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A LEVEL

Delivery Guide

DESIGN AND TECHNOLOGY

H404, H405, H406
For first teaching in 2017

Topic Area 7: Manufacturing Processes and Techniques – Design Engineering

Version 1

Contents

TOPIC AREA 7: MANUFACTURING PROCESSES AND TECHNIQUES – DESIGN ENGINEERING

Introduction

A LEVEL
DESIGN AND TECHNOLOGY

A guide to approaching the teaching of the content related to Topic Area 7: Manufacturing Processes and Techniques – 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

Specification content (Sub Topic 1)

Sub Topic 1: Making iterative models

Exam content

7.1 How can materials and processes be used to make iterative models?

a. Understand that 3D iterative models can be made from a range of materials and components to create block models and working prototypes to communicate and test ideas, moving parts and structural integrity.

b. Demonstrate an understanding of simple processes that can be used to model ideas using hand tools and digital tools, such as rapid prototyping, or digital simulation packages.

NEA content

c. 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.

d. Select and use appropriate processes and techniques to demonstrate practical making skills with hand, machine and digital technologies through the creation of models, simulations and final prototypes. Reflecting on the effectiveness of the processes and techniques used.

Thinking conceptually

General approaches:

Different prototypes explore different aspects of an intended design: proof of principle prototype, working prototype, visual prototype, user-experience prototype, functional prototype and paper prototype. Learners should appreciate that the need for the model/ prototype will determine the type of material or component used to create it. Focused Practical Tasks (FTPs) would be valuable in learners experimenting with different materials (such as card, foam board, grey board, etc.) using hand tools (such as craft knives, paper drills, etc.) or machines (such as hot wire sculptors) to produce models. Using CAD, they could experiment with creating models that they can then run finite element analysis (FEA) on to test them and then make iterative improvements based on their findings. Learners should be proficient and confident in the use of hand, machine, and digital technologies so that they can make informed choices in their NEA project and working independently.

Common misconceptions or difficulties learners may have:

Some learners may find distinguishing between different types modelling materials challenging and will require exposure to suitable examples to gain an understanding of distinguishing features and properties of the materials. Learners should be encouraged to carry out material sample tests to experiment with the properties, texture, and quality of model they could obtain from different material types to suit the requirements of their NEA project. They should also be able to appreciate the difference in finishes that can be achieved by hand and machine tools. Regarding CAM, learners may find it difficult to distinguish between different milling strategies.

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 topic lends itself well to product analysis and design generation in a mini-project, where learners could be given products to disassemble, make sketches of their features and parts and then use modelling to generate design proposals. That would reflect the iterative nature of the NEA and help learners develop skills required.

Thinking contextually

Model Project

Learners to be given a brief and specification of a product to model. The project should provide opportunities to develop their skills in part modelling, assemblies and output to CAM.

The STEM resource allows learners to design and model a 3D robot arm.

The Envisage UK resource attached allows learners to design and model a desk lamp.

Tutorials

These can be class tutorials or self-paced tutorials based on printed or video resources available.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Additional description detail	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
3D Modelling	STEM	https://www.stem.org.uk/elibrary/resource/35177	In this activity learners design and model a 3D robot arm. Robot arms are an example of a programmable system. In this series of activities, learners will design and model the physical elements of a robot arm, produce a 3D model of a robot arm.	This activity assumes that learners have previously made a 2D model of a robot arm. The teacher notes give clear and comprehensive details on how the activities are to be delivered.	Thinking Contextually	7.1.a, 7.1.b, NEA 7.c, 7.d
Introduction to Fusion 360: Design a Lamp in an Hour	Autodesk Design Academy	https://academy.autodesk.com/course/88151/introduction-to-fusion360-design-a-lamp-in-an-hour	This training guide is a self-guided tutorial for learners to develop their modelling skills in Fusion 360 through a desk lamp design project.	This allows the learners to familiarise themselves with different tools and features of Fusion 360 through both solid- and freeform-modelling.	Thinking Contextually	7.1.a, 7.1.b, NEA 7.c, 7.d
Fusion Tutorials	Autodesk	https://www.youtube.com/user/AutodeskFusion360	These video tutorials are self-guided for learners to learn different aspects of Fusion 360.	This channel contains loads of videos dedicated to teaching resources, and tips and best practices for Fusion 360.	Thinking Contextually	7.1.a, 7.1.b, NEA 7.c, 7.d

Learner Activity

Introduction to Fusion 360: Design a Lamp

Introduction

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

- understand that 3D iterative models can be made from a range of materials and components to create block models and working prototypes to communicate and test ideas, moving parts and structural integrity.

