4 Be able to produce 3D solid model(s) using Computer Aided Design (CAD)
	LO5 Be able to produce 2D CAD engineering drawing from a 3D solid model
Cambridge Technicals in Engineering – Level 3	
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards(PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely
Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
Unit 10	LO1 Be able to produce 3D models using Computer Aided Design (CAD)
	LO2 Be able to create 3D assemblies of components within a CAD system
	LO3 Be able to produce 2D CAD engineering drawings
	LO4 Understand the use of simulation tools within CAD systems

Unit 12	LO1 Be able to carry out simulations to establish reactions in moving mechanical assemblies
	LO2 Be able to carry out simulations to assess the manufacturability of components or products
	LO3 Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components
	LO4 Be able to carry out Computational Fluid Dynamic (CFD)simulations to assess the operational performance of components
GCSE Design and Technology	
Topic Area 4	4.1 How can design solutions be communicated to demonstrate their suitability to a third party? a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations,
	4.2 How do designers source information and thinking when problem solving? a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.4 How do industry professionals use digital design tools when exploring and developing design ideas? a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions.

EDR component analysis

The EDR platform is manufactured from two key groups of materials, **ferrous and non-ferrous metals**, and **thermo and thermosetting polymers**. Through linked learning using the components of EDR, learners will be able to:
- identify materials
- identity applications of materials based on their characteristics
- identify processes used to create components
- identify strengths and weaknesses of production processes
- identify finishes appropriate to material groups
- identify alternative materials suited to achieve a similar application

SECTION 3 VEX EDR USE IN SCHOOLS

- be able to identify a material, production process or finish, based on the application in context, or be provided a context, and be able to propose appropriate materials

Once learners have learnt in the context of EDR components, they can fabricate their own components using materials and processes and finishes available to them in the workshop of their school. This can include working with:
- papers and boards for modelling
- material and man-made timbers
- composite materials including multi material group materials such as GRP
- fabrication using hand and CAD/CAM approaches

Each material, VEX EDR or non EDR materials, can be taught in conjunction with its:
- characteristic properties (density, strength, etc.)
- working properties (processing and post processing)
- sourcing (harvesting, mining, etc.)
- recycling
- available forms (cost, stock sizes, etc.)

Example: Using the VEX EDR system, learners are challenged with making a unique part, an actuator for a robotic arm. The actuator can be used to carry out any task, but the design, fabrication and material choice must be made with sound reasoning. Learners will need to be able to identify the context, e.g. allowing a robot to paint a canvas for a repeated piece of artwork production. The actuator will need to be designed to fit the EDR system using standard components. The actuator will need to be fabricated using suitable materials, and the new part will need to be costed and its lifecycle considered. Learners can then fabricate the actuator, and create a report supporting its design and fabrication.

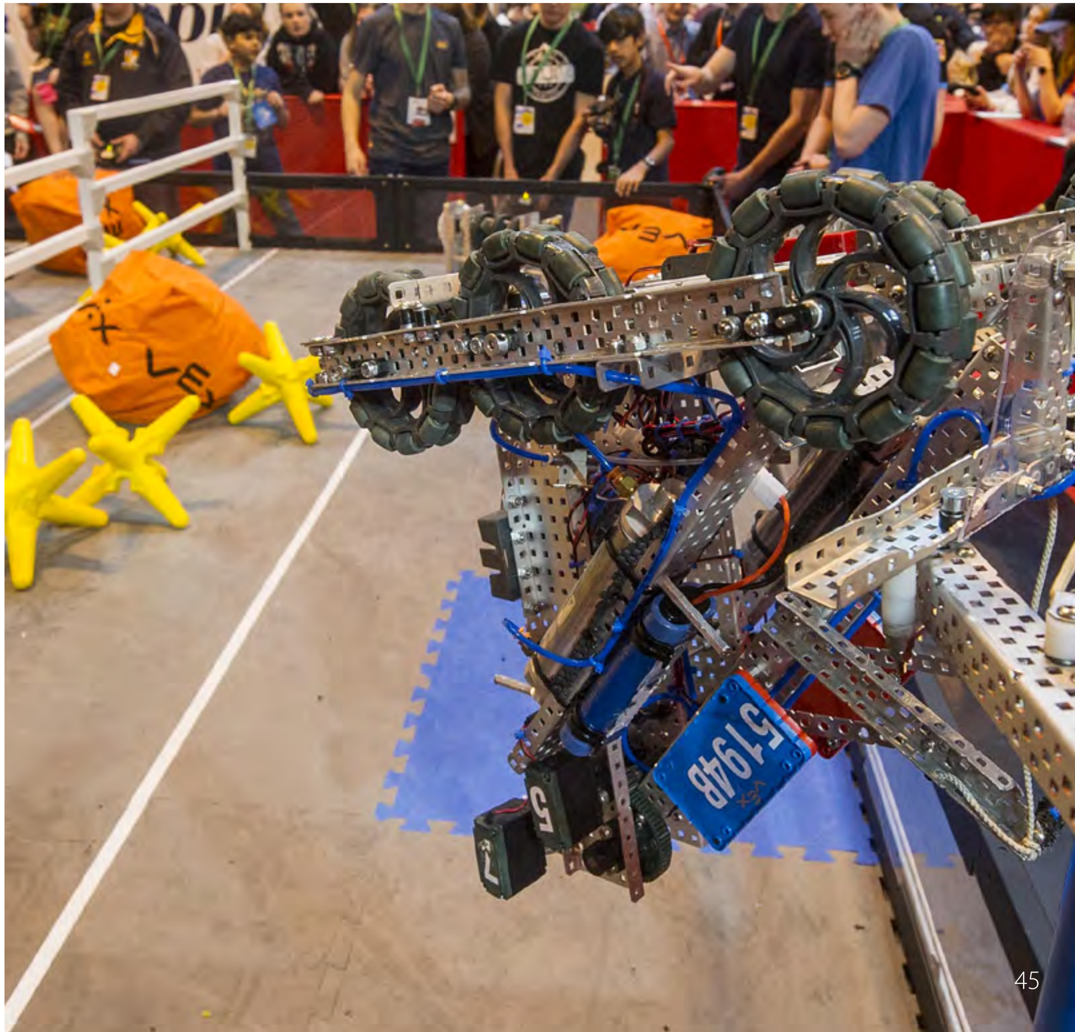
This stage supports:

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business	
R101	LO1 Understand physical properties and mechanical principles
	LO2 Understand physical properties and electrical principles
	LO3 Understand physical properties and fluid power principles
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits
R114	LO1 Be able to use CAD for circuit simulation and design
	LO2 Be able to construct circuits
	LO3 Be able to test electronic circuits
R116	LO1 Understand the application and operation of microcontrollers and microprocessors in engineered products
	LO2 Be able to design, develop and simulate a control system
	LO3 Be able to test control systems
Cambridge Technicals in Engineering – Level 2	
Unit 1	LO2 Know how to classify common engineering materials
	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
Unit 2	LO2 Understand why engineering materials are suitable for specific engineering applications

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Technicals in Engineering – Level 3	
Unit 5	LO1 Be able to apply AC and DC circuit theory to circuit design
	LO3 Be able to apply a systems approach to electrical design
	LO5 Understand the application of programmable process devices in electronic design
Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
GCSE Design and Technology	
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials.
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components. d. The lifecycle of specific materials and/or system components when used in products

Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes.
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods.



SECTION 3 VEX EDR USE IN SCHOOLS

Creation of EDR systems

The EDR platform allows learners to engage with a broad range of technical learning activities using the components across the system range. Learners will be able to achieve the following.

Technical understanding	EDR applications/examples
Reinforcing or stiffening to withstand force and stress	Construct a structure that achieves specific performance requirements when forces are acting on the structure (e.g. a bridge)
Movement including rotary, linear, oscillating and reciprocating	Construct gear systems that achieve each of the types of movement and transfer movement from a rotating motor into different forms. Identify the movement types in an industrial context
Forces of load, effort and fulcrum	Create a lever system using EDR structural parts and gear parts to learn about movement about a fulcrum for acting on a weight
Learn about motion and changing magnitude of force and direction using cams, gears, pulleys and belts, levers and linkages	Using the full structural and gearing system for EDR, recreate all types of assemblies to explore cams, gears, pulleys, belts, levers and linkages, in an easy to assemble and adapt kit
Electronic systems including sensors, switches, outputs and programmable components such as microcontrollers	Using the EDR cortex or V5 Brain, sensor set, and structural system, create functional robotic solutions that can sense their surroundings using switches, an ultrasonic range finder, light sensor, or other component. Adapt motors to become smart using servo motor conversion kits. Program the robotic outcome to work driver control or autonomous, with abilities and behaviours to engage with its environment.

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
	LO3 Know about the wider influences on the design of new products
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
	LO3 Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
R110	LO1 Be able to plan for the making of a pre-production product
	LO2 Be able to use processes, tools and equipment safely to make a pre-production model
Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R113	LO1 Understand basic electronic principles
	LO2 Understand the operating principles of electronic components
	LO3 Know test methods for electronic circuits

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Cambridge Technicals in Engineering – Level 2	
Unit 1	LO4 Know how to calculate mechanical motion and force
	LO5 Know electrical and electronic principles for electronic control and electrical motion
Unit 2	LO2 Understand why engineering materials are suitable for specific engineering applications
	LO4 Understand how to select electrical and electronic devices for engineering purposes
	LO5 Understand the operation and application of fluid power sources, actuators and valves
Unit 3	LO3 Be able to interpret engineering drawings to produce engineered component(s)
	LO5 Be able to select and use tools, and work-holding devices to create machined component(s)
Unit 4	LO1 Be able to work safely when undertaking electrical operations
	LO2 Be able to construct electronic circuits by interpreting circuit diagrams
	LO3 Be able to test electronic circuits for functionality
Unit 5	LO1 Understand the key components, applications and basic architecture of programmable devices
	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.
	LO3 Be able to programme an identified automated control system
	LO4 Be able to test the operation of an automated control system
Unit 6	LO1 Be able to create 2D and 3D drawings to present engineering components
	LO2 Be able to save, store, organise and retrieve engineering drawings
	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software
	LO4 Be able to produce 3D solid model(s) using Computer Aided Design (CAD)
	LO5 Be able to produce 2D CAD engineering drawing from a 3D solid model

Unit 7	LO1 Be able to prepare and plan for product assembly and manufacture
	LO2 Be able to follow efficient and safe working procedures for product assembly and manufacture
	LO3 Be able to produce an engineering product using product assembly and manufacturing techniques

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Technicals in Engineering – Level 3	
Unit 5	LO1 Be able to apply AC and DC circuit theory to circuit design
	LO3 Be able to apply a systems approach to electrical design
	LO5 Understand the application of programmable process devices in electronic design
Unit 6	LO1 Be able to use Computer Aided Design (CAD) for circuit design and simulation
	LO2 Be able to use Computer Aided Design (CAD) to design printed circuit boards(PCBs)
	LO3 Be able to manufacture and construct electronic circuits safely
Unit 7	LO2 Understand electrical sensors and actuators
	LO3 Understand how to use signal conditioning techniques and signal conversion devices
Unit 8	LO1 Understand operating and performance characteristics of electrical and electronic components and devices
	LO2 Be able to work safely with electricity
	LO3 Be able to construct electrical and electronic circuits
	LO4 Be able to fault find in electrical and electronic equipment
Unit 9	LO1 Be able to use graphical and engineering drawing techniques to communicate design solutions
	LO2 Be able to select appropriate engineering materials to achieve design solutions
	LO4 Be able to optimise design to improve performance
Unit 10	LO1 Be able to produce 3D models using Computer Aided Design (CAD)
	LO2 Be able to create 3D assemblies of components within a CAD system
	LO3 Be able to produce 2D CAD engineering drawings
	LO4 Understand the use of simulation tools within CAD systems
Unit 13	LO1 Be able to plan for production in mechanical engineering
	LO2 Be able to use bench processes, tools and equipment to produce quality components

