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A LEVEL

Delivery Guide

DESIGN AND TECHNOLOGY

H404, H405, H406
For first teaching in 2017

Topic Area 4: Design thinking and communication – Product Design

Version 1

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Contents

TOPIC AREA 4: DESIGN THINKING AND COMMUNICATION – PRODUCT DESIGN

Introduction

A LEVEL
DESIGN AND TECHNOLOGY

A guide to approaching the teaching of the content related to Topic Area 4: Design thinking and communication – Product Design

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

Link to qualification:

http://www.ocr.org.uk/qualifications/as-a-level-gce-design-and-technology-h004-h006-h404-h406-from-2017/

Specification content (Sub Topic 1)

Sub Topic 1: Techniques for communicating ideas

Exam content

4.1 How do product designers use annotated 2D and 3D sketching and digital tools to graphically communicate ideas?

a. Demonstrate an understanding of how to use annotated sketching and digital tools to graphically communicate ideas and sketch modelling to explore possible improvements, in terms of physical requirements, such as:

- function, usability, construction, movement, stability, composition, strength
- aesthetic qualities
- manufacturing processes
- suitability of materials and components.

b. Demonstrate an understanding of methods used to communicate the construction of design solutions to inform third parties, including:

i. Working/technical drawings

ii. digital visualisations

iii. schematic drawings and lay plans if appropriate

iv. flowcharts with associated symbols

v. prototypes and models.

4.2 How do industry professionals use digital design tools to support and communicate the exploration, innovation and development of design ideas?

a. Demonstrate an understanding of how designers develop products using digital tools and online collaboration, such as:

- discussing and exchanging ideas with specialists
- developing designs concurrently with other designers
- explaining and communicating their design decisions to stakeholders.

b. Demonstrate an understanding of how digital design software is used during product development, such as:

- visual presentation, rendering and photo-quality imaging
- product simulation
- scientific analysis of real-world physical factors to determine whether a product will break or work the way it is intended.

NEA content

d. Apply digital and non-digital skills and techniques that are suitable to the stage of development and record real-time progress throughout an iterative design process, such as:

- informal 2D and 3D sketching and modelling to communicate initial ideas
- system and schematic diagrams, annotated sketches, exploded diagrams, models and written notes, to communicate development iterations
- audio and visual recordings to share thinking, explorations and the functionality of ideas
- formal 2D and 3D working drawings to outline specification requirements; 3D illustrations, mathematical modelling and computer-based tools to present final design solutions; schedules and flow charts to deliver planning
- writing reports and/or summaries to record the thinking process
- presentations and real-time evidence to communicate throughout the project.

Thinking conceptually

General approaches:

Quality, visual communication used throughout the design process is an essential skill and one which is often given too little consideration. It is highly impactful on all aspects that follow from creativity to communicating when working as part of a team. Learners begin the GCE specification with a varying level of ability. It can be highly effective to have induction programmes, which focus on promoting high level communication skills. This often provides learners with the platform to build their skills and give them the ability to reach higher grades through far more effective and reasoned communication techniques.

Creation of an environment that accepts or better still encourages failure in design outcomes often frees learners to experiment and trial more risky ideas. Ideally learners will be instilled with a willingness to fail and are supported by timely feedback with a background of high standards.

Sketching in Product Design should be a key starting point. Poor quality sketching means that learners struggle to convey simple concepts or have difficulty realising them in the first place. It can be observed that learners who are confident in their ability to sketch are often able to evidence a wider breadth of approaches to a problem and communicate the detail of their design thinking with greater levels of clarity.

An integral part of the design process will be modelling. Learners should aim to produce a breadth of models (which, at times, can be very simplistic) to convey ideas and pilot conceptual iterations. Once the core skills have been learned, CAD (Computer-Aided Design) can be a very viable option to allow swift changes to be made to trial small adaptations, especially if the learners have access to rapid prototyping. Staff should be aware of guiding learners in the use of appropriate modelling time, as they will often spend lengthy periods on a single model, which ultimately has little value as they make limited progress from previous prototypes.