The activity

Teacher to print out and photocopy the resource (https://academy.autodesk.com/course/88151/introduction-to-fusion360-design-a-lamp-in-an-hour) and provide to the learners. Alternatively, learners could use an electronic copy at the PC they are using to access Fusion 360.

Learners to follow the step-by-step guide to create the model for a desk lamp. They can also access video tutorials via the AutoDesk Fusion 360 YouTube channel (https://www.youtube.com/user/AutodeskFusion360) for further guidance. They could then make iterative changes to the lamp to personalise it to their own design.

Extension activities/questions:

Learners could apply Finite Element Analysis to their model(s) to check for stress and strain points based on different material types or load points.

Specification content (Sub Topic 2)

Sub Topic 2: Making final prototypes in a workshop

Exam content

7.2 How can materials and processes be used to make final prototypes?

a. Understand how to select and safely use common workshop tools, equipment and machinery to manipulate materials by methods of:

   i. wastage/subtraction processes such as cutting, drilling, turning, milling

   ii. addition processes such as soldering, brazing, welding, adhesives, fasteners

   iii. Deforming and reforming processes such as bending, vacuum forming.

b. Demonstrate an understanding of the role of computer-aided manufacture (CAM) and computer-aided engineering (CAE) to fabricate parts of a final prototype:

   i. additive manufacturing (3D printing) to fabricate a usable part

   ii. subtractive CNC manufacturing such as laser/plasma cutting, milling, turning and routing.

c. Demonstrate an understanding of measuring instruments and techniques used to ensure that products are manufactured accurately or within tolerances as appropriate.

d. Understand how the available forms, costs and working properties of materials contribute to the decisions about suitability of materials when developing and manufacturing their own products.

NEA content

a. Use appropriate and accurate marking out methods including: consideration and use of reference/datum points; use templates, jigs and/or patterns where appropriate; working within tolerances; understanding efficient cutting and how to minimise waste. Ensuring appropriate accuracy and precision required for their product to fulfil its intended purpose.

b. Select and use appropriate specialist tools, equipment and machinery, both manually and digitally operated, when creating their prototypes, products and systems.

c. Investigate the feasibility and suitability of techniques and processes to be used during the process of designing and making prototypes through experimentation, testing and modelling.

d. Select and use appropriate processes and techniques to demonstrate practical making skills with hand, machine and digital technologies through the creation of models, simulations and final prototypes. Reflecting on the effectiveness of the processes and techniques used.

e. Understand the principles of Design for Manufacture and Assembly (DFMA) to develop design solutions that ensure accuracy and precision are met, and economy and efficiency are achieved.

Thinking conceptually

General approaches:

Learners should be exposed to a wide variety of manufacturing processes as possible within the school workshop, or alternatively via video or industrial visits. They should ideally have some prior knowledge about material properties, forms and costs. They will need to compare the suitability, and pros and cons of processes to be able to make informed choices when tackling their NEA project or design and manufacture questions in the examination.

Key aspects of processes relating to measuring and marking, preparation of billets/samples, and mould design such as datum points, references, offset, draft angles, feed rates, tooling, etc. need to be ingrained to ensure final outcomes are made to a high quality and free of defects.

Common misconceptions or difficulties learners may have:

The difference between additive and subtractive manufacturing processes is sometimes difficult for some learners to grasp via theoretical teaching only, hence recommending practical exposure to the processes within the workshop environment, videos, or industrial visits to ensure that learners can see the piece of equipment in action to draw out how they work.

In the measuring and marking aspects, they need to understand the need to avoid errors such as zero, parallax and compound errors by using reference and datum points. When making, they need to work to within acceptable tolerances and appreciate that different products have different tolerances depending of their use, e.g. an airplane turbine blade having much tighter tolerances than a fan blade.

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

Materials and subsequent manufacturing processes choice will impact on the quality of the outcome for the NEA project and also the cost of the product when the learners have to evaluate the commercial feasibility of their outcome.