Unit 14	LO1 Understand control system theory in engineering
	LO2 Understand the implementation of control in automated systems
	LO3 Understand sensors and actuators used in automation control systems
	LO6 Understand the application of robotics in automation control systems
Unit 15	LO1 Understand mechanical elements of control systems
	LO2 Understand the electrical elements of control systems
	LO3 Understand simple hydraulic systems
	LO4 Understand simple pneumatic systems
Unit 16	LO1 Understand programming techniques
	LO2 Be able to program embedded devices in a system
	LO3 Be able to program Programmable Logic Controllers (PLCs)
	LO4 Understand commercial testing and validation strategies
Unit 24	LO1 Understand the stages of project management
	LO2 Understand project management roles and the skills needed to be an effective project manager
	LO3 Be able to use project management tools
	LO4 Be able to use information to support project management decisions
	LO5 Understand how and why projects are monitored
	LO6 Understand how to measure the success of a project

SECTION 3 VEX EDR USE IN SCHOOLS

GCSE Design and Technology	
Topic Area 5	5.1 What are the main categories of materials available to designers when developing design solutions? Understanding that products are predominantly made from multiple materials.
	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that
	5.3 Why is it important to understand the sources or origins of materials and/ or system components? a. The sources and origins of specific materials and/or system components. d. The lifecycle of specific materials and/or system components when used in products e. Consideration of recycling, reuse and disposal of specific materials and/or system components.
Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses. b. Awareness of the processes that can be used to ensure the structural integrity of a product.
	6.2 How can materials and products be finished for different purposes? a. The processes used for finishing and adding surface treatments to materials and products for specific purposes.
	6.3 How do we introduce controlled movement to products and systems? a. An overview of different sorts of movement and types of motion b. The effect of forces on the ease of movement c. How different mechanical devices are used to change the magnitude and direction of motion or forces.
	6.4 How do electronic systems provide functionality to products and processes? a. How sensors and control devices respond to a variety of inputs b. How devices are used to produce a range of outputs c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation.
Topic Area 7	7.1 How can materials and processes be used to make iterative models? a. The processes and techniques used to produce early models and/or toiles to support iterative designing.
	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes? a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes
	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products? a. The use of appropriate and accurate marking out methods.
	7.4 How do industry professionals use digital design tools when exploring and developing design ideas? a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions.
Topic Area 8	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing? a. The significance of the cost of specific materials and/or system components in relation to commercial viability, different stakeholder needs and marketability b. How to calculate the quantities, cost and sizes of materials and/or system components required in a design or product, being able to apply this to different applications.

Use fabrication techniques to prototype for the EDR platform

Using the EDR platform as a base, learners can learn and develop an ability to manufacture both by hand and using aided manufacturing systems to create prototypes and iterations of an idea. The use of CAD/CAM as well as common workshop tools will allow learners to fabricate parts that can adapt and improve a VEX EDR system, potentially commencing with a simple robotic solution.

Learners will be able to:
- explore papers and boards for structural components, folding, perforating and lamination
- timbers for sawing and drilling, adhesion and lamination
- metals for sawing, drilling and sheering, adhesion, bending, pressing, welding, braising and riveting
- polymers for sawing and drilling, vacuum forming, moulding, line bending and adhesion.

All of these processes and more would provide feasible outcomes that would work with the existing EDR system. Learners would also be able to apply and design with:
- reference points, measurements, lines and surfaces

SECTION 3 VEX EDR USE IN SCHOOLS

- templates, jigs and patterns
- tolerances
- cutting efficiencies and minimising waste

Where available, learners will also be able to design for all aspects of digital design tool application, including rapid prototyping, cnc routers, sheet metal folding, pressing and stamps, die casting, compression moulding, injection moulding, vacuum forming, rotational moulding, extrusion, blow moulding, laser cutting, plasma cutting, 3D printing, etc.

Example: Using any material, process and technique, learners are tasked with:
A. fabricating a new gear system that allows a robotic solution to pull itself up a rope
B. fabricating a protective body that ensures the electronic system cannot be damaged by falling debris or rain
or
C. fabricating structural parts and connectors that make the robotic outcome as light as possible
Alternatively, learners with sufficient time can attempt to achieve all three desired requirements in a robotic solution, using workshop and digital tools.

This stage supports:

Cambridge Nationals Level 1/2 – Engineering Design	
R105	LO1 Understand the design cycle and the relationship between design briefs and design specifications
	LO2 Understand the requirements of design specifications for the development of a new product
R107	LO1 Be able to generate design proposals using a range of techniques
	LO2 Know how to develop designs using engineering drawing techniques and annotation
R108	LO1 Know how to plan the making of a prototype
	LO2 Understand safe working practices used when making a prototype
	LO3 Be able to produce a prototype
	LO4 Be able to evaluate the success of a prototype
Cambridge Nationals Level 1/2 – Engineering Manufacture	
R109	LO1 Know about properties and uses of engineering materials
	LO2 Understand engineering processes and their application
R110	LO1 Be able to plan for the making of a pre-production product
	LO2 Be able to use processes, tools and equipment safely to make a pre-production model

Cambridge Nationals Level 1/2 – Systems Control in Engineering	
R112	LO1 Understand the importance of quality control
	LO2 Be able to assess product quality from inspection and quality control techniques
Cambridge Technicals in Engineering – Level 2	
Unit 1	LO2 Know how to classify common engineering materials
	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces
	LO5 Know electrical and electronic principles for electronic control and electrical motion
Unit 2	LO2 Understand why engineering materials are suitable for specific engineering applications
	LO3 Understand materials processing techniques
Unit 3	LO1 Know the Health and Safety practices and procedures required in an engineering workplace
	LO2 Be able to work safely when performing engineering activities
	LO3 Be able to interpret engineering drawings to produce engineered component(s)
	LO4 Be able to prepare and mark out materials to produce engineered component(s)
	LO5 Be able to select and use tools, and work-holding devices to create machined component(s)
	LO6 Be able to perform machine operations to create machined component(s)
Unit 7	LO1 Be able to prepare and plan for product assembly and manufacture
	LO2 Be able to follow efficient and safe working procedures for product assembly and manufacture
	LO3 Be able to produce an engineering product using product assembly and manufacturing techniques

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Technicals in Engineering – Level 3	
Unit 5	LO3 Be able to apply a systems approach to electrical design
Unit 8	LO2 Be able to work safely with electricity
Unit 11	LO1 Understand material structure and classification
	LO2 Understand properties, standard forms and failure modes of materials
	LO3 Understand material processing techniques
	LO4 Know the applications and benefits of modern and smart materials
	LO5 Be able to test the suitability of materials for different applications
Unit 13	LO1 Be able to plan for production in mechanical engineering
	LO2 Be able to use bench processes, tools and equipment to produce quality components
Unit 24	LO1 Understand the stages of project management
	LO2 Understand project management roles and the skills needed to be an effective project manager
	LO3 Be able to use project management tools
	LO4 Be able to use information to support project management decisions
	LO5 Understand how and why projects are monitored
	LO6 Understand how to measure the success of a project
GCSE Design and Technology	
Topic Area 5	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing? a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses b. The physical and working properties of specific materials and/or system components c. Other factors that influence the selection of materials and/or components.
	5.3 Why is it important to understand the sources or origins of materials and/or system components? a. The sources and origins of specific materials and/or system components. d. The lifecycle of specific materials and/or system components when used in products e. Consideration of recycling, reuse and disposal of specific materials and/or system components.

Topic Area 6	6.1 What gives a product structural integrity? a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses. b. Awareness of the processes that can be used to ensure the structural integrity of a product.
	6.2 How can materials and products be finished for different purposes? a. The processes used for finishing and adding surface treatments to materials and products for specific purposes.

Using VEX EDR as a context for mathematical considerations

The design of the EDR platform allows for learners to apply mathematical approaches in a design context. This will allow them to take learning from their GCSE mathematics course, and use this learning with a physical solution to hand. The physical solution can help learners to see outcomes and answers and engage with the application of mathematics which some can find challenging.

Learners will be able to:

1. Use decimals in relation to measurements of EDR components
2. Use fractions, ratios and percentages in relation to movement of motors and gear rations
3. Use areas and volumes in relation to surface areas of sheet materials or using sensors and an environment
4. Use data in relation to outcomes from a programmed robot that repeats a task and results are recorded and plotted to graphs
5. Use angles and measurements in relation to autonomous movement of a robot or motor
6. Use 2D and 3D forms in relation to drawing components or test rigs using EDR
7. Use calculations of areas and shapes using EDR structures
8. Use surface areas and volumes in the context or material used for EDR component manufacture.

This stage supports:

SECTION 3 VEX EDR USE IN SCHOOLS

Cambridge Nationals Level 1/2 – Principles in Engineering and Engineering Business		
R101	LO1 Understand physical properties and mechanical principles	
	LO2 Understand physical properties and electrical principles	
	LO3 Understand physical properties and fluid power principles	
Cambridge Technicals in Engineering – Level 2		
Unit 1	LO1 Know what common SI units and their derivatives are and how to use them in engineering	
	LO4 Know how to calculate mechanical motion and force	
Cambridge Technicals in Engineering – Level 3		
Unit 12	LO1 Be able to carry out simulations to establish reactions in moving mechanical assemblies	
	LO2 Be able to carry out simulations to assess the manufacturability of components or products	
	LO3 Be able to carry out Finite Element Analysis (FEA) simulations to assess the operational performance of components	
	LO4 Be able to carry out Computational Fluid Dynamic (CFD) simulations to assess the operational performance of componentsr	

VEX Robotics and GCSE NEA Content

The areas of coverage for using VEX EDR to deliver the Non-exam assessment content – Iterative Design Challenge (J310/02,03) are as follows:

- Learning from existing products and practice through reverse engineering
- Design thinking and communication for systems thinking, prototyping
- Material considerations for early and final prototypes
- Technical understanding to achieve functional solutions
- Manufacturing processes and techniques to produce an efficiently planned prototype using appropriate techniques with sufficient accuracy
- Viability of design solutions to enable evaluation, feedback and future iterations to be achieved.

In order to use VEX EDR as a prototyping platform for the Design and Technology NEA, the learner will need be working towards a manufactured outcome of sufficient complexity that the EDR system allows for the learner to test its performance better than without the system. The solution will also need to present sufficient complexity that the EDR system is not the assessed element of the prototype, but rather an element that allows for better assessment of the parts manufactured by the learner. The programming of the EDR system is an additional opportunity to iterate through design, and allows learners to iterate both the physical product and the performance through microcontrollers, with freedom and opportunity to innovate.

NB the microcontroller system along with all EDR components, and the design of the system assembly can be used as an assessed element of the solution if it demonstrates challenge appropriate to the learner.

Using EDR at stages of the Iterative Design Challenge

Learning from existing products and practice
EDR provides build instructions for robotic solutions designed to carry out specific activities. The Clawbot, as an example, is designed to pick up a bean bag, and deposit into a scoring trough at a specific height.

Using the criteria for success, learners can build and critique its performance to assess how well it achieves this goal. Learners could conduct similar testing on other robotic solutions including static arms or autonomous robots such as a Tumbler using sensors.

Using the outcomes from their analysis, learners can establish:
- design opportunities
- requirements from stakeholders
- data on performance

Design thinking and communication

EDR will allow learners to explore the platform as a way of quickly iterating a functional prototype. The ability to build in sensing, programmable content, movement and behaviours means that solutions can tackle complex contexts where the learner is aiming to meet the needs of stakeholders with 21st century solutions. The learner might tackle the opportunity to develop autonomous robotics to make products smart and responsive, or use the system to make functional solutions that rely on the motors and gears to create outcomes.

Learners can use the platform to sketch components, digitally design and fabricate components, rough model and prototype in other materials, and work quickly either with physical kit or using a CAD software package and virtual environments.

Material considerations/technical understanding/manufacturing processes and techniques
The EDR platform is fabricated using commonly available and well considered materials. Learners can use the physical performance properties, working properties and

SECTION 3 VEX EDR USE IN SCHOOLS

characteristics of materials and their finishes to make material considerations for real solutions (not using EDR). Learners will be able to use the information about existing material choice, manufacturing techniques, finishes applied, and use these decisions to inform their own in anticipation of producing the technical specification.

Viability of design solutions

EDR allows for functional prototypes that are programmed, perform, and can achieve complex human controlled or autonomous functionality. The platform will allow learners to produce complex prototypes that test and prove a concept, which would support an aesthetic model alongside it. This will allow learners to focus on what is important in the design process, functional performance that proves the concept, aesthetic modelling separate that allows the stakeholders to envisage the final solution. Learners will be able to produce more complex outcomes with smart and response features by employing the EDR platform. Learners will be able to also use the learning to prepare for the GCE Design Engineering qualification.

