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A LEVEL

Delivery Guide

DESIGN AND TECHNOLOGY

H404, H405, H406
For first teaching in 2017

Topic Area 6: Technical Understanding – Design Engineering

Version 1

www.ocr.org.uk/aleveldesignandtechnology

Contents

TOPIC AREA 6: TECHNICAL UNDERSTANDING – DESIGN ENGINEERING

Introduction

A LEVEL

DESIGN AND TECHNOLOGY

A guide to approaching the teaching of the content related to Topic Area 6: Technical Understanding - Design Engineering

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- **Content:** A clear outline of the content covered by the delivery guide;
- **Thinking Conceptually:** Expert guidance on the key concepts involved, common difficulties learners may have, approaches to teaching that can help learners understand these concepts and how this topic links conceptually to other areas of the subject;
- **Thinking Contextually:** A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

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

DISCLAIMER

This resource was designed using the most up to date information from the specification at the time it was published. Specifications are updated over time, which means there may be contradictions between the resource and the specification, therefore please use the information on the latest specification at all times. If you do notice a discrepancy please contact us on the following email address: resources.feedback@ocr.org.uk

Sub Topic 1: Technical considerations in iterative designing

NEA content

a. Understand how investigations of existing products and user and stakeholder requirements can be used to understand the requirements for functionality and usability when designing and creating prototypes.

b. Understand the importance of appropriate materials, components, finishes and use of technology when creating and developing functional and easy-to-use products and systems.

c. Understand aesthetics, ergonomics and anthropometrics in order to ensure their design solutions are fit for purpose in meeting stakeholder and design requirements.

General approaches:

To be able to generate iterative and creative design ideas and solution(s), learners will need to have a clear understanding of: existing products to be aware of; features in competitors' products; the essential needs and desirable requirements of the primary user(s) and/or stakeholder(s); and design factors and choice of materials that affect the performance, durability and cost of the proposed solution(s).

It is important that learners understand the fundamental need to draw on and expand their technical knowledge to make explicit links between requirements and opportunity for innovation in their NEA projects. Being able to do this instinctively will drive iteration and ensure a good flow within their portfolio.

Common misconceptions or difficulties learners may have:

Learners require an understanding of the framework used for analysing existing products, whereby they make observations about different aspects of the product, such as, function, materials used, manufacturing processes, etc. Thus, learners need to have a clear definition of each of these key areas to be able to gather useful information from each of the key aspects. It is important that learners analyse the products critically, from a neutral point-of-view to ensure fair analysis, e.g. some learners may be biased towards a particular product because of brand loyalty rather than the product's actual performance. Hence, the teacher may have to play 'devil's advocate' to guide learners towards different perspectives.

With regards to materials, components, finishes and use of technology, learners will need to have some prior knowledge of those topics which they can delve into in order to carry out the product analysis of existing products. Misconceptions tend to arise around which components, finishes and technologies are appropriate to each material group.

Learners should be schooled in the modern principle of 'form follows function' rather than the classical 'function follows form' approach. Anthropometrics should be clearly defined as the science of human body measurements that feeds into the process of designing ergonomically for the safety and comfort or users. Learners should be directed towards academic sources of information for reference due to the dearth of different anthropometric data available.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The product analysis skills developed within the NEA project will also be useful in the examination aspect of the qualification, as learners may be provided with a product to examine and comment on the material and manufacturing process used, as well as be asked questions related to anthropometrics and ergonomics. These are also applicable for questions that require them to suggest technical improvements to a problem. Being able to recall material properties and uses, manufacturing processes, components and finishes will be invaluable to such questions in the examination.

Thinking contextually

Product Analysis

Learners to bring in, or use the internet to look up, existing product(s) linked to their chosen NEA context. Use ACCESS FM (Aesthetics, Customer, Cost, Environment, Size, Safety, Function, Material) as a framework to analyse the features of the product(s).

Product Disassembly

To learn about the different aspects of product analysis, the Dyson Foundation has a free Engineering Box available for 6-weeks blocks (booking through their website) that allows learners to disassemble a Dyson vacuum-cleaner. This also provides opportunities for sketching activities (section/assembly/engineering drawings).