Knowledge of materials and manufacturing processes are also a major element of design questions whereby learners will have to outline their reasons for choosing specific materials and components to satisfy the context and specification provided in the question. Regarding manufacturing processes, learners will have to recall the steps to manufacturing processes for contextual product manufacture question.

Thinking contextually

Focussed Practical Tasks

Learners to be given material samples that they then have to use as part of a carousel to learn about the use of different processes.

Short Projects

Short design and make projects based around one particular family of material where learners have to manufacture a product based on a given set of criteria. Alternatively, the product could be set by the teacher so that learners can only focus on manufacturing skills. e.g. a wire cutter made out of mild steel could cover measuring and marking, cutting, drilling, filing, polishing, and a number of fixtures such as pop rivets or bolts and nuts.

Demonstrations/Videos

The teacher to demonstrate or show videos of the use of different tools and equipment suitable for a particular material type.

Revision Cards

Learners to be assigned particular tools or piece of equipment for a material type and have to create revision cards about the technique used and possible applications. This would also help learners in tackling design questions in the examination aspect of the course.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Design Technology: Resistant Materials 2	Focus Educational Software	https://www.focuseducational.com/category/item/2	Resistant Materials for Design Technology KS3, GCSE and A Level project work is simply the most comprehensive and useful project work database available today. This Design Technology program includes information and prices for most materials, components and fittings found in DT Resistant Materials design projects.	Thinking Conceptually	7.2.a, 7.2.b, 7.2.c, 7.2.d, NEA 7.a, 7.b, 7.c, 7.d, 7.f
Fundamental Manufacturing Processes	YouTube	https://www.youtube.com/playlist?list=PL3AFB507B668AF162	SME's award-winning video series on fundamental manufacturing processes	Thinking Contextually	7.2.a, 7.2.b, 7.2.c, 7.2.d, NEA 7.a, 7.b, 7.c, 7.d, 7.f

Learner Activity

Mini Project – e.g. Bottle Opener

Introduction

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

- understand how to select and safely use common workshop tools, equipment and machinery to manipulate materials.

The activity

Learners to be set a mini-project by the teacher where they will make use of a variety of measuring and marking and making tools and equipment.

Teacher to demonstrate the variety of tools and equipment used before the task or break delivery into chunks which are covered as learners get to certain milestones within the measuring or making step.

Learners to be given a mild steel blank from where they will need to measure and mark a bottle opener accurately based on a given engineering drawing. Once marked, they should have it checked by the teacher who can then give feedback upon which the learners have to make changes if required.

Learners to use the tools and equipment to waste the material blank into the shape required.

Extension activities/questions:

Learners could mould a handle in polymorph as an extension into ergonomic design for the user and also cover joining of sub-parts into a main assembly.

Specification content (Sub Topic 3)

Sub Topic 3: Manufacturing commercial products

Exam content

7.3 How can materials and processes be used to make commercial products?

a. Demonstrate an understanding of the industrial processes and machinery used for manufacturing component parts in various materials, including:

   i. polymer moulding methods, such as injection moulding, blow moulding, compression moulding and thermoforming

   ii. metal casting methods such as sand casting and die casting

   iii. sheet metal forming methods using equipment such as punches, rollers, shears and stamping machines.

b. Demonstrate an understanding of the industrial methods used for assembling electronic products, including:

   i. surface mount technology (SMT)

   ii. PCB assembly using solder stencils, pick-and-place machines and reflow soldering ovens.

c. Demonstrate an understanding of the benefits and flexibility of using computer-controlled machinery during industrial production, such as:

   - automated material handling systems
   - robot arms to stack, assemble, join and paint parts.

d. Understand the necessity for manufacturers to optimise the use of materials and production processes, such as:

   - economical cutting and costing, ensuring cost effective production for viability
   - working to a budget through efficient manufacture and making the best use of labour and capital throughout the design and manufacturing process.

NEA content

e. Understand manufacturing methods, scales of production and quality to ensure their final prototype of their design solution meets identified stakeholder requirements.

f. Understand the principles of Design for Manufacture and Assembly (DFMA) to develop design solutions that ensure accuracy and precision are met, and economy and efficiency are achieved.

Thinking conceptually

General approaches:

This topic will be best delivered through a combination of theory and practical lessons where possible, to give learners have an opportunity to see manufacturing processes in action through demonstrations or to try them out for themselves.