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

In this section teachers will find a set of tables that link the key activities introduced previously with the units that make up the different qualifications.

The qualifications covered are:

- Cambridge Nationals Level 1/2 Engineering
- Cambridge Technicals Level 2 Engineering
- Cambridge Technicals Level 3 Engineering
- GCSE Design and Technology

The mapping is done at unit level which means that the activity or competition stage could be used to support the unit listed. Appendix 1 takes this mapping further to the learning outcome level. It is assumed that teachers will use the mapping in this section in the first instance and use the more detailed mapping in the appendix for the units deemed to be of specific interest.

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE NATIONALS LEVEL 1/2 ENGINEERING	Engineering Principles and Business				Engineering Design				Engineering Manufacture				Engineering systems and control			
	R101: Engineering principles	R102: The engineered business world	R103: Sustainable engineering	R104: Optimising performance in engineering systems and products	R105: Design briefs, design specifications and user requirements	R106: Product analysis and research	R107: Developing and presenting engineering designs	R108: 3D design realisation	R109: Engineering materials, processes and production	R110: Preparing and planning for manufacture	R111: Computer-aided manufacturing	R112: Quality control of engineered products	R113: Electronic principles	R114: Simulate, construct and test electronic circuits	R115: Engineering applications of computers	R116: Process control systems
	VEX ROBOTICS COMPETITION															
Classroom Based Stages																
Introduce and set up competition																
Allocate team roles																
Equipment familiarisation	X															
Initial Design																
Test Design																
Refine Design																
Final Programming of Robot	X															
Compete (judging Criteria)																
Innovative Engineering	X															
Innovative solution soundly crafted	X															
Features integrated in a well crafted robot	X															
Effective autonomous code			X	X				X							X	X
Consistent autonomous code on the field			X	X			X	X							X	X
Engineering notebook is clear, complete document of the team's design process	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Effectivce use of mechanical and electrical components	X		X	X				X	X	X	X	X	X	X		
Designed with details to hazards and competition rigors					X	X	X	X	X			X	X	X	X	X
Unique design solution			X	X	X	X	X	X	X		X		X	X	X	X
Highly creative design process and methodology			X	X	X	X	X	X	X		X	X	X	X	X	X
Non-competition stage																
Sponsor and Partner Information		X														

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE NATIONALS LEVEL 1/2 ENGINEERING	Engineering Principles and Business				Engineering Design				Engineering Manufacture				Engineering systems and control			
	R101: Engineering principles	R102: The engineered business world	R103: Sustainable engineering	R104: Optimising performance in engineering systems and products	R105: Design briefs, design specifications and user requirements	R106: Product analysis and research	R107: Developing and presenting engineering designs	R108: 3D design realisation	R109: Engineering materials, processes and production	R110: Preparing and planning for manufacture	R111: Computer-aided manufacturing	R112: Quality control of engineered products	R113: Electronic principles	R114: Simulate, construct and test electronic circuits	R115: Engineering applications of computers	R116: Process control systems
Design your Own Part Activity																
Parametric Modeling - Basic Inventor Skills					X	X	X	X	X	X						
Free Form Modeling – Basic Fusion					X	X	X	X	X	X						
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor					X	X	X	X	X	X						
Designing a Wheel – Free Form Modeling using Autodesk Fusion					X	X	X	X	X	X						
	VEX EDR															
Non-Competition EDR																
Reflective analysis of existing VEX EDR solutions	X					X							X			X
Deconstruction of EDR Clawbot	X					X										X
Industrial Context task		X	X			X										
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts							X	X					X	X	X	X
EDR component analysis	X							X	X				X	X		X
Creation of EDR systems					X		X	X	X	X			X			
Use fabrication techniques to prototype for the EDR platform					X		X	X	X	X		X				
Using VEX EDR as a context for mathematical considerations	X															

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE TECHNICALS LEVEL 2 ENGINEERING	Unit 1 Fundamentals of mechanical, electrical/electronic and fluid power engineering	Unit 2 Application of engineering principles	Unit 3 Mechanical engineering – machine operations	Unit 4 Electrical, electronic engineering - operations and application	Unit 5 Engineering systems control - operations and application	Unit 6 Develop and present engineering 2D and 3D design solutions	Unit 7 Product manufacture and fabrication	Unit 8 Optimise and maintain performance in engineering systems
	VEX ROBOTICS COMPETITION							
Classroom Based Stages								
Introduce and set up competition								
Allocate team roles								
Equipment familiarisation	X				X			
Initial Design	X	X			X	X		
Test Design		X						X
Refine Design	X	X						
Final Programming of Robot					X			X
Compete (judging Criteria)								
Innovative Engineering	X	X	X	X				
Innovative solution soundly crafted	X	X	X	X				
Features integrated in a well crafted robot								
Effective autonomous code					X			
Consistent autonomous code on the field					X			X
Engineering notebook is clear, complete document of the team's design process	X		X		X	X		
Effectivce use of mechanical and electrical components	X	X			X			
Designed with details to hazards and competition rigors								X
Unique design solution	X			X	X			
Highly creative design process and methodology	X			X	X			
Non-competition stage								
Sponsor and Partner Information								

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE TECHNICALS LEVEL 2 ENGINEERING	Unit 1 Fundamentals of mechanical, electrical/electronic and fluid power engineering	Unit 2 Application of engineering principles	Unit 3 Mechanical engineering – machine operations	Unit 4 Electrical, electronic engineering - operations and application	Unit 5 Engineering systems control - operations and application	Unit 6 Develop and present engineering 2D and 3D design solutions	Unit 7 Product manufacture and fabrication	Unit 8 Optimise and maintain performance in engineering systems
Design your Own Part Activity								
Parametric Modeling - Basic Inventor Skills			X			X	X	
Free Form Modeling – Basic Fusion			X			X	X	
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor			X			X	X	
Designing a Wheel – Free Form Modeling using Autodesk Fusion			X			X	X	
	VEX EDR							
Non-Competition EDR								
Reflective analysis of existing VEX EDR solutions	X	X			X			
Deconstruction of EDR Clawbot	X	X	X	X	X			
Industrial Context task								
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X			X		X		
EDR component analysis	X	X						
Creation of EDR systems	X	X	X	X	X	X	X	
Use fabrication techniques to prototype for the EDR platform	X	X	X				X	
Using VEX EDR as a context for mathematical considerations	X							

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE TECHNICALS LEVEL 3 ENGINEERING	Unit 5: Electrical and Electronic Design	Unit 6: Circuit Simulation and Manufacture	Unit 7: Electrical Devices	Unit 8: Eelectrical Operations	Unit 9: Mechanical Design	Unit 10: Computer Aided Design (CAD)	Unit 11: Materials Science	Unit 12: Mechanical Simulation and Modelling	Unit 13: Mechanical Operations	Unit 14: Automation Control and Robotics	Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control	Unit 16: Systems and Programming	Unit 20: Business for Engineering	Unit 21: Maintenance	Unit 22: Engineering and the Environment	Unit 24: Project management for engineers	Unit 25: Promoting Continuous Improvement
	VEX ROBOTICS COMPETITION																
Classroom Based Stages																	
Introduce and set up competition																	
Allocate team roles																X	
Equipment familiarisation			X														
Initial Design	X	X	X	X	X		X	X		X	X					X	
Test Design	X	X		X			X	X		X	X				X	X	X
Refine Design	X		X	X	X			X		X	X					X	X
Final Programming of Robot	X		X					X		X		X					X
Compete (judging Criteria)							X										
Innovative Engineering		X	X	X	X				X								
Innovative solution soundly crafted		X		X	X			X	X	X				X			
Features integrated in a well crafted robot			X	X	X												
Effective autonomous code	X		X							X		X					
Consistent autonomous code on the field	X									X		X		X			
Engineering notebook is clear, complete document of the team's design process	X	X	X	X	X	X	X	X	X	X	X			X		X	X
Effectivce use of mechanical and electrical components	X	X	X	X	X		X	X	X	X	X						
Designed with details to hazards and competition rigors							X							X			
Unique design solution	X	X	X	X	X	X	X								X		
Highly creative design process and methodology		X	X		X	X	X	X							X		
Non-competition stage																	
Sponsor and Partner Information													X				

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

CAMBRIDGE TECHNICALS LEVEL 3 ENGINEERING	Unit 5: Electrical and Electronic Design	Unit 6: Circuit Simulation and Manufacture	Unit 7: Electrical Devices	Unit 8: Eelectrical Operations	Unit 9: Mechanical Design	Unit 10: Computer Aided Design (CAD)	Unit 11: Materials Science	Unit 12: Mechanical Simulation and Modelling	Unit 13: Mechanical Operations	Unit 14: Automation Control and Robotics	Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control	Unit 16: Systems and Programming	Unit 20: Business for Engineering	Unit 21: Maintenance	Unit 22: Engineering and the Environment	Unit 24: Project management for engineers	Unit 25: Promoting Continuous Improvement
Design your Own Part Activity																	
Parametric Modeling - Basic Inventor Skills					X	X	X										
Free Form Modeling – Basic Fusion					X	X	X										
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor					X	X	X										
Designing a Wheel – Free Form Modeling using Autodesk Fusion					X	X	X										
	VEX EDR																
Non-Competition EDR																	
Reflective analysis of existing VEX EDR solutions	X		X	X	X		X			X	X	X					
Deconstruction of EDR Clawbot	X		X	X	X		X				X	X					
Industrial Context task										X	X						
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts		X		X	X	X		X									
EDR component analysis	X		X	X			X				X						
Creation of EDR systems	X	X	X	X	X	X			X	X	X	X				X	
Use fabrication techniques to prototype for the EDR platform	X			X			X		X								
Using VEX EDR as a context for mathematical considerations								X								X	

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

GCSE Design and Technology	1. Identifying requirements	2. Learning from existing products & practice	3. Implications of wider issues	4. Design thinking and communication	5. Material considerations	6. Technical understanding	7. Manufacturing processes and techniques	8. Viability of design solutions
	VEX ROBOTICS COMPETITION							
Classroom Based Stages								
Introduce and set up competition								
Allocate team roles								
Equipment familiarisation							X	
Initial Design	X	X		X	X	X	X	X
Test Design						X	X	X
Refine Design						X		X
Final Programming of Robot						X X		
Compete (judging Criteria)				X				
Innovative Engineering	X	X	X	X	X	X		
Innovative solution soundly crafted				X	X	X		
Features integrated in a well crafted robot		X			X	X		
Effective autonomous code						X		
Consistent autonomous code on the field						X		
Engineering notebook is clear, complete document of the team's design process				X	X	X		X
Effectivce use of mechanical and electrical components					X	X		
Designed with details to hazards and competition rigors					X	X		
Unique design solution			X	X				
Highly creative design process and methodology			X	X		X		
Non-competition stage								
Sponsor and Partner Information								X
Design your Own Part Activity								
Parametric Modeling - Basic Inventor Skills	X	X		X	X	X	X	
Free Form Modeling – Basic Fusion	X	X		X	X	X	X	

SECTION 4 ACTIVITY MAPPING TO QUALIFICATION UNITS

GCSE Design and Technology	1. Identifying requirements	2. Learning from existing products & practice	3. Implications of wider issues	4. Design thinking and communication	5. Material considerations	6. Technical understanding	7. Manufacturing processes and techniques	8. Viability of design solutions
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X		X	X	X	X	
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X		X	X	X	X	
	VEX EDR							
Non-Competition EDR								
Reflective analysis of existing VEX EDR solutions	X				X	X	X	
Deconstruction of EDR Clawbot		X			X	X	X	
Industrial Context task		X	X			X	X	
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts				X		X	X	
EDR component analysis					X		X	
Creation of EDR systems					X	X	X	X
Use fabrication techniques to prototype for the EDR platform						X		
Using VEX EDR as a context for mathematical considerations								

SECTION 5: LINKS TO ADDITIONAL RESOURCES

OCR – CPD HUB FOR ENGINEERING SUBJECTS

https://www.cpdhub.ocr.org.uk/DesktopDefault.aspx?e=fjefcbdbhgnidcpoonie&CATN_ID=1

OCR INTERCHANGE FOR EXEMPLAR CANDIDATE WORK

https://interchange.ocr.org.uk/Modules/PastPapers/Pages/PastPapers.aspx?menuindex=97&menuid=250

MAPPING GUIDES – A LEVELS TO CAMBRIDGE TECHNICALS IN ENGINEERING

Maths

http://www.ocr.org.uk/Images/346191-mapping-guide-a-level-mathematics.pdf

Physics

http://www.ocr.org.uk/Images/343978-mapping-guide-a-level-physics.pdf

MEI and Royal Academy of Engineering

http://www.ocr.org.uk/Images/297760-mei-mapping-guide.pdf

OCR SKILLS GUIDES

http://www.ocr.org.uk/qualifications/resources/skills-guides/

SECTION 6: 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.