Investigation – Materials, Processes, Finishes

Learners to use DT and engineering related websites (e.g. www.technologystudent.com, www.mr-dt.com, http://www.bpf.co.uk/plastipedia/default.aspx) to research about material properties, different types of materials and finishes, and associated manufacturing processes.

Case Studies – Aesthetics, Anthropometrics and Ergonomics

Learners to read through different case studies of badly designed products and workspaces make a summary of design decisions that they ought to take into consideration when designing ergonomically.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
ACCESS FM Tools	ACCESS FM	http://accessfm.com/tools/	This website provides different tools that would help learners in their NEA for product analysis.	Thinking Conceptually, Thinking Contextually	NEA 6.a, 6.b, 6.c
Dyson Engineering Box	Dyson	http://www.jamesdysonfoundation.co.uk/resources/engineering-box/	The Engineering Box is a reverse engineering kit that takes learners through the design process by disassembling a Dyson machine – understanding how a machine works by taking it apart.	Thinking Contextually	NEA 6.a, 6.b, 6.c
Materials and Finishes	Mr DT	http://www.mr-dt.com/materials/main.htm	This webpage is useful for investigation/research as it provides concise information about different types of materials and finishes.	Thinking Contextually	NEA 6.a, 6.b, 6.c
Case Studies	Bad Designs	http://www.baddesigns.com/examples.html	This webpage provides case studies of different products and workspaces with poor design choices.	Thinking Contextually	NEA 6.a, 6.b, 6.c
Ergonomics and Design	STEM	https://www.stem.org.uk/elibrary/resource/33198	In this activity, learners carry out a product analysis of a provided wireless product (such as a TV with a remote control or a remote control car). This can be done using the ACCESS FM framework for guidance.	Thinking Contextually	NEA 6.a, 6.b, 6.c
Anthropometrics and Ergonomics	Technology Student	http://www.technologystudent.com/despro_flsh/revise11.html	This webpage provides revision materials about anthropometrics and ergonomics.	Thinking Contextually	NEA 6.a, 6.b, 6.c

Learner Activity

Product Analysis

Introduction

By the end of the lesson, learners will be able to:

- use ACCESS FM to analyse existing products to gather information to understand the requirements for functionality and usability when designing and creating prototypes
- understand the importance of appropriate materials, components, finishes and use of technology when creating and developing functional and easy-to-use products and systems.

The activity

Teachers to provide examples of existing products linked to NEA contexts chosen by the learners. Alternatively, learners to gather examples themselves as part of the preparation for the lesson. For a one-off lesson to develop product analysis and disassembly skills, teachers could book the Dyson Engineering Box.

Learners to sketch out their chosen product to practice their sketching skills (using crating technique for a 3D sketch or assembly drawing). Teachers to provide an ACCESS FM guidance sheet that learners can use to analyse the product according to the sub-headings Aesthetics, Customer, Cost, Environment, Size, Safety, Function and Materials (and Manufacturing). Learners should support their analysis using internet research for some of the product specifications that may be readily available through the manufacturer's or reseller's website. They should be encouraged to present data using an evaluative method, such as star ratings, star charts or other numerical rating, to compare different existing products.

Extension activities/questions:

What are the manufacturing techniques used to make the whole, or part(s) of the product(s)?

What are the legislation covering the safety of the product(s)?

How does the choice of material(s) or finish(es) affect the functionality, performance and durability of the product(s)?

How could you make a model of the product(s)?

Sub Topic 2: Ensuring Structural Integrity

Exam content

6.1 What considerations need to be made about the structural integrity of a design solution?

a. Learners should understand how and why some materials and/or system components need to be reinforced or stiffened to withstand forces and stresses to fulfil the structural integrity of products.

b. Learners should understand processes that can be used to ensure the structural integrity of a product, such as:

- triangulation
- reinforcing.

Thinking conceptually

General approaches:

Learners should be able to differentiate between the three main different types of structures: solid, frame and shell. An understanding of types of forces and struts (members in compression) and ties (members in tension) is necessary to help learners in analysing the forces that a structure is experiencing which lead to the need for reinforcement.