Debates and group discussions will work well for developing pupils' confidence and knowledge in the capabilities of different processes, especially weighing in the pros and cons of each. Learners will need to be aware about the possible restrictions on the choice of manufacturing process due to design factors or material properties dictating that decision. Lots of video and animation content can be used to exemplify the manufacturing processes to learners.

Where possible, industrial visits to local factories with highly automated assembly lines would be beneficial for learners to see how things work contextually.

Common misconceptions or difficulties learners may have:

Differentiating the different manufacturing processes based on their suitability to the various families of materials can be a challenge for learners due to the size of the 'database' they are required to memorise, e.g., typical materials used for injection moulding are ABS, Nylon, PC, PP and PS. They may find that creating revision cards on each with sketches to help them with step-by-step description of the manufacturing processes.

Learning the new terminology relating to specific manufacturing processes (e.g., parison, flash, etc.) and automation will be a challenge for some pupils. Again, the use of case studies will be useful, as will flash cards to enable the new terminology to become embedded into learners' vocabulary.

Rote learning plays only a small part in the delivery of this topic, with learners' knowledge will be examined on their ability to apply and analyse the information in front of them to make and justify correct manufacturing decisions based on a design rather than just recall.

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 topic could be linked to product analysis activities to have learners identify the manufacturing processes based on the product features and finish. Knowledge of manufacturing processes will be beneficial to create a commercially viable for their NEA project, e.g., some may choose to etch or mill their PCBs for their iterative project outcome. Scale of production can be linked to sustainable design, industrial systems of automation and Total Quality Management.

Thinking contextually

Demonstrations/Animations/Videos

Where possible in the school workshop, teachers can deliver demonstrations of the manufacturing processes. Otherwise, there are a variety of step-by-step guides, animations and videos available on YouTube as well as specialist websites such as:

- British Plastics Federation (BPF) for plastics.
- The Library of Manufacturing for metals.

Industrial Visits

Organise a visit to a local factory, e.g., Coca Cola in Edmonton, North London, to see automated industrial systems in action.

Case Studies

Learners to read through different case studies of badly designed products and workspaces and 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
A-Z Plastic Processes	British Plastic Federation	http://www.bpf.co.uk/plastipedia/processes/Default.aspx	Overview of plastics manufacturing processes with information on typical materials used and typical products produced. It also includes animations for main processes.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f
Casting, Forming and Powder Processes	The Library of Manufacturing	http://thelibraryofmanufacturing.com/index.html	Step-by-step guides about different metal casting, forming and powder metallurgy processes.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f
Design Technology: Metals Manufacturing Processes	Focus Educational Software	https://www.focuseducational.com/category/item/2	Focus on Metals: Manufacturing Processes interactive learning resource examines the main techniques that a Design Technology learner will come across when studying Engineering at GCSE or A Level. Focus on Metals provides an excellent way of bringing examples of industrial practice into the classroom.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f
Design Technology: Plastics Manufacturing Processes	Focus Educational Software	https://www.focuseducational.com/category/item/2	Focus on Plastics interactive software program and VLE SCORM package examines the 8 main manufacturing techniques studied in Design Technology at KS3, GCSE and A Level. Each topic includes a simulation of the process and a wealth of detailed information and photographs.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f
Circuit Skills: Surface Mount Devices	Make:	https://www.youtube.com/watch?v=ihoX7x0RBz8	Join Collin Cunningham as he explores the oh-so-tiny world of surface mount electronics. Follow along as he constructs what may be the world's smallest phototheremin all in super-macro detail.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f
Surface Mount technology Assembly Line	Marl International Ltd	https://www.youtube.com/watch?v=WfK185zO7o0	A video of the new Marl production line at Ulverston that can assemble 22,000 surface mount components per hour.	Thinking Contextually	7.3.a, 7.3.b, 7.3.c, 7.3.d, NEA 7.e, 7.f

Learner Activity

Demonstration/Animations/Video – Notes Taking

Introduction

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

- demonstrate an understanding of the industrial processes and machinery used for manufacturing component parts in various materials.

The activity

Teacher to demonstrate the variety of industrial processes using workshop facilities if possible, or can use animation and videos available online.