Principles in Engineering and Engineering Business

http://www.ocr.org.uk/Images/174535-units-r101-r104-mapping-to-other-qualifications.pdf

Engineering Design

http://www.ocr.org.uk/Images/174552-units-r105-r108-mapping-to-other-qualifications.pdf

Engineering Manufacture

http://www.ocr.org.uk/Images/174554-units-r109-r112-mapping-to-other-qualifications.pdf

Systems Control in Engineering

http://www.ocr.org.uk/Images/174556-units-r113-to-r116-mapping-to-other-qualifications.pdf

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.

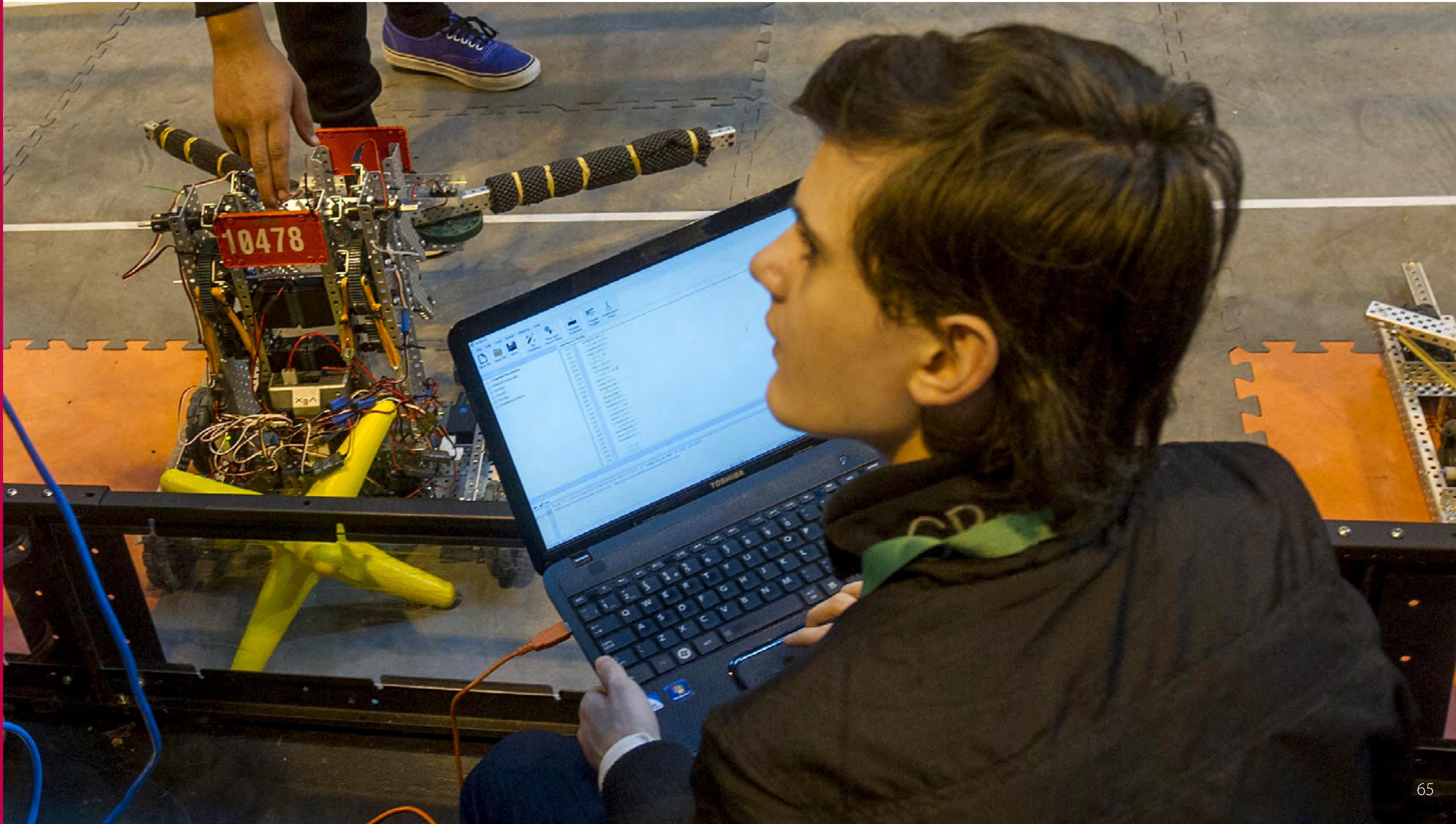
	Keywords/Themes	Theme	Foundation Initial	Foundation Bronze
LO1	Calculations: ohms law and potential divider. Power law. Voltage, current, resistance, capacitance, inductance, electromagnetism, frequency.	Fundamental electrical calculations e.g. Using ohms law, power law.	FIN2 Add and subtract threedigit 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.

APPENDIX 1 VEX ROBOTICS COMPETITION AND VEX EDR MAPPED TO SPECIFIC QUALIFICATION LEARNING OUTCOMES

This section takes the mapping of the activities one stage further providing information on the specific learning outcomes supported by the different stages mentioned.

For each of the competition stages and EDR approaches you can use the tables to identify which specific learning outcomes can be supported by the activities mentioned.

These are not meant to be restrictive and teachers are encouraged to use the competition and equipment as fully as possible.



CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING PRINCIPLES AND BUSINESS

	Engineering Principles and Business														
	R101 Engineering principles				R102 The engineered business world				R103 Sustainable engineering			R104 Optimising performance in engineering systems and products			
	Understand physical properties and mechanical principles	Understand physical properties and electrical principles	Understand physical properties and fluid power principles	Know about the systems used to transmit power in engineering	Know about engineering sectors, their products and services	Understand how engineering companies operate	Know about employment in engineering	Understand innovation and technical advances in engineering	Know about the sustainability of engineering materials and products	Know about sustainable design for engineered products	Understand the impact of global manufacturing	Understand why engineering systems and products are designed and maintained for optimum performance	Know methods used in engineering sectors to maintain optimum performance	Understand factors that contribute to system/product failure	Be able to perform simple procedures to optimise product/system performance
	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO4
Classroom Based Stages															
Introduce and set up competition															
Allocate team roles															
Equipment familiarisation	X	X	X	X											
Initial Design															
Test Design														X	X
Refine Design														X	X
Final Programming of Robot	X	X	X	X									X	X	
Compete (judging Criteria)															
Innovative Engineering	X	X	X	X								X	X	X	X
Innovative solution soundly crafted	X	X	X	X								X	X	X	X
Features integrated in a well crafted robot	X	X	X	X					X	X		X	X	X	X
Effective autonomous code									X	X		X	X	X	X
Consistent autonomous code on the field									X	X		X	X	X	X
Engineering notebook is clear, complete document of the team's design process	X	X	X	X					X	X		X	X	X	X
Effective use of mechanical and electrical components	X	X	X	X					X	X		X			
Designed with details to hazards and competition rigors															
Unique design solution									X	X		X			
Highly creative design process and methodology									X	X		X			

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING PRINCIPLES AND BUSINESS

Engineering Principles and Business

	R101 Engineering principles				R102 The engineered business world				R103 Sustainable engineering			R104 Optimising performance in engineering systems and products			
	Understand physical properties and mechanical principles	Understand physical properties and electrical principles	Understand physical properties and fluid power principles	Know about the systems used to transmit power in engineering	Know about engineering sectors, their products and services	Understand how engineering companies operate	Know about employment in engineering	Understand innovation and technical advances in engineering	Know about the sustainability of engineering materials and products	Know about sustainable design for engineered products	Understand the impact of global manufacturing	Understand why engineering systems and products are designed and maintained for optimum performance	Know methods used in engineering sectors to maintain optimum performance	Understand factors that contribute to system/product failure	Be able to perform simple procedures to optimise product/system performance
	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO4
Non-competition stage															
Sponsor and Partner Information					X	X	X	X							
Design your Own Part Activity															
Parametric Modeling - Basic Inventor Skills															
Free Form Modeling – Basic Fusion															
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor															
Designing a Wheel – Free Form Modeling using Autodesk Fusion															
Non-Competition EDR															
Reflective analysis of existing VEX EDR solutions	X	X													
Deconstruction of EDR Clawbot	X	X													
Industrial Context task					X	X		X		X					
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts															
EDR component analysis	X	X	X												
Creation of EDR systems															
Use fabrication techniques to prototype for the EDR platform															
Using VEX EDR as a context for mathematical considerations	X	X	X												

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING DESIGN

	Engineering Design													
	R105: Design briefs, design specifications and user requirement			R106: Product analysis and research			R107: Developing and presenting engineering designs			R108: 3D design realisation				
	Understand the design cycle and the relationship between design briefs and design specifications	Understand the requirements of design specifications for the development of a new product	Know about the wider influences on the design of new products	Know how commercial production methods, quality and legislation impact on the design of products and components	Be able to research existing products	Be able to analyse an existing product through disassembly	Be able to generate design proposals using a range of techniques	Know how to develop designs using engineering drawing techniques and annotation	Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals	Know how to plan the making of a prototype	Understand safe working practices used when making a prototype	Be able to produce a prototype	Be able to evaluate the success of a prototype
	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3	LO4
Classroom Based Stages													
Introduce and set up competition	X		X		X								
Allocate team roles	X	X	X		X								
Equipment familiarisation					X	X							
Initial Design	X	X	X		X	X	X	X	X	X	X	X	X
Test Design													X
Refine Design									X				X
Final Programming of Robot	X	X			X	X				X	X	X	X
Compete (judging Criteria)													
Innovative Engineering	X	X			X	X	X	X	X	X	X	X	X
Innovative solution soundly crafted	X	X	X				X	X	X	X	X	X	X
Features integrated in a well crafted robot							X	X	X	X	X	X	X
Effective autonomous code										X	X	X	X
Consistent autonomous code on the field							X	X	X	X	X	X	X
Engineering notebook is clear, complete document of the team's design process	X	X			X	X	X	X	X	X	X	X	X
Effective use of mechanical and electrical components										X	X	X	X
Designed with details to hazards and competition rigors	X	X	X	X	X	X	X	X	X	X	X	X	X
Unique design solution	X	X	X	X	X	X	X	X	X	X	X	X	X
Highly creative design process and methodology	X	X	X	X	X	X	X	X	X	X	X	X	X

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING DESIGN

	Engineering Design												
	R105: Design briefs, design specifications and user requirement			R106: Product analysis and research			R107: Developing and presenting engineering designs			R108: 3D design realisation			
	Understand the design cycle and the relationship between design briefs and design specifications	Understand the requirements of design specifications for the development of a new product	Know about the wider influences on the design of new products	Know how commercial production methods, quality and legislation impact on the design of products and components	Be able to research existing products	Be able to analyse an existing product through disassembly	Be able to generate design proposals using a range of techniques	Know how to develop designs using engineering drawing techniques and annotation	Be able to use Computer Aided Design (CAD) software and techniques to produce and communicate design proposals	Know how to plan the making of a prototype	Understand safe working practices used when making a prototype	Be able to produce a prototype	Be able to evaluate the success of a prototype
	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3	LO4
Non-competition stage													
Sponsor and Partner Information													
Design your Own Part Activity													
Parametric Modeling - Basic Inventor Skills	X	X	X		X	X	X	X	X	X	X	X	
Free Form Modeling – Basic Fusion	X	X	X		X	X	X	X	X	X	X	X	
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X	X		X	X	X	X	X	X	X	X	
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X	X		X	X	X	X	X	X	X	X	
Non-Competition EDR													
Reflective analysis of existing VEX EDR solutions													
Deconstruction of EDR Clawbot													
Industrial Context task													
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow chart							X	X	X	X	X	X	X
EDR component analysis										X	X	X	X
Creation of EDR systems	X	X	X	X	X								
Use fabrication techniques to prototype for the EDR platform	X	X					X	X		X	X	X	X
Using VEX EDR as a context for mathematical considerations													