Triangulation involves the use of triangular shapes to give stability to structures. It relates particularly to pinned or hinged structures. Usually these types of structures offer no resistance to bending moments when a force is applied.

Common misconceptions or difficulties learners may have:

Learners may perceive certain materials as 'weaker' but these could be strengthened as a result of a change in structure or the addition of reinforcements, e.g. concrete in compression versus concrete with reinforcing bars, honeycomb structures within columns, etc.

Within triangulation, members trying to resist bending do not need to be as strong. However, they can easily be pushed out of shape by external forces and hence are not in equilibrium.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

This could be linked to 7.1 'How can materials and processes be used to make iterative models?' and NEA 5. 'Material considerations' so learners may consider reinforcement when making decisions in the material and construction of models and prototypes.

Thinking contextually

Case Studies – 3Arena in Dublin and Stansted Airport

Learners to read through different case studies of 3Arena in Dublin and Stansted Airport. They will have to investigate these three questions:

- What were the key issues the architect had to resolve?
- Why did they not want any columns supporting the roof structure?
- What was the span they had to achieve in metres?

Learners are then asked to design a structure that will support the given piece of A4 card 300mm off the ground. The base (footprint) of the structure cannot exceed 100mm square.

They have ten minutes to design and model a solution.

Design Challenge

Learners to design and engineer a roof structure that will span an area of 500mm x 300mm with specific constraints on the materials and construction methods used.

Design and Make Challenge

Set the learners one of the challenges from a choice of seven available from the STEM resources website in which they have an opportunity to explore the strength and stability of structures and a variety of resistant materials.

Video Case Studies

Various videos about the history of different structures and how advances in technology have impacted our ability to build ever bigger structures. These could be used as a basis for case studies of reinforcements (the episode on brides has a section about the latter).

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Structural Engineering 1	STEM	https://www.stem.org.uk/elibrary/resource/33124	Using a case study, learners investigate the design of the 3Arena building in Dublin and Stansted Airport in terms of structure. They look specifically at the requirements of the building and the constraints in terms of structural design and also the solution provided.	Thinking Contextually	6.1.a, 6.1.b, NEA 8.a
Structural Engineering 2	STEM	https://www.stem.org.uk/elibrary/resource/33125	This practical activity challenges learners to design and engineer a roof structure that will span an area of 500mm x 300mm with specific constraints on the materials and construction methods used.	Thinking Contextually	6.1.a, 6.1.b, NEA 8.a
Structures Post-16	STEM	https://www.stem.org.uk/resources/elibrary/resource/28115/structures-post-16	Produced by the Technology Enhancement Programme (TEP), this book contains five design and make challenges and seven study files. The materials and activities help learners to investigate structures and the use of resistant materials.	Thinking Contextually	6.1.a, 6.1.b, NEA 8.a
Big, Bigger, Biggest	YouTube - Playlist	https://www.youtube.com/playlist?list=PLIGI3jMsdCeytvXraO07n-SnOVxXorvfBR	Various videos about the history of different structures and how advances in technology have impacted our ability to build ever bigger structures. These could be used as a basis for case studies of reinforcements (the episode on brides has a section about the latter).	Thinking Conceptually, Thinking Contextually	6.1.a, 6.1.b, NEA 8.a

Learner Activity

Design and Make Challenge – Space Frame Structures

Introduction

By the end of the lessons, learners will be able to:

- understand how and why some materials and/or system components need to be reinforced or stiffened to withstand forces and stresses to fulfil the structural integrity of products
- design and make a model of a free-standing framed structure capable of carrying a set weight.

The activity

Teachers to go through the study files provided in the TEP resource (https://www.stem.org.uk/resources/elibrary/resource/28115/structures-post-16) to introduce the basic principles of space frame structures and the structural elements that make up a frame, including the properties desired, forces at work, and joints in a structure.

The teacher should provide a particular scenario for the design and make task, such as: small exhibition system, consumer product - CD storage stack, consumer product - floor standing lamp. The learners should be given materials (e.g. rolled paper tubes, spaghetti) to model a space frame structure fulfilling the scenario provided. The final model could be tested to check for performance.