Learners to take notes of the industrial processes seen to include: step-by-step sketches of the processes (this will help for manufacturing questions in the exam), materials that can be processed using that particular method, advantages and disadvantages, and typical products made. This can be supplemented by additional individual research online.

Learners could be assigned a specific manufacturing process and asked to deliver a presentation about it. Alternatively, this could be turned into a revision game such as blind date, where learners have to identify the manufacturing processes based on their characteristics or properties.

Extension activities/questions:

Learners could be given different products to suggest which type of industrial process they think would be most suitable manufacture the product and give arguments to support their decision.

Specification content (Sub Topic 4)

Sub Topic 4: Manufacturing to different scales of production

Exam content

7.4 How is manufacturing organised and managed for different scales of production?

a. Understand how and why different production methods are used when manufacturing products, dependent on market demand, including:

   i. one-off and bespoke, batch and high volume production systems

   ii. modular/cell production systems

   iii. lean manufacturing

   iv. just-in-time manufacture

   v. fully automated manufacture.

b. Understand how ICT and digital technologies are changing modern manufacturing:

   i. customised manufacture systems

   ii. rapid prototyping

   iii. additive and digital manufacture methods

   iv. stock control, monitoring, purchasing logistics in industry.

NEA content

c. Understand manufacturing methods, scales of production and quality to ensure their final prototype of their design solution meets identified stakeholder requirements.

Thinking conceptually

General approaches:

This topic can be delivered with a mixture or rote theory lessons, case studies and simulations. Learners need to be able to differentiate between the 3 methods of production based on the output volume. They should be familiar with the features, pros and cons of each method of production. An appreciation of how production systems and factory layout have an impact on costs, speed, flexibility, stock, efficiency and quality among the many elements of manufacturing. That should be linked to the commercial viability of products that are designed and engineered.

Additionally, the use of ICT and automation have had similar impact on the manufacturing and business elements mentioned above. Learners should be aware of the changes brought about by the advance of digital technologies which are giving rise to fully CAM operated manufacturing facilities such as the Adidas 'Speed Factory' and also effectively empowering entrepreneurs and help launch start-ups.

Common misconceptions or difficulties learners may have:

Learners may sometimes misunderstand the volume of products where the context may be ambiguous, e.g. a pair of branded trainers that are mass produced but may also include an element of one-off/bespoke production if they are personalised with the customer's name. They should also recognise that manufacturing may use a combination of production systems rather than stand-alone solutions only like in the case of lean manufacturing and Just-in-Time that are generally used in conjunction whereby the latter is used to achieve the lower stock levels desired in the former.

The distinction between various methods of additive or subtractive rapid prototyping and digital manufacturing must be made clear to the learners, e.g. Fused Deposition Modelling (FDM), laser sintering, stereolithography, etc.

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

Production methods and systems could be delivered alongside 7.5 to include Total Quality Management via case studies so that learners can see the holistic impact that these strategies have on both the manufacturing and commercial aspects of a business.

The rapid prototyping and digital manufacturing could be linked to 7.1 and 7.2 when considering model making and the use of CAM methods. Learners could be assigned a contextual mini-project where they improve an existing product through the use of CAD modelling using CAM to output.

Thinking contextually

Presentation/Identification Activity

Teacher to deliver a presentation about methods of production, their features and advantages and disadvantages followed by an activity where the learners have to identify which method of production for different products.

Learner Presentation Activity

Each learner in a group to be assigned a different production method and systems which they then need to research, prepare a presentation and deliver to the rest of the group.

CAD/CAM and Production Methods Booklet

Learners to complete a number of activities linked to researching CADCAM and production methods.