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING MANUFACTURE

	Engineering Manufacture															
	R109: Engineering materials, processes and production				R110: Preparing and planning for manufacture			R111: Computer-aided manufacturing				R112: Quality control of engineered products				
	Know about properties and uses of engineering materials	Understand engineering processes and their application	Know about developments in engineering processes	Understand the impact of modern technologies on engineering production	Be able to plan for the making of a pre-production product	Be able to use processes, tools and equipment safely to make a pre-production model	Be able to modify a production plan for different scales of production	Be able to plan the production of components on Computer Numerical Control (CNC) machines	Be able to interpret information from CAD to manufacture components on CNC equipment	Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components	Know about applications of computer control processes used to manufacture products	Understand the importance of quality control	Be able to assess product quality from inspection and quality control techniques	Know how modern technologies can be used in quality control	Know the principles of lean manufacturing	
	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO4	
Classroom Based Stages																
Introduce and set up competition																
Allocate team roles					X			X								
Equipment familiarisation	X	X	X	X		X	X	X	X	X						
Initial Design					X					X						
Test Design							X									
Refine Design							X									
Final Programming of Robot																
Compete (judging Criteria)																
Innovative Engineering	X	X	X		X	X		X	X	X	X	X	X	X		
Innovative solution soundly crafted	X	X	X		X	X		X	X	X		X	X			
Features integrated in a well crafted robot									X	X						
Effective autonomous code																
Consistent autonomous code on the field																
Engineering notebook is clear, complete document of the team's design process	X	X	X	X	X	X		X	X	X		X	X			
Effective use of mechanical and electrical components	X	X			X	X		X	X	X		X	X			
Designed with details to hazards and competition rigor	X	X										X	X			
Unique design solution	X	X						X	X	X						
Highly creative design process and methodology	X	X						X	X	X		X	X			

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING MANUFACTURE

	Engineering Manufacture														
	R109: Engineering materials, processes and production				R110: Preparing and planning for manufacture			R111: Computer-aided manufacturing				R112: Quality control of engineered products			
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	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO4
Non-competition stage															
Sponsor and Partner Information															
Design your Own Part Activity															
Parametric Modeling - Basic Inventor Skills	X	X			X	X	X								
Free Form Modeling – Basic Fusion	X	X			X	X	X								
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X			X	X	X								
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X			X	X	X								
Non-Competition EDR															
Reflective analysis of existing VEX EDR solutions															
Deconstruction of EDR Clawbot															
Industrial Context task															
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts															
EDR component analysis	X	X													
Creation of EDR systems	X	X			X	X									
Use fabrication techniques to prototype for the EDR platform	X	X			X	X						X	X		
Using VEX EDR as a context for mathematical considerations															

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING SYSTEMS AND CONTROL

	Engineering systems and control												
	R113: Electronic principles				R114: Simulate, construct and test electronic circuits			R115: Engineering applications of computers			R116: Process control systems		
	Understand basic electronic principles	Understand the operating principles of electronic components	Know test methods for electronic circuits	Understand commercial circuit construction methods	Be able to use CAD for circuit simulation and design	Be able to construct circuits	Be able to test electronic circuits	Understand how computers are used in engineering design, manufacture and process control	Understand how computers are used for maintenance of engineering systems	Know how computers are used to communicate and use data for production and maintenance	Understand the application and operation of microcontrollers and microprocessors in engineered products	Be able to design, develop and simulate a control system	Be able to test control systems
	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3
Classroom Based Stages													
Introduce and set up competition													
Allocate team roles													
Equipment familiarisation	X	X		X	X			X	X	X	X		
Initial Design	X	X			X	X		X		X	X	X	
Test Design			X				X			X			X
Refine Design		X	X			X	X			X		X	X
Final Programming of Robot	X	X	X	X	X	X	X				X	X	X
Compete (judging Criteria)													
Innovative Engineering	X	X	X		X	X	X	X		X	X	X	X
Innovative solution soundly crafted	X	X	X		X	X	X	X		X	X	X	X
Features integrated in a well crafted robot	X	X	X		X	X	X	X		X	X	X	X
Effective autonomous code								X		X	X	X	X
Consistent autonomous code on the field								X		X	X	X	X
Engineering notebook is clear, complete document of the team's design process	X	X	X		X	X	X	X		X	X	X	X
Effective use of mechanical and electrical components	X	X	X	X	X	X	X						
Designed with details to hazards and competition rigors	X	X			X		X	X		X	X	X	X
Unique design solution	X	X	X	X	X	X	X	X		X	X	X	X
Highly creative design process and methodology	X	X	X	X	X	X	X	X		X	X	X	X

CAMBRIDGE NATIONALS IN ENGINEERING: ENGINEERING SYSTEMS AND CONTROL

	Engineering systems and control													
	R113: Electronic principles				R114: Simulate, construct and test electronic circuits			R115: Engineering applications of computers			R116: Process control systems			
	Understand basic electronic principles	Understand the operating principles of electronic components	Know test methods for electronic circuits	Understand commercial circuit construction methods	Be able to use CAD for circuit simulation and design	Be able to construct circuits	Be able to test electronic circuits	Understand how computers are used in engineering design, manufacture and process control	Understand how computers are used for maintenance of engineering systems	Know how computers are used to communicate and use data for production and maintenance	Understand the application and operation of microcontrollers and microprocessors in engineered products	Be able to design, develop and simulate a control system	Be able to test control systems	
	LO1	LO2	LO3	LO4	LO1	LO2	LO3	LO1	LO2	LO3	LO1	LO2	LO3	
Non-competition stage														
Sponsor and Partner Information														
Design your Own Part Activity														
Parametric Modeling - Basic Inventor Skills														
Free Form Modeling – Basic Fusion														
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor														
Designing a Wheel – Free Form Modeling using Autodesk Fusion														
Non-Competition EDR														
Reflective analysis of existing VEX EDR solutions	X	X									X			
Deconstruction of EDR Clawbot														
Industrial Context task														
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X	X	X		X	X	X	X	X	X	X	X	X	
EDR component analysis	X	X	X		X	X	X				X	X	X	
Creation of EDR systems	X	X	X											
Use fabrication techniques to prototype for the EDR platform														
Using VEX EDR as a context for mathematical considerations														

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 1 AND 2

	Unit 1 Fundamentals of mechanical, electrical/electronic and fluid power engineering						Unit 2 Application of engineering principles				
	LO1 Know what common SI units and their derivatives are and how to use them in engineering	LO2 Know how to classify common engineering materials	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces	LO4 Know how to calculate mechanical motion and force	LO5 Know electrical and electronic principles for electronic control and electrical motion	LO6 Know how to recognise fluid power components and their symbols and calculate fluid power	LO1 Understand the factors that determine efficiency in engineering systems	LO2 Understand why engineering materials are suitable for specific engineering applications	LO3 Understand materials processing techniques	LO4 Understand how to select electrical and electronic devices for engineering purposes	LO5 Understand the operation and application of fluid power sources, actuators and valves
Classroom Based Stages											
Introduce and set up competition											
Allocate team roles											
Equipment familiarisation	X	X									
Initial Design			X	X	X			X		X	X
Test Design							X			X	
Refine Design				X						X	
Final Programming of Robot											
Compete (judging Criteria)											
Innovative Engineering			X	X					X	X	
Innovative solution soundly crafted			X	X					X	X	
Features integrated in a well crafted robot											
Effective autonomous code											
Consistent autonomous code on the field											
Engineering notebook is clear, complete document of the team's design process	X	X			X						
Effective use of mechanical and electrical components			X		X					X	X
Designed with details to hazards and competition rigors											
Unique design solution			X								
Highly creative design process and methodology			X								
Non-competition stage											
Sponsor and Partner Information											

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 1 AND 2

	Unit 1 Fundamentals of mechanical, electrical/electronic and fluid power engineering						Unit 2 Application of engineering principles				
	LO1 Know what common SI units and their derivatives are and how to use them in engineering	LO2 Know how to classify common engineering materials	LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces	LO4 Know how to calculate mechanical motion and force	LO5 Know electrical and electronic principles for electronic control and electrical motion	LO6 Know how to recognise fluid power components and their symbols and calculate fluid power	LO1 Understand the factors that determine efficiency in engineering systems	LO2 Understand why engineering materials are suitable for specific engineering applications	LO3 Understand materials processing techniques	LO4 Understand how to select electrical and electronic devices for engineering purposes	LO5 Understand the operation and application of fluid power sources, actuators and valves
Design your Own Part Activity											
Parametric Modeling - Basic Inventor Skills											
Free Form Modeling – Basic Fusion											
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor											
Designing a Wheel – Free Form Modeling using Autodesk Fusion											
Non-Competition EDR											
Reflective analysis of existing VEX EDR solutions		X	X		X					X	X
Industrial Context task		X	X		X			X		X	X
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts.				X							
EDR component analysis		X	X					X			
Creation of EDR systems				X	X			X		X	X
Use fabrication techniques to prototype for the EDR platform		X	X		X			X	X		
Using VEX EDR as a context for mathematical considerations	X			X							

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 3, 4 AND 5

	Unit 3 Mechanical engineering – machine operations						Unit 4 Electrical, electronic engineering - operations and application			Unit 5 Engineering systems control - operations and application			
	LO1 Know the Health and Safety practices and procedures required in an engineering workplace	LO2 Be able to work safely when performing engineering activities	LO3 Be able to interpret engineering drawings to produce engineered component(s)	LO4 Be able to prepare and mark out materials to produce engineered component(s)	LO5 Be able to select and use tools, and work-holding devices to create machined component(s)	LO6 Be able to perform machine operations to create machined component(s)	LO1 Be able to work safely when undertaking electrical operations	LO2 Be able to construct electronic circuits by interpreting circuit diagrams	LO3 Be able to test electronic circuits for functionality	LO1 Understand the key components, applications and basic architecture of programmable devices	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.	LO3 Be able to programme an identified automated control system	LO4 Be able to test the operation of an automated control system
Classroom Based Stages													
Introduce and set up competition													
Allocate team roles													
Equipment familiarisation										X	X	X	
Initial Design								X		X	X	X	
Test Design									X				X
Refine Design													X
Final Programming of Robot										X	X	X	
Compete (judging Criteria)													
Innovative Engineering			X					X					
Innovative solution soundly crafted		X	X					X					
Features integrated in a well crafted robot													
Effective autonomous code										X	X	X	X
Consistent autonomous code on the field										X	X	X	X
Engineering notebook is clear, complete document of the team's design process		X	X							X	X	X	X
Effective use of mechanical and electrical components										X	X	X	
Designed with details to hazards and competition rigors													
Unique design solution								X			X	X	
Highly creative design process and methodology								X			X	X	
Non-competition stage													
Sponsor and Partner Information													

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 3, 4 AND 5

	Unit 3 Mechanical engineering – machine operations						Unit 4 Electrical, electronic engineering - operations and application			Unit 5 Engineering systems control - operations and application			
	LO1 Know the Health and Safety practices and procedures required in an engineering workplace	LO2 Be able to work safely when performing engineering activities	LO3 Be able to interpret engineering drawings to produce engineered component(s)	LO4 Be able to prepare and mark out materials to produce engineered component(s)	LO5 Be able to select and use tools, and work-holding devices to create machined component(s)	LO6 Be able to perform machine operations to create machined component(s)	LO1 Be able to work safely when undertaking electrical operations	LO2 Be able to construct electronic circuits by interpreting circuit diagrams	LO3 Be able to test electronic circuits for functionality	LO1 Understand the key components, applications and basic architecture of programmable devices	LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.	LO3 Be able to programme an identified automated control system	LO4 Be able to test the operation of an automated control system
Design your Own Part Activity													
Parametric Modeling - Basic Inventor Skills		X	X	X	X	X							
Free Form Modeling – Basic Fusion		X	X	X	X	X							
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor		X	X	X	X	X							
Designing a Wheel – Free Form Modeling using Autodesk Fusion		X	X	X	X	X							
Non-Competition EDR													
Reflective analysis of existing VEX EDR solutions										X	X	X	
Deconstruction of EDR Clawbot			X				X			X	X	X	
Industrial Context task													
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts								X					
EDR component analysis													
Creation of EDR systems			X		X		X	X	X	X	X	X	X
Use fabrication techniques to prototype for the EDR platform	X	X	X	X	X	X							
Using VEX EDR as a context for mathematical considerations													