Extension activities/questions:

How could the model be manufactured into a final product – which material, form of supply, joints would be used?

Sub Topic 3: Mechanics in Design Engineering

Exam content

6.2 How do mechanisms provide functionality to products and systems?

a. Demonstrate an understanding of the functions that mechanical devices offer to products, providing different types of motion, including:

   i. rotary

   ii. linear

   iii. reciprocating

   iv. oscillating.

b. Demonstrate an understanding of devices and systems that are used to change the magnitude and direction of forces and torques, including:

   i. gears, cams, pulleys and belts, levers, linkages, screw threads, worm drives, sprockets, chain drives and belt drives

   ii. epicyclic gear systems

   iii. bearings and lubrication

   iv. efficiency in mechanical systems.

6.3 What forces need consideration to ensure structural and mechanical efficiency?

a. Demonstrate an understanding of static and dynamic forces in structures and how to achieve rigidity, including:

   i. tension, compression, torsion and bending

   ii. stress, strain and elasticity

   iii. mass and weight

   iv. rigidity

   v. modes of failure.

Thinking conceptually

General approaches:

6.2

a. Learners should be able to distinguish between the different types of motion:

- rotary: turning in a circle
- linear: moving in a straight line
- reciprocating: moving backwards and forwards in a straight line
- oscillating: swinging from side to side.

Discussion of examples and having learners analyse different mechanisms to identify the types of motion would be helpful.

b. Learners should be able to differentiate between the different types of mechanisms and the type of motion transfer possible through their use. They should be able to carry out the calculations for velocity ratio, mechanical advantage, output speed, etc. linked to the various types of mechanisms. From there, they should be able to come up with ways of improving the efficiency of mechanisms with bearings and lubrication to reduce friction.

6.3

a. Learners should be able to understand the mechanics and interaction of tension, compression, torsion and bending forces, and calculate forces in simple structures. They should material properties such as stress, strain, elasticity, mass and weight affect the forces involved in a structure. They should also develop an appreciation for the main modes of failure: fracture, yielding, stiffness, buckling, fatigue and creep.

Common misconceptions or difficulties learners may have:

Learners can sometimes find distinguishing between linear and reciprocating motion or between rotary and oscillating motion difficult, so it is important that the teacher uses contextual examples to illustrate the types of motion.

Similarly, using physical models or animations to demonstrate the types of mechanisms is important so that the learners can picture how they work and see examples of different systems, such as, compound gear trains, pulley systems, etc. and the mechanical advantage they bring.

For forces, having the learners carry out tests or experiments with material samples where possible, really helps to reinforce the understanding behind stress and strain leading to failure.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The systems approach of Input-Process-Output can be applied to both mechanical and electronic systems. Learners should know that inputs are sensing components, processes being the operations performed in order to produce outputs in the form of light, sound or actuation.

Learners must be able to apply the knowledge developed in this topic holistically with the mechanisms topic in the problem solving paper to come up with workable design solutions to the contextual question posed.

Knowledge of various calculations of forces is necessary across the topics of levers and structures. This can also be linked to materials properties and testing, and the implications of modes of failure in operation.

Investigation

Learners should go through a carrousel of physical models of different types of mechanisms with some reference documentation from which they can investigate how the mechanisms work and take notes.

Presentation

Learners to be assigned different types of mechanisms to research each and create a presentation that they then have to deliver to the rest of the group. The teacher should moderate the content and make discuss any misinterpretations or misconception during presentation feedback.

Calculations Exercises

Learners to complete different activities based on forces, moments, gear ratio, etc.