Case Studies

Learners to go through case studies of companies that use rapid prototyping and digital manufacturing, and their impact on the business.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Additional description detail	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Commercial production methods: One-off, batch or mass production?	OCR	http://www.ocr.org.uk/Images/174407-unit-r110-commercial-production-methods-one-off-batch-or-mass-production-lesson-element-teacher-instructions.pdf	Though this activity is from a Level 1/2 qualification, it forms a good starting point for extension activity. Learners are required to identify, with reasons, which commercial production method might commonly be used to produce a range of items (identified from photographs). Once understood more complex products should be investigated.	The teacher might begin by giving learners an introduction to production methods: one-off production, batch production and mass production giving examples of where each is used and for what reasons. The activity might be undertaken individually or in pairs, and internet research will most likely prove to be a useful source of information. The activity might also be undertaken as a whole-class activity.	Thinking Contextually	7.4.a, 7.4.b, NEA 7.e
CAD/CAM and Production Methods	Boclair Academy – Design Technology Department	http://www.technicaldept.co.uk/Higher%20Product%20Design%20-%20CADCAM%20Production%20methods%20[Compatibility%20Mode].pdf	Activity booklet covering CADCAM and production methods.		Thinking Contextually	7.4.a, 7.4.b, NEA 7.e
Operations: Methods of Production (Overview)	Tutor 2 U	https://www.tutor2u.net/business/reference/operations-methods-of-production-overview	Link to Tutor2U Business resource about methods of operation.		Thinking Contextually	7.4.a, 7.4.b, NEA 7.e

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Additional description detail	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Case Studies - AM reduces production steps, lead time and cost	3T RPD	https://www.3trpd.co.uk/portfolio/am-reduces-production-steps-lead-time-and-cost/gallery/metal-additive-manufacturing-case-studies/	Directing learners to engage with an industrial rapid prototyping company's website, in order to access the case studies of the impact of CADCAM.		Thinking Contextually	7.4.a, 7.4.b, NEA 7.e
Case Studies - Plastic AM mass production of conference gifts	3T RPD	https://www.3trpd.co.uk/portfolio/plastic-am-mass-production-of-conference-gifts/gallery/sls-case-studies/	Directing learners to engage with an industrial rapid prototyping company's website, in order to access the case studies of the impact of CADCAM.		Thinking Contextually	7.4.a, 7.4.b, NEA 7.e

Learner Activity

Case Studies

Introduction

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

- understand how and why different production methods are used when manufacturing products, dependent on market demand
- understand how ICT and digital technologies are changing modern manufacturing.

The activity

Each group of learners to be given a different case study to go through.

Learners to read through the information provided and pick out the decision-making process points and how the implementation of different methods of production or rapid prototyping have had an impact on the business, thus effectively picking out the advantages and disadvantages while developing their evaluative skills.

The final findings could be presented to the rest of the group via a presentation or a shared document to promote collaborative working.

Extension activities/questions:

Once group feedback is completed, the teacher could give a scenario for learners to then analyse and give recommendations for a suitable method of production or RPT to be used in that particular context by providing supporting arguments to back their proposed solution.

Sub Topic 5: Quality control through production

Exam content

7.5 How is the quality of products controlled through manufacture?

a. Understand the processes that need to be undertaken to ensure products meet legal requirements and are high quality:

i. quality control

ii. quality assurance

iii. 'Total Quality Management' (TQM)

iv. European and British standards.

NEA content

a. Understand the principles of Design for Manufacture and Assembly (DFMA) to develop design solutions that ensure accuracy and precision are met, and economy and efficiency are achieved.

b. Understand and apply quality control and quality assurance principles to their project.

Thinking conceptually

General approaches:

Learners should have a clear understanding of the differences between Quality Assurance (QA) and Quality Control (QC) and that they represent sub-systems within the bigger picture that Total Quality Management (TQM) governs. They should be familiar with QC aspects such as tolerances, Defects per Million (DPM), standard deviation and Six Sigma among others. They should appreciate the benefits reaped from the implementation of TQM both from a manufacturing and a commercial aspect of the organisation. It is important that they recognise the need for their designs and outcomes to be designed using the Design for Manufacture and Assembly (DFMA) principle to satisfy both European and British Standards for their products to be commercially viable, especially on the NEA content.

Common misconceptions or difficulties learners may have:

Learners often misconstrue the definitions for Quality Assurance (QA) and Quality Control (QC) where QA is process oriented and is the part of quality management focused on providing confidence that quality requirements will be fulfilled, while QC is product orientated and is the part of quality management focused on fulfilling quality requirements. They need to appreciate that TQM is a long-term improvement cycle that requires the dedication of all members of an organisation in adhering to the eight main elements of TQM (customer-focused, total employee involvement, process-centred, integrated system, strategic and systematic approach, continual improvement, fact-based decision making, communications) which otherwise would not work if implemented discretely.

Learners should understand that DFMA is the combination of two methodologies; Design for Manufacture, which means the design for ease of manufacture of the parts that will form a product, and Design for Assembly, which means the design of the product for ease of assembly.