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 6, 7 AND 8

	Unit 6 Develop and present engineering 2D and 3D design solutions					Unit 7 Product manufacture and fabrication				Unit 8 Optimise and maintain performance in engineering systems			
	LO1 Be able to create 2D and 3D drawings to present engineering components	LO2 Be able to save, store, organise and retrieve engineering drawings	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software	LO4 Be able to produce 3D solid model(s) using Computer Aided Design (CAD)	LO5 Be able to produce 2D CAD engineering drawing from a 3D solid model	LO1 Be able to prepare and plan for product assembly and manufacture	LO2 Be able to follow efficient and safe working procedures for product assembly and manufacture	LO3 Be able to produce an engineering product using product assembly and manufacturing techniques	LO4 Be able to apply quality control checks to product assembly and manufacture	LO1 Understand the importance of maintenance to optimise performance	LO2 Be able to plan maintenance to optimise performance	LO3 Be able to perform maintenance operations	LO4 Be able to perform unscheduled repair procedures
Classroom Based Stages													
Introduce and set up competition													
Allocate team roles													
Equipment familiarisation													
Initial Design	X		X										
Test Design										X	X	X	
Refine Design											X	X	
Final Programming of Robot											X	X	
Compete (judging Criteria)													
Innovative Engineering													
Innovative solution soundly crafted													
Features integrated in a well crafted robot													
Effective autonomous code													
Consistent autonomous code on the field										X	X	X	X
Engineering notebook is clear, complete document of the team's design process	X		X										
Effective use of mechanical and electrical components													
Designed with details to hazards and competition rigors										X	X	X	X
Unique design solution													
Highly creative design process and methodology													
Non-competition stage													
Sponsor and Partner Information													

CAMBRIDGE TECHNICALS: LEVEL 2 ENGINEERING UNITS 6, 7 AND 8

	Unit 6 Develop and present engineering 2D and 3D design solutions					Unit 7 Product manufacture and fabrication				Unit 8 Optimise and maintain performance in engineering systems			
	LO1 Be able to create 2D and 3D drawings to present engineering components	LO2 Be able to save, store, organise and retrieve engineering drawings	LO3 Be able to produce and modify 2D drawing(s) using 3D Computer Aided Design (CAD) software	LO4 Be able to produce 3D solid model(s) using Computer Aided Design (CAD)	LO5 Be able to produce 2D CAD engineering drawing from a 3D solid model	LO1 Be able to prepare and plan for product assembly and manufacture	LO2 Be able to follow efficient and safe working procedures for product assembly and manufacture	LO3 Be able to produce an engineering product using product assembly and manufacturing techniques	LO4 Be able to apply quality control checks to product assembly and manufacture	LO1 Understand the importance of maintenance to optimise performance	LO2 Be able to plan maintenance to optimise performance	LO3 Be able to perform maintenance operations	LO4 Be able to perform unscheduled repair procedures
Design your Own Part Activity													
Parametric Modeling - Basic Inventor Skills	X	X	X	X	X	X	X	X	X				
Free Form Modeling – Basic Fusion	X	X	X	X	X	X	X	X	X				
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X	X	X	X	X	X	X	X				
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X	X	X	X	X	X	X	X				
Non-Competition EDR													
Reflective analysis of existing VEX EDR solutions													
Deconstruction of EDR Clawbot													
Industrial Context task													
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X	X	X	X	X								
EDR component analysis													
Creation of EDR systems	X	X	X	X	X	X	X	X					
Use fabrication techniques to prototype for the EDR platform						X	X	X					
Using VEX EDR as a context for mathematical considerations													

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 5 AND 6

	Unit 5: Electrical and Electronic Design					Unit 6: Circuit Simulation and Manufacture				
	1.Be able to apply AC andDC circuit theory to circuitdesign	2.Understand the applicationof electromagnetism inelectrical design	3.Be able to apply a systemsapproach to electrical design	4.Be able to use semi-conductors in electrical andelectronic design	5.Understand the applicationof programmable processdevices in electronicdesign	1.Be able to useComputer AidedDesign (CAD) forcircuit design andsimulation	2.Be able to useComputer AidedDesign (CAD) todesign printedcircuit boards (PCBs)	3.Be able to manufacture and construct electronic circuits safely	4.Be able to test andperform fault-finding onelectronic circuits	5. Understand commercial circuit manufacture
Classroom Based Stages										
Introduce and set up competition										
Allocate team roles										
Equipment familiarisation										
Initial Design		X	X		X	X	X	X		
Test Design		X	X			X	X	X	X	
Refine Design			X					X	X	
Final Programming of Robot			X		X				X	
Compete (judging Criteria)										
Innovative Engineering						X	X			
Innovative solution soundly crafted						X	X	X		
Features integrated in a well crafted robot										
Effective autonomous code					X					
Consistent autonomous code on the field					X					
Engineering notebook is clear, complete document of the team's design process	X		X		X	X	X	X		
Effective use of mechanical and electrical components		X	X				X			
Designed with details to hazards and competition rigors										
Unique design solution	X					X	X	X		
Highly creative design process and methodology						X	X	X		
Non-competition stage										
Sponsor and Partner Information										

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 5 AND 6

	Unit 5: Electrical and Electronic Design					Unit 6: Circuit Simulation and Manufacture				
	1.Be able to apply AC andDC circuit theory to circuitdesign	2.Understand the applicationof electromagnetism inelectrical design	3.Be able to apply a systemsapproach to electrical design	4.Be able to use semi-conductors in electrical andelectronic design	5.Understand the applicationof programmable processdevices in electronicdesign	1.Be able to useComputer AidedDesign (CAD) forcircuit design andsimulation	2.Be able to useComputer AidedDesign (CAD) todesign printedcircuit boards (PCBs)	3.Be able to manufacture and construct electronic circuits safely	4.Be able to test andperform fault-finding onelectronic circuits	5. Understand commercial circuit manufacture
Design your Own Part Activity										
Parametric Modeling - Basic Inventor Skills										
Free Form Modeling – Basic Fusion										
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor										
Designing a Wheel – Free Form Modeling using Autodesk Fusion										
Non-Competition EDR										
Reflective analysis of existing VEX EDR solutions	X									
Deconstruction of EDR Clawbot	X									
Industrial Context task										
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts						X	X	X		
EDR component analysis	X		X		X					
Creation of EDR systems	X		X		X	X	X	X		
Use fabrication techniques to prototype for the EDR platform			X							
Using VEX EDR as a context for mathematical considerations										

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 7, 8 AND 9

	Unit 7: Electrical Devices				Unit 8: Electrical Operations				Unit 9: Mechanical Design			
	1.Understand semi-conductor and programmable devices	2.Understand electrical sensors and actuators	3.Understand how to use signal conditioning techniques and signal conversion devices	4.Understand the application of smart and modern materials in electrical	1.Understand operating and performance characteristics of electrical and electronic components and devices	2.Be able to work safely with electricity	3.Be able to construct electrical and electronic circuits	4.Be able to fault find I nelectrical and electronic equipment	1.Be able to use graphical and engineering drawing techniques to communicate design solutions	2.Be able to select appropriate engineering materials to achieve design solutions	3.Be able to design components that can be successfully manufactured	4.Be able to optimise design to improve performance
Classroom Based Stages												
Introduce and set up competition												
Allocate team roles												
Equipment familiarisation	X	X	X									
Initial Design		X	X	X	X	X	X		X	X	X	
Test Design								X				X
Refine Design				X	X				X	X		X
Final Programming of Robot	X											X
Compete (judging Criteria)												
Innovative Engineering	X	X					X			X		
Innovative solution soundly crafted						X	X			X	X	
Features integrated in a well crafted robot			X	X	X					X		
Effective autonomous code		X										
Consistent autonomous code on the field												
Engineering notebook is clear, complete document of the team's design process		X	X	X	X	X		X	X	X	X	X
Effective use of mechanical and electrical components		X	X	X	X		X			X		
Designed with details to hazards and competition rigors												
Unique design solution				X	X				X	X		
Highly creative design process and methodology				X					X	X		
Non-competition stage												
Sponsor and Partner Information												

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 7, 8 AND 9

	Unit 7: Electrical Devices				Unit 8: Electrical Operations				Unit 9: Mechanical Design			
	1.Understand semi-conductor and programmable devices	2.Understand electrical sensors and actuators	3.Understand how to use signal conditioning techniques and signal conversion devices	4.Understand the application of smart and modern materials in electrical	1.Understand operating and performance characteristics of electrical and electronic components and devices	2.Be able to work safely with electricity	3.Be able to construct electrical and electronic circuits	4.Be able to fault find I nelectrical and electronic equipment	1.Be able to use graphical and engineering drawing techniques to communicate design solutions	2.Be able to select appropriate engineering materials to achieve design solutions	3.Be able to design components that can be successfully manufactured	4.Be able to optimise design to improve performance
Design your Own Part Activity												
Parametric Modeling - Basic Inventor Skills									X	X	X	X
Free Form Modeling – Basic Fusion									X	X	X	X
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor									X	X	X	X
Designing a Wheel – Free Form Modeling using Autodesk Fusion									X	X	X	X
Non-Competition EDR												
Reflective analysis of existing VEX EDR solutions		X	X		X							
Deconstruction of EDR Clawbot		X	X		X							
Industrial Context task												
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts					X				X	X		
EDR component analysis		X	X		X							
Creation of EDR systems		X	X		X	X	X	X	X	X		X
Use fabrication techniques to prototype for the EDR platform						X						
Using VEX EDR as a context for mathematical considerations												

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 10 AND 11

	Unit 10: Computer Aided Design (CAD)				Unit 11: Materials Science				
	1.Be able to produce 3D models using ComputerAided Design (CAD)	2.Be able to create 3D assemblies of components within a CAD system	3.Be able to produce 2D CAD engineering drawings	4.Understand the use of simulation tools within CAD systems	1.Understand material structure and classification	2.Understand properties, standard forms and failure modes of materials	3.Understand material processing techniques	4.Know the applications and benefits of modern and smart materials	5.Be able to test the suitability of materials for different applications
Classroom Based Stages									
Introduce and set up competition									
Allocate team roles									
Equipment familiarisation									
Initial Design					X			X	
Test Design						X			X
Refine Design									
Final Programming of Robot									
Compete (judging Criteria)					X				
Innovative Engineering							X	X	
Innovative solution soundly crafted							X	X	
Features integrated in a well crafted robot									
Effective autonomous code									
Consistent autonomous code on the field									
Engineering notebook is clear, complete document of the team's design process	X	X	X		X	X			X
Effective use of mechanical and electrical components					X	X	X		X
Designed with details to hazards and competition rigors	X	X	X			X			
Unique design solution	X	X	X			X		X	
Highly creative design process and methodology	X	X	X			X		X	
Non-competition stage									
Sponsor and Partner Information									

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 10 AND 11

	Unit 10: Computer Aided Design (CAD)				Unit 11: Materials Science				
	1.Be able to produce 3D models using ComputerAided Design (CAD)	2.Be able to create 3D assemblies of components within a CAD system	3.Be able to produce 2D CAD engineering drawings	4.Understand the use of simulation tools within CAD systems	1.Understand material structure and classification	2.Understand properties, standard forms and failure modes of materials	3.Understand material processing techniques	4.Know the applications and benefits of modern and smart materials	5.Be able to test the suitability of materials for different applications
Design your Own Part Activity									
Parametric Modeling - Basic Inventor Skills	X	X	X	X	X	X	X		
Free Form Modeling – Basic Fusion	X	X	X	X	X	X	X		
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X	X	X	X	X	X		
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X	X	X	X	X	X		
Non-Competition EDR									
Reflective analysis of existing VEX EDR solutions					X	X			
Deconstruction of EDR Clawbot					X	X			
Industrial Context task									
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X	X	X	X					
EDR component analysis					X	X			
Creation of EDR systems	X	X	X	X					
Use fabrication techniques to prototype for the EDR platform					X	X	X	X	X
Using VEX EDR as a context for mathematical considerations									