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Mechanisms	Technology Student	http://www.technologystudent.com/cams/camdex.htm	Includes information for research, activities and revision material about mechanisms topics.	Thinking Conceptually, Thinking Contextually	6.2a, 6.2b, 6.3
Design Technology: Mechanisms	Focus Educational Software	https://www.focuseducational.com/product/design-technology-mechanisms/38	Includes information for research, quizzes and revision material about mechanisms topics	Thinking Conceptually, Thinking Contextually	6.2a, 6.2b, 6.3
Mechanical Calculations	Khan Academy	https://www.khanacademy.org/	Videos explaining the method to carry out mechanics calculations	Thinking Conceptually	6.2b, 6.3

Specification content (Sub Topic 4)

Sub Topic 4: Electronic systems in Design Engineering

Exam content

6.4 How can electronic systems offer functionality to design solutions?

a. Demonstrate an understanding of how electronic systems provide input, control and output process =functions, including:
   - i. switches and sensors, to produce signals in response to a variety of inputs
   - ii. programmable control devices
   - iii. signal amplification
   - iv. devices to produce a variety of outputs including light, sound, motion.

b. Demonstrate an understanding of the function of an overall system, referring to aspects including:
   - i. passive components: resistors, capacitors, diodes
   - ii. inputs: sensors for position, light, temperature, sound, infra-red, force, rotation and angle
   - iii. process control: programmable microcontroller
   - iv. signal amplification: MOSFET, driver ICs
   - v. outputs: LED, sounder, solenoid, DC motor, servo motor, stepper motor, piezo actuator, displays
   - vi. analogue and digital signals and conversion between them
   - vii. open and closed loop systems including feedback in a system and how it affects the overall performance
   - viii. sub-systems and systems thinking.

c. Demonstrate an understanding of what can be gained from interfacing electronic circuits with mechanical and pneumatic systems and components, such as:
   - the ability to add electronic control as an input to mechanical or pneumatic output
   - the use of flow restrictors to control cylinder speed
   - the use of sensors to measure rotational speed, strain/force, distance.

d. Demonstrate an understanding of networking and of communication protocols, including:
   - i. wireless devices, such as: RFID, NFC, Wi-Fi, bluetooth
   - ii. embedded devices
   - iii. smart objects
   - iv. networking electronic products to exchange information.

e. Demonstrate an understanding of the basic principles of electricity, including:
   - i. voltage
   - ii. current
   - iii. Ohm's law
   - iv. power.

6.5 How can programmable devices and smart technologies provide functionality in system design?

a. Demonstrate an understanding of how smart materials change the functionality of engineered products, such as:
   - colour changes, shape-shifting, motion control, self-cleaning and self-healing.

b. Demonstrate an understanding of how programmable devices are used to add functionality to products, relating to coding of and specific applications of programmable components, such as:
   - how they incorporate enhanced features that can improve the user experience and solve problems in system design
   - how they use basic techniques for measuring, controlling, storing data and displaying information in practical situations electronic prototyping platforms and integrated development environments (IDE) for simulation in virtual environments
   - the use of programmable components and microcontrollers found in products and systems, such as robotic arms or cars
   - creating flowcharts to describe processes and decisions within a process to control input and output components.

Thinking conceptually

General approaches:

Learners will have to understand how different electronic components work and interact in circuits, taking input from sensors then processed by discrete components or microcontrollers to produce outputs in light, sound or motion. They will need to be able to use block diagrams, circuit symbols diagrams and flowcharts to produce design ideas in electronics and programming. Learners should be able to carry out basic calculations such as resistance, capacitance, Ohm's Law and frequencies among others, so that they can make decisions on component choices. They should ideally know a number of basic circuits such as light-sensing, heat-sensing and latching circuits that are the basis for more complex circuitry. It is important that learners be confident with breadboarding or CAD circuit modelling so that they can model and test out their ideas. This should be coupled with scientific methods when observing, recording and storing data from their modelling experiments.

For programming, they should be exposed to Raspberry Pis and Arduinos that are good, easily accessible DIY electronic prototyping platforms for simple projects.

Common misconceptions or difficulties learners may have:

Learners may confuse some of the component symbols which look similar so regular recapping is necessary to ensure they consistently identify component correctly. They should be aware that different components could be used to achieve the same function whether they be input, process or output, e.g. LDR and photodiode as light sensors. They will need to clearly distinguish between analogue signals that can have a range of values and digital signals which are only on and off, and which types of electronic components fall under each category. The differentiation between closed loop and open loop systems is key to designing automated solutions in their NEA project. For electronic calculations, the use of the Ohm's Law and Power triangle helps with learners' understanding of the changing of subject of formula.