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 topic could be delivered in conjunction to 7.4 so that learners can have a holistic view of how production methods, systems and TQM all play a role in improving an organisation's efficiency and performance. The QC aspect could be linked to product analysis activities where learners could compare different versions of the same product to check for defects or variations in quality.

The DFMA aspects could be incorporated in the Focused Practical Tasks (FPTs) designed to deliver practical manufacturing processes in using different types of materials so that learners have a context to the outcome that they will be producing.

Thinking contextually

Presentation/Identification Activity

Teachers to deliver a presentation about Quality Assurance, Quality Control and Total Quality Management, their features and advantages and disadvantages followed by case studies which learners have to go through.

Case Studies

Learners to go through case studies of companies that use Total Quality Management, and/or have applied for ISO9001 certification.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Case Studies - Total Quality Management: Three case studies from around the world	European CEO	https://www.europeanceo.com/business-and-management/total-quality-management-three-case-studies-from-around-the-world/	Directing learners to engage with European CEO magazine's website, in order to access the case studies of the impact of TQM.	Think Contextually	7.5.a, NEA 7.f, 7.g
Case Studies - Total Quality Management Implementation and Systems	American Society for Quality (ASQ)	http://asq.org/learn-about-quality/total-quality-management/overview/tqm-gets-results.html	Directing learners to engage with ASQ's website, in order to access the case studies of the impact of TQM implementation.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
BSI Case Study – Shades of Comfort Ltd	BSI	https://www.bsigroup.com/Documents/iso-9001/case-studies/BSI-ISO-9001-ISO-14001-case-study-Shades-of-Comfort-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of ISO 9001 and ISO 14001 to increase sales.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
BSI Case Study - Costain	BSI	https://www.bsigroup.com/Documents/iso-22301/case-studies/Costain-case-study-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of integrating management systems to improve business performance and achieve sustained competitive advantage.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
BSI Case Study – Pentagon Group	BSI	https://www.bsigroup.com/Documents/Kitemark-VDR/case-studies/BSI-Kitemark-Vehicle-Damage-Repair-case-study-Pentagon-Group-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of BSI's Kitemark helping national car body repair network win two new contracts and reassure customers over vehicle safety.	Thinking Contextually	7.5.a, NEA 7.f, 7.g

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
BSI Case Study – Warwick Council	BSI	https://www.bsigroup.com/LocalFiles/en-GB/Kitemark/energy-reduction-verification/case-studies/BSI-KMERV-Case-Study-Warickshire-Council-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of BSI's Kitemark for energy reduction verification helping local authority prove 6% reduction in emissions for buildings and street lighting.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
BSI Case Study – FMG Support	BSI	https://www.bsigroup.com/Documents/lean-six-sigma/case-studies/BSI-Training-lean-six-sigma-case-study-FMG-Support-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of an incident management and fleet services provider using Lean Six Sigma to improve their business to the tune of 800K.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
BSI Case Study – Nippon Gohsei	BSI	https://www.bsigroup.com/Documents/lean-six-sigma/case-studies/Nippon-Case-Study-UK-EN.pdf	Directing learners to engage with BSI's website, in order to access the case studies of the impact of Nippon Gohsei's partnership with BSI to embed a culture of continual improvement.	Thinking Contextually	7.5.a, NEA 7.f, 7.g
Quality in Manufacturing – Case Studies	ASQ	http://asq.org/manufacturing/why-quality/case-studies.html	Some real-world examples of how manufacturers are using quality tools and processes to improve their work and the bottom line.	Thinking Contextually	7.5.a, NEA 7.f, 7.g

Learner Activity

Case Studies

Introduction

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

- understand the processes that need to be undertaken to ensure products meet legal requirements and are high quality.

The activity

Each group of learners to be given a different case study to go through.

Learners to read through the information provided and pick out the QA and QC related points and how the implementation of different quality management techniques and tools have had an impact on the business, thus effectively picking out the advantages and disadvantages while developing their evaluative skills.

The final findings could be presented to the rest of the group via a presentation or a shared document to promote collaborative working.

Extension activities/questions:

Once group feedback is completed, the teacher could give a scenario for learners to then analyse and give recommendations for a suitable quality management technique and/or tool to be used in that particular context by providing supporting arguments to back their proposed solution.

The small print

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