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 12 AND 13

	Unit 12: Mechanical Simulation and Modelling				Unit 13: Mechnical Operations				
	1.Be able to carry out simulations to establish reactions in moving mechanical assemblies	2.Be able to carry ou tsimulations to assess the manufacturability of components or products	3.Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components	4.Be able to carry out Computational FluidDynamic (CFD)simulation to assess the operational performance of components	1.Be able to plan for production in mechanical engineering	2.Be able to use bench processes, tools and equipment to produce quality components	3.Be able to use the centre lathe to produce quality components	4.Be able to use drilling and milling machines to produce quality components	5.Be able to quality assure components
Classroom Based Stages									
Introduce and set up competition									
Allocate team roles									
Equipment familiarisation									
Initial Design			X	X					
Test Design	X								
Refine Design			X	X					
Final Programming of Robot	X								
Compete (judging Criteria)									
Innovative Engineering						X			
Innovative solution soundly crafted			X	X		X			
Features integrated in a well crafted robot									
Effective autonomous code									
Consistent autonomous code on the field									
Engineering notebook is clear, complete document of the team's design process	X		X	X		X			
Effective use of mechanical and electrical components			X	X		X			
Designed with details to hazards and competition rigors									
Unique design solution									
Highly creative design process and methodology			X	X					
Non-competition stage									
Sponsor and Partner Information									

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 12 AND 13

	Unit 12: Mechanical Simulation and Modelling				Unit 13: Mechnical Operations				
	1.Be able to carry out simulations to establish reactions in moving mechanical assemblies	2.Be able to carry ou tsimulations to assess the manufacturability of components or products	3.Be able to carry out Finite Element Analysis (FEA)simulations to assess the operational performance of components	4.Be able to carry out Computational FluidDynamic (CFD)simulations to assess the operational performance of components	1.Be able to plan for production in mechanical engineering	2.Be able to use bench processes, tools and equipment to produce quality components	3.Be able to use the centre lathe to produce quality components	4.Be able to use drilling and milling machines to produce quality components	5.Be able to quality assure components
Design your Own Part Activity									
Parametric Modeling - Basic Inventor Skills									
Free Form Modeling – Basic Fusion									
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor									
Designing a Wheel – Free Form Modeling using Autodesk Fusion									
Non-Competition EDR									
Reflective analysis of existing VEX EDR solutions									
Deconstruction of EDR Clawbot									
Industrial Context task									
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X	X	X	X					
EDR component analysis									
Creation of EDR systems					X	X			
Use fabrication techniques to prototype for the EDR platform					X	X			
Using VEX EDR as a context for mathematical considerations	X	X	X	X					

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 14 AND 15

	Unit 14: Automation Control and Robotics						Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control			
	1.Understand control system theory in engineering	2.Understand the implementation of control in automated systems	3.Understand sensors and actuators used in automation control systems	4.Know about industrial network systems	5.Know about maintenance in automation control systems	6.Understand the application of robotics in automation control systems	1.Understand mechanical elements of control systems	2.Understand the electrical elements of control systems	3.Understand simple hydraulic systems	4.Understand simple pneumatic systems
Classroom Based Stages										
Introduce and set up competition										
Allocate team roles										
Equipment familiarisation										
Initial Design	X	X	X				X	X	X	X
Test Design	X	X	X			X	X	X	X	X
Refine Design	X	X	X			X	X	X	X	X
Final Programming of Robot	X	X	X		X	X				
Compete (judging Criteria)										
Innovative Engineering										
Innovative solution soundly crafted						X				
Features integrated in a well crafted robot										
Effective autonomous code	X	X	X		X	X				
Consistent autonomous code on the field	X	X	X		X	X				
Engineering notebook is clear, complete document of the team's design process	X	X	X		X		X	X	X	X
Effective use of mechanical and electrical components	X	X	X			X	X	X	X	X
Designed with details to hazards and competition rigors					X	X				
Unique design solution										
Highly creative design process and methodology										
Non-competition stage										
Sponsor and Partner Information										

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 14 AND 15

	Unit 14: Automation Control and Robotics						Unit 15: Electrical, Mechanical, Hydraulic and Pneumatic Control			
	1.Understand control system theory in engineering	2.Understand the implementation of control in automated systems	3.Understand sensors and actuators used in automation control systems	4.Know about industrial network systems	5.Know about maintenance in automation control systems	6.Understand the application of robotics in automation control systems	1.Understand mechanical elements of control systems	2.Understand the electrical elements of control systems	3.Understand simple hydraulic systems	4.Understand simple pneumatic systems
Design your Own Part Activity										
Parametric Modeling - Basic Inventor Skills										
Free Form Modeling – Basic Fusion										
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor										
Designing a Wheel – Free Form Modeling using Autodesk Fusion										
Non-Competition EDR										
Reflective analysis of existing VEX EDR solutions	X	X	X			X	X			
Deconstruction of EDR Clawbot							X			
Industrial Context task	X	X	X	X	X	X	X	X	X	X
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts										
EDR component analysis							X	X	X	X
Creation of EDR systems	X	X	X			X	X	X	X	X
Use fabrication techniques to prototype for the EDR platform										
Using VEX EDR as a context for mathematical considerations										

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 16, 20 AND 21

	Unit 16: Ssystems and Programming				Unit 20: Business for Engineering					Unit 21: Maintenance				
	1.Understand programming techniques	2.Be able to program embedded devices in a system	3.Be able to program Programmable Logic Controllers (PLCs)	4.Understand commercia ltesting and validation strategies	1. Know how size, ownership and key stakeholders can influence engineering businesses	2. Understand strategies and techniques used to improve engineering businesses	3. Understand external factors which affect engineering businesses	4. Understand influences on innovation and entrepreneurship in engineering	5. Understand key financial terms and documents for engineering businesses	1. Know about maintenance strategies and operations	2. Understand failure modes	3. Be able to analyse reliability-centred maintenance data	4. Be able to plan maintenance operations	5. Be able to undertake maintenance operations
Classroom Based Stages														
Introduce and set up competition														
Allocate team roles														
Equipment familiarisation														
Initial Design														
Test Design														
Refine Design														
Final Programming of Robot	X	X	X											
Compete (judging Criteria)														
Innovative Engineering														
Innovative solution soundly crafted														X
Features integrated in a well crafted robot														
Effective autonomous code	X	X	X											
Consistent autonomous code on the field	X	X	X							X	X		X	X
Engineering notebook is clear, complete document of the team's design process										X	X		X	X
Effective use of mechanical and electrical components														
Designed with details to hazards and competition rigors										X	X		X	X
Unique design solution														
Highly creative design process and methodology														
Non-competition stage														
Sponsor and Partner Information					X			X	X					

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 16, 20 AND 21

	Unit 16: Ssystems and Programming				Unit 20: Business for Engineering					Unit 21: Maintenance				
	1.Understand programming techniques	2.Be able to program embedded devices in a system	3.Be able to program Programmable Logic Controllers (PLCs)	4.Understand commercia ltesting and validation strategies	1. Know how size, ownership and key stakeholders can influence engineering businesses	2. Understand strategies and techniques used to improve engineering businesses	3. Understand external factors which affect engineering businesses	4. Understand influences on innovation and entrepreneurship in engineering	5. Understand key financial terms and documents for engineering businesses	1. Know about maintenance strategies and operations	2. Understand failure modes	3. Be able to analyse reliability-centred maintenance data	4. Be able to plan maintenance operations	5. Be able to undertake maintenance operations
Design your Own Part Activity														
Parametric Modeling - Basic Inventor Skills														
Free Form Modeling – Basic Fusion														
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor														
Designing a Wheel – Free Form Modeling using Autodesk Fusion														
Non-Competition EDR														
Reflective analysis of existing VEX EDR solutions	X	X	X	X										
Deconstruction of EDR Clawbot	X	X	X	X										
Industrial Context task														
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts														
EDR component analysis														
Creation of EDR systems	X	X	X	X										
Use fabrication techniques to prototype for the EDR platform														
Using VEX EDR as a context for mathematical considerations														

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 22, 24 AND 25

	Unit 22: Engineering and the Environment					Unit 24: Project management for engineers						Unit 25: Promoting Continuous Improvement		
	1. Understand sustainability in engineering	2. Understand the contribution and potential of renewable energy	3. Know how to evaluate UK performance against global, national and local environmental targets related to engineering	4. Understand environmental arguments for and against global manufacturing	5. Know how innovation is making a difference to the way engineering interacts with the environment	1. Understand the stages of project management	2. Understand project management roles and the skills needed to be an effective project manager	3. Be able to use project management tools	4: Be able to use information to support project management decisions	5. Understand how and why projects are monitored	6. Understand how to measure the success of a project	1: Be able to reflect on own performance and performance of systems, processes or artefacts	2: Be able to develop a plan for improvements to a system, process or artefact	3: Be able to implement a plan to make improvements
Classroom Based Stages														
Introduce and set up competition														
Allocate team roles						X		X						
Equipment familiarisation														
Initial Design						X		X						
Test Design	X					X		X	X	X		X	X	
Refine Design						X		X	X	X		X	X	X
Final Programming of Robot								X	X	X		X	X	
Compete (judging Criteria)						X		X		X	X			
Innovative Engineering	X				X									
Innovative solution soundly crafted														
Features integrated in a well crafted robot														
Effective autonomous code														
Consistent autonomous code on the field														
Engineering notebook is clear, complete document of the team's design process						X						X	X	
Effective use of mechanical and electrical components														
Designed with details to hazards and competition rigors														
Unique design solution	X				X									
Highly creative design process and methodology	X				X									
Non-competition stage														
Sponsor and Partner Information														

CAMBRIDGE TECHNICALS: LEVEL 3 ENGINEERING UNITS 22, 24 AND 25

	Unit 22: Engineering and the Environment					Unit 24: Project management for engineers						Unit 25: Promoting Continuous Improvement		
	1. Understand sustainability in engineering	2. Understand the contribution and potential of renewable energy	3. Know how to evaluate UK performance against global, national and local environmental targets related to engineering	4. Understand environmental arguments for and against global manufacturing	5. Know how innovation is making a difference to the way engineering interacts with the environment	1. Understand the stages of project management	2. Understand project management roles and the skills needed to be an effective project manager	3. Be able to use project management tools	4: Be able to use information to support project management decisions	5. Understand how and why projects are monitored	6. Understand how to measure the success of a project	1: Be able to reflect on own performance and performance of systems, processes or artefacts	2: Be able to develop a plan for improvements to a system, process or artefact	3: Be able to implement a plan to make improvements
Design your Own Part Activity														
Parametric Modeling - Basic Inventor Skills														
Free Form Modeling – Basic Fusion														
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor														
Designing a Wheel – Free Form Modeling using Autodesk Fusion														
Non-Competition EDR														
Reflective analysis of existing VEX EDR solutions														
Deconstruction of EDR Clawbot														
Industrial Context task														
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts														
EDR component analysis														
Creation of EDR system						X	X	X	X	X	X			
Use fabrication techniques to prototype for the EDR platform						X	X	X	X	X	X			
Using VEX EDR as a context for mathematical considerations														

GCSE DESIGN AND TECHNOLOGY UNITS 1, 2, 3 AND 4

	1. Identifying requirements		2. Learning from existing products & practice		3. Implications of wider issues				4. Design thinking and communication	
	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes?	1.2 Why is usability an important consideration when designing prototypes?	2.1 What are the opportunities and constraints that influence design and making requirements?	2.2 How do developments in Design and Technology influence design decisions and practice?	3.1 What are the impacts of new and emerging technologies when developing design solutions?	3.2 How do designers choose appropriate sources of energy to make products and power systems?		3.3 What wider implications can have an influence on the processes of designing and making?	4.1 How can design solutions be communicated to demonstrate their suitability to a third party?	4.2 How do designers source information and thinking when problem solving?
	a. Considerations for exploring a context	a. Considerations in relation to user interaction with design solutions	a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations	a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives	a. Exploration of the impacts within different contexts	a. The generation of electricity and how energy is stored and transferred.	b. The appropriate use in products and systems of renewable and non-renewable sources	a. Consideration of environmental, social and economic influences	a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations,	a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.
Classroom Based Stages										
Introduce and set up competition										
Allocate team roles										
Equipment familiarisation										
Initial Design	X	X	X	X					X	X
Test Design										
Refine Design										
Final Programming of Robot										
Compete (judging Criteria)									X	X
Innovative Engineering	X	X	X	X	X				X	X
Innovative solution soundly crafted										
Features integrated in a well crafted robot			X	X						
Effective autonomous code										
Consistent autonomous code on the field										
Engineering notebook is clear, complete document of the team's design process									X	X
Effective use of mechanical and electrical components										
Designed with details to hazards and competition rigors										