Smart materials should not be confused with new materials as they are specifically materials which properties change to react to an environmental stimulus.

For programming, learners should be exposed to different platforms but should make the distinction between the coding languages. They should understand that some blocks of code are common to program and could just be modified to suit their needs rather than start from scratch for every project. Flowchart symbols can sometimes be confusing as they may vary from one software to another, so learners will need to be able to adapt to whichever package is available.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

The systems approach of Input-Process-Output can be applied to both mechanical and electronic systems. Learners should know that inputs are sensing components, processes being the operations performed in order to produce outputs in the form of light, sound or actuation.

Learners must be able to apply the knowledge developed in this topic holistically with the mechanisms topic in the problem solving paper, to come up with workable design solutions to the contextual question posed.

Thinking contextually

Breadboarding Projects

Learners are given different types of circuits (light sensing, heat sensing, relays, etc.) to build to investigate how they work.

Simulation Projects

Learners are given different types of circuits (light sensing, heat sensing, relays, etc.) to build to investigate how they work.

Presentation/Revision Cards

Learners given a set of components to research and create a presentation or revision cards. These can then be shared among the group.

Calculations Exercises

Learners to complete different activities based on Ohm's Law, etc.

Smart Materials Handling Box

The smart materials handling case contains a vast array of smart and unusual materials and is ideal for those required to give presentations or demonstrations about materials.

Smart Materials Videos

Use video case studies of real-life applications of different smart materials.

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Top 10 Breadboard Projects for Beginners in Engineering	Elprocus	https://www.elprocus.com/breadboard-projects-for-engineering-learners/	10 breadboarding basic projects to set the learners.	Thinking Contextually	6.4a, 6.4b, 6.4c, 6.4d, 6.4e, 6.5a, 6.5b
Electronics for Learners, Teachers and Engineers	EduTek	http://www.edutek.ltd.uk/index.html	Resources to help with the NEA with exemplar circuits and projects that learners can look up for reference.	Thinking Contextually	6.4a, 6.4b, 6.4c, 6.4d, 6.4e, 6.5a, 6.5b
Electronics	Technology Student	http://www.technologystudent.com/elec1/elecex.htm	Includes information for research, activities and revision material about electronics topics.	Thinking Contextually	6.4a, 6.4b, 6.4c, 6.4d, 6.4e, 6.5a, 6.5b
Kitronik University	Kitronik	https://www.kitronik.co.uk/blog/kitronik-university/	Various worksheets, activities and quizzes on electronics.	Thinking Contextually	6.4a, 6.4b, 6.4c, 6.4d, 6.4e, 6.5a, 6.5b
Electrical Engineering	Khan Academy	https://www.khanacademy.org/science/electrical-engineering	Videos explaining the method to carry out electronics calculations.	Thinking Contextually	6.4e
Smart Materials Handling Box	Mindsets	https://mindsetsonline.co.uk/shop/smart-materials-handling-box/?productID=3a7e6844-dc7b-4928-b92b-a7c5a0e4cd42&catalogueLevelItemID=931c9c38-7585-4c65-afd9-05bfb3d7562	The smart materials handling case contains a vast array of smart and unusual materials and is ideal for those required to give presentations or demonstrations about materials.	Thinking Contextually	6.5a
A Quick Guide to Smart and modern Materials	YouTube	https://www.youtube.com/watch?v=FgrIDibPmJo	A short intro video to a few smart and modern materials being used in Design and Technology.	Thinking Contextually	6.5a

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Smart Materials Playlist	YouTube	https://www.youtube.com/watch?v=rYIWfn2Jz2g&list=PL669D46485A589D27	A playlist of different video case studies of smart materials applications.	Thinking Contextually	6.5a
RFID Case Studies	RFID Journal	https://www.rfidjournal.com/manufacturing/case-studies	A number of case studies focusing on the use of RFID in the manufacturing industry.	Thinking Contextually	6.5a

Learner Activity

Electronic Components and Simulation – e.g. resistors

Introduction

By the end of the lesson, learners should be able to:

- understand how electronic systems provide input, control and output process functions
- understand the function of an overall system referring to aspects of discrete components.

The activity

Teachers to go through basic principles of electronics and introduce Ohm's Law, identifying resistor colour codes (using the resistor table or colour wheel), resistors in series and resistors in parallel. Learners to attempts some activities related to Ohm's Law and resistance calculations.

Learners to use Yenka Technology (or other circuit simulation software available) to build and simulate a number of resistor circuits and test how different resistor values affect the circuit. Alternatively, have learners use breadboards to build and simulate the circuits physically. Learners can take notes of changes seen when modifying resistor values and sensor positions in the circuit(s).

Extension activities/questions:

Circuits can be extended from simple resistor circuits to potential divider, light sensing, heat sensing and pressure sensing circuits.

Specification content (Sub Topic 2)

Sub Topic 5: Ensuring structural integrity

Exam content

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, such as:

- triangulation
- plastic webbing
- reinforcing.

NEA content

a. Apply technical principles appropriately to ensure functional requirements are achieved when developing a design solution.

General approaches:

Learners should be given the opportunity to compare different structures both reinforced and non-reinforced, and look at how the forces act. This could be through simple physical models or using finite element analysis (FEA) in CAD models with learners being able to see the colour-coded stresses and strains in the latter option. Reinforcement can be exemplified by natural structures as well, such as honeycombing and shells that essentially present the fundamentals repeated when considering reinforcement in engineering. Having learners model some structures will also help with reinforcing that knowledge practically. Components and knock-down fittings used for reinforcements should also be explored.

Common misconceptions or difficulties learners may have:

Learners will need to have some background knowledge of forces within a structure regarding tension, compression, etc. so they can then make informed decisions about the reinforcement required. They should also differentiate between the direction of forces, e.g., Longitudinal, lateral or axial, that would have an impact on the type of reinforcement used.

Conceptual links to other areas of the specification – useful ways to approach this topic to set learners up for topics later in the course:

NEA 5. 'Material considerations'

Learners will need a mastery of this topic in conjunction with forces in structures to have an appreciation of factors affecting their design decisions and material considerations when completing their NEA. They will need to consider material properties and, based on modelling and testing, make iterative changes to improve their outcome(s).

Thinking contextually

Model Studies

Provide different models of reinforced and non-reinforced structures and have learners compare them.

Challenge - Moving House

This activity sheet for learners will enable them to demonstrate the idea of reinforced materials and conclude which is the best to choose for a specific task, in this case, constructing buildings resistant to earthquakes and high winds. The work of a structural engineer is also profiled.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Moving House	STEM	https://www.stem.org.uk/elibrary/resource/28103	This activity sheet for learners will enable them to demonstrate the idea of reinforced materials and conclude which is the best to choose for a specific task, in this case constructing buildings resistant to earthquakes and high winds. The work of a structural engineer is also profiled.	Think Contextually	6.1.a, 6.1.b, NEA 5.a

Learner Activity

Moving House

Introduction

By the end of the lesson, learners should be able to:

- understand how and why specific materials and/or system components need to be reinforced or stiffened to withstand forces and stresses.

The activity

Teachers introduce the topic of reinforcements and types of reinforcement techniques available.

Learners to imagine that they need to build in a possible earthquake area. This task looks at making the strongest jelly, that will move but not break under vibration – remember we do not want too much wobble!

Learners to follow the instructions for their particular jelly, but use approximately a quarter less water than the instructions state, then pour into a cup, only filling halfway. They then make another batch, but before pouring arrange one of the other materials in the cup. They should remember not to overfill the jelly with material. This is repeated for the number of jellies/materials you have available. Note: each group to try a different material or structural reinforcement to shorten the length of the activity.

Jellies with different structural reinforcements left to set. Once set, they should be placed on the jitterbug for testing timed at 3 minutes. The aim is to see which reinforced jelly can withstand the vibrations the best from the observation of wobble and/or breakage during testing.

Extension activities/questions:

How can we reinforce space frame structures?

The small print

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