GCSE DESIGN AND TECHNOLOGY UNITS 1, 2, 3 AND 4

	1. Identifying requirements		2. Learning from existing products & practice		3. Implications of wider issues				4. Design thinking and communication	
	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes?	1.2 Why is usability an important consideration when designing prototypes?	2.1 What are the opportunities and constraints that influence design and making requirements?	2.2 How do developments in Design and Technology influence design decisions and practice?	3.1 What are the impacts of new and emerging technologies when developing design solutions?	3.2 How do designers choose appropriate sources of energy to make products and power systems?		3.3 What wider implications can have an influence on the processes of designing and making?	4.1 How can design solutions be communicated to demonstrate their suitability to a third party?	4.2 How do designers source information and thinking when problem solving?
	a. Considerations for exploring a context	a. Considerations in relation to user interaction with design solutions	a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations	a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives	a. Exploration of the impacts within different contexts	a. The generation of electricity and how energy is stored and transferred.	b. The appropriate use in products and systems of renewable and non-renewable sources	a. Consideration of environmental, social and economic influences	a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations,	a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.
Unique design solution					X	X	X		X	X
Highly creative design process and methodology					X	X	X		X	X
Non-competition stage										
Sponsor and Partner Information										
Design your Own Part Activity										
Parametric Modeling - Basic Inventor Skills	X	X	X						X	X
Free Form Modeling – Basic Fusion	X	X	X						X	X
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X	X						X	X
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X	X						X	X
Non-Competition EDR										
Reflective analysis of existing VEX EDR solutions	X	X								
Deconstruction of EDR Clawbot			X	X						
Industrial Context task			X	X	X	X	X	X		
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts									X	X

GCSE DESIGN AND TECHNOLOGY UNITS 1, 2, 3 AND 4

	1. Identifying requirements		**2. Learning from existing products & practice**		**3. Implications of wider issues**				**4. Design thinking and communication**	
	1.1 How can exploring the context a design solution is intended for inform decisions and outcomes?	1.2 Why is usability an important consideration when designing prototypes?	2.1 What are the opportunities and constraints that influence design and making requirements?	2.2 How do developments in Design and Technology influence design decisions and practice?	3.1 What are the impacts of new and emerging technologies when developing design solutions?	3.2 How do designers choose appropriate sources of energy to make products and power systems?		3.3 What wider implications can have an influence on the processes of designing and making?	4.1 How can design solutions be communicated to demonstrate their suitability to a third party?	4.2 How do designers source information and thinking when problem solving?
	a. Considerations for exploring a context	a. Considerations in relation to user interaction with design solutions	a. Exploration and critique of existing designs, systems and products to identify features and methods, considerations	a. Critical evaluation of how new and emerging technologies influence and inform design decisions, considering both contemporary and potential future scenarios from the perspectives	a. Exploration of the impacts within different contexts	a. The generation of electricity and how energy is stored and transferred.	b. The appropriate use in products and systems of renewable and non-renewable sources	a. Consideration of environmental, social and economic influences	a. The use of graphical techniques to communicate ideas, modifications, constructional and technical considerations,	a. Awareness of different design approaches, b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.
EDR component analysis										
Creation of EDR system										
Use fabrication techniques to prototype for the EDR platform										
Using VEX EDR as a context for mathematical considerations										

GCSE DESIGN AND TECHNOLOGY UNIT 5

	5. Material considerations									
	5.1 What are the main categories of materials available to designers when developing design solutions?	5.2 What factors are important to consider when selecting appropriate materials and/or system components when designing?			5.3 Why is it important to understand the sources or origins of materials and/or system components?					5.4 Why is it important to know the different available forms of specific materials and/or systems components?
	Understanding that products are predominantly made from multiple materials.	a. The characteristic properties of the main categories of materials (5.1a-e, not the specific materials) and why this makes them appropriate for different uses	b. The physical and working properties of specific materials and/or system components	c. Other factors that influence the selection of materials and/or components	a. The sources and origins of specific materials and/or system components.	b. An overview of the processes used to extract and/or convert the source material into a workable form.	c. Consideration of the ecological, social and ethical issues associated with processing specific materials and/or system components to convert them into workable forms	d. The lifecycle of specific materials and/or system components when used in products	e. Consideration of recycling, reuse and disposal of specific materials and/or system components	a. Awareness of commonly available forms and standard units of measurement of specific materials and/or system components when calculating costs and quantities,
Classroom Based Stages										
Introduce and set up competition										
Allocate team roles										
Equipment familiarisation										
Initial Design	X	X								
Test Design										
Refine Design										
Final Programming of Robot										
Compete (judging Criteria)										
Innovative Engineering					X	X	X			
Innovative solution soundly crafted		X	X	X	X	X	X			
Features integrated in a well crafted robot			X		X	X	X			
Effective autonomous code										
Consistent autonomous code on the field										
Engineering notebook is clear, complete document of the team's design process						X	X	X	X	
Effective use of mechanical and electrical components	X	X	X		X	X	X			
Designed with details to hazards and competition rigors				X						

GCSE DESIGN AND TECHNOLOGY UNIT 5

	5. Material considerations									
	5.1 What are the main categories of materials available to designers when developing design solutions?	5.2 What factors are important to consider when selecting appropriate materials and/ or system components when designing?			5.3 Why is it important to understand the sources or origins of materials and/or system components?					5.4 Why is it important to know the different available forms of specific materials and/or systems components?
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Unique design solution										
Highly creative design process and methodology										
Non-competition stage										
Sponsor and Partner Information										
Design your Own Part Activity										
Parametric Modeling - Basic Inventor Skills	X	X	X	X						
Free Form Modeling – Basic Fusion	X	X	X	X						
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X	X	X	X						
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X	X	X	X						
Non-Competition EDR										
Reflective analysis of existing VEX EDR solutions	X	X	X	X	X		X	X		
Deconstruction of EDR Clawbot	X	X	X	X	X			X		
Industrial Context task										
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts										

GCSE DESIGN AND TECHNOLOGY UNIT 5

	5. Material considerations									
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EDR component analysis	X	X	X	X	X			X		
Creation of EDR systems	X	X	X	X	X			X	X	
Use fabrication techniques to prototype for the EDR platform		X	X	X	X			X	X	
Using VEX EDR as a context for mathematical considerations										

GCSE DESIGN AND TECHNOLOGY UNIT 6

	6. Technical understanding								
	6.1 What gives a product structural integrity?		6.2 How can materials and products be finished for different purposes?	6.3 How do we introduce controlled movement to products and systems?			6.4 How do electronic systems provide functionality to products and processes?		
	a. How and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses.	b. Awareness of the processes that can be used to ensure the structural integrity of a product,	a. The processes used for finishing and adding surface treatments to materials and products for specific purposes	a. An overview of different sorts of movement and types of motion	b. The effect of forces on the ease of movement	c. How different mechanical devices are used to change the magnitude and direction of motion or forces	a. How sensors and control devices respond to a variety of inputs	b. How devices are used to produce a range of outputs	c. The use of programmable components such as microcontrollers, to embed functionality into products in order to enhance and customise their operation.
Classroom Based Stages									
Introduce and set up competition									
Allocate team roles									
Equipment familiarisation									
Initial Design	X			X	X	X	X	X	X
Test Design	X	X		X	X	X	X	X	X
Refine Design	X	X		X	X	X	X	X	X
Final Programming of Robot							X	X	X
Compete (judging Criteria)									
Innovative Engineering				X	X	X	X	X	X
Innovative solution soundly crafted				X	X	X	X	X	X
Features integrated in a well crafted robot	X	X							
Effective autonomous code				X	X	X	X	X	X
Consistent autonomous code on the field				X	X	X	X	X	X
Engineering notebook is clear, complete document of the team's design process				X	X	X	X	X	X
Effective use of mechanical and electrical components				X	X	X	X	X	X
Designed with details to hazards and competition rigors	X	X							

GCSE DESIGN AND TECHNOLOGY UNIT 6

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Unique design solution									
Highly creative design process and methodology	X	X							
Non-competition stage									
Sponsor and Partner Information									
Design your Own Part Activity									
Parametric Modeling - Basic Inventor Skills	X								
Free Form Modeling – Basic Fusion	X								
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor	X								
Designing a Wheel – Free Form Modeling using Autodesk Fusion	X								
Non-Competition EDR									
Reflective analysis of existing VEX EDR solutions			X	X	X	X	X	X	v
Deconstruction of EDR Clawbot	X	X	X	X	X	X	X	X	X
Industrial Context task		X	X						
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts									X

GCSE DESIGN AND TECHNOLOGY UNIT 6

	6. Technical understanding								
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EDR component analysis									
Creation of EDR systems	X	X	X	X	X	X	X	X	X
Use fabrication techniques to prototype for the EDR platform	X	X	X						
Using VEX EDR as a context for mathematical considerations									

GCSE DESIGN AND TECHNOLOGY UNITS 7 AND 8

	7. Manufacturing processes and techniques							8. Viability of design solutions	
	7.1 How can materials and processes be used to make iterative models?	7.2 How can materials be manipulated and joined in different ways in a workshop environment when making final prototypes?	7.3 How do designers and manufacturers ensure accuracy when making prototypes and products?	7.4 How do industry professionals use digital design tools when exploring and developing design ideas?	7.5 How do processes vary when manufacturing products to different scales of production?		7.6 How do new and emerging technologies have an impact on production techniques and systems?	8.1 How can cost and availability of specific materials and/or system components affect their selection when designing?	
	a. The processes and techniques used to produce early models and/or toiles to support iterative designing.	a. The specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high quality prototypes,	a. The use of appropriate and accurate marking out methods	a. The use of 2D and 3D digital technology and tools are used to present, model, design and manufacture solutions	a. The methods used for manufacturing at different scales of production	b. Awareness of manufacturing processes used for larger scales of production	b. Awareness of manufacturing processes used for larger scales of production	a. The significance of the cost of specific materials and/ or system components in relation to commercial viability, different stakeholder needs and marketability.	b. How to calculate the quantities, cost and sizes of materials and/or system components required in a design or product, being able to apply this to different applications.
Classroom Based Stages									
Introduce and set up competition									
Allocate team roles									
Equipment familiarisation		X	X	X					
Initial Design	X	X							X
Test Design	X	X							X
Refine Design	X	X							X
Final Programming of Robot									
Compete (judging Criteria)									
Innovative Engineering									
Innovative solution soundly crafted									
Features integrated in a well crafted robot									
Effective autonomous code									
Consistent autonomous code on the field									
Engineering notebook is clear, complete document of the team's design process									X
Effective use of mechanical and electrical components									
Designed with details to hazards and competition rigors									

GCSE DESIGN AND TECHNOLOGY UNITS 7 AND 8

	7. Manufacturing processes and techniques							8. Viability of design solutions	
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Unique design solution									
Highly creative design process and methodology									
Non-competition stage									
Sponsor and Partner Information								X	
Design your Own Part Activity									
Parametric Modeling - Basic Inventor Skills		X	X	X					
Free Form Modeling – Basic Fusion		X	X	X					
Designing a Battery Clip - Parametric Modeling using Autodesk Inventor		X	X	X					
Designing a Wheel – Free Form Modeling using Autodesk Fusion		X	X	X					
Non-Competition EDR									
Reflective analysis of existing VEX EDR solutions	X		X						
Deconstruction of EDR Clawbot	X	X	X						
Industrial Context task	X								
Using EDR to support communication techniques through sketching, prototyping, CAD, systems thinking, and for mathematical modelling and flow charts	X			X					

GCSE DESIGN AND TECHNOLOGY UNITS 7 AND 8

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EDR component analysis	X	X	X						
Creation of EDR systems	X	X	X	X				X	X
Use fabrication techniques to prototype for the EDR platform									
Using VEX EDR as a context for mathematical considerations									

The small print

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