A real strength can be seen in using CAD to realise design solutions and iterations. Rapid progression and numerous iterations for UCD (User-Centred Design) can help motivate learners and move them towards higher-order solutions. In addition, well produced CAD models can be used to simulate parts stress, structural strength or problems with mould flow. Clearly, this can have a positive impact on learners using and understanding the correct application of materials and relative thicknesses to designs which will feed into the technical principles outlined in the specification. There are a plethora of different software packages available to help learners. Many are freely available including CAD and rendering software (see **Common misconceptions or difficulties learners may have**' section for additional detail).

Common misconceptions or difficulties learners may have:

In some centres, access to professional quality software packages can be limited due to budgetary constraints. Learners often benefit greatly from working with a range of CAD, rendering and artistic software with high level functionality. This can allow them to present very high quality work, which to do so in other formats, would be a real challenge. Numerous free 3D modelling options are available such as AutoCAD, Creo, and SketchUp. The rendering options in some free versions are limited and centres may consider KeyShot (available for a short free trial or in single seats) or Strata.

Throughout their previous education experience, learners will often have learned bad habits or imprecise techniques. This can hinder progress further along their educational journey and should be tackled early on in the course so they have time to fully implement new skills and benefit from this. At times, this process can put them out of their comfort zone and be heavy going for teachers. However, the long-term benefits of a robust approach, buoyed up with positivity and a clear narrative as to why these actions are being undertaken, will move learners to new levels of ability.

Many learners believe that their ability is set and that they will not improve very far in a given aspect of the course. This is clearly untrue for the majority of learners and they should be introduced to the concept of a 'growth mind-set'. All learners have a range of new skills to learn and develop and are far from the finished article. A 'high expectation' culture will rapidly see benefits if combined with solid, forward-thinking teaching and exemplar material

Given the rapid progress of technology in D&T, teachers can have difficulty keeping abreast of the changes in industry and technological developments, falling back to preferred styles/ methods of working, rather than pushing the boundaries. Promoting learners to become independent learners early on and teaching them research skills to do so effectively will allow them to proactively source and embrace new methodologies. Resources like YouTube and the variety of channels and online materials can help learners to go beyond the prescribed teaching.

Learners often aim for high quality or overly complicated prototypes too early in the design process. This is counter-intuitive and often means they input a great deal of time and learn only a little. They should be guided to complete a wider range of experimental models at a basic level to cover more ground and determine the best approaches and solutions. Higher quality or more detailed models can be produced every so often within the iterative process to evidence quality and ability or to allow more meaningful stakeholder feedback.

Thinking conceptually

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

4.3 Sketching, presentation and modelling skills learnt throughout the induction and early stages of the course will benefit learners in many ways. It often allows them to become more proficient at self-reflection which allows them to access skills needed to be independent learners. Clearly the skills here will be borne out and extensively used in the NEA project.

5.3 With clarity of communication and the ability to convey conceptual designs, learners are likely to look more deeply into outcomes and ultimately all facets of a design, including material properties and selection.

6. a and b. Introduction of CAD software can allow them to understand and apply knowledge regarding material thickness and structure. It also allows the ability to test for these aspects as part of the iterative or final design stages.

7.2 Skills here will all lead to the making of final prototypes, which are based on a range of experimental and incrementally improved design solutions, focused on the user and context of the product's use. CAD skills will also evidently allow production of final prototype components through a range of manufacturing techniques.

Thinking contextually

Start with the basics. Learners often start GCE courses with differing skill sets and ability due to prior attainment, teaching groups or because they join from another centre. Sketching skills are fundamental in terms of learners making rapid progress and being able to explain their conceptual thinking. In addition, it will motivate learners and help them to see their own potential for growth. Often this involves breaking bad habits and adding challenge in terms of precision and accuracy, before building them up with praise and learners' own individual successes. See the **Introduction of Sketching Skills** activity for an ideal induction session.

Instil a formal method for presenting i.e. numbers of images per sheet, prescribed font size from the outset of the course. Teachers can set rules on style and layout through templates or careful instruction and feedback. Exemplar materials can then help learners determine what makes a well laid out sheet or what hinders the communication of information. A marking exercise can be used here utilising a mark scheme, which not only makes learners aware of their goals, but will help them in being more reflective of their own practice. Over time, these presentation skills will become ingrained and can be relaxed, allowing learners to grow (and break the original rules) to develop their own style.

Tasks and mini projects set within the SOW for learners should build in opportunities to practice, revisit and improve skills over the breadth of the course. Learners will greatly benefit from extended practice to allow them to bed in high-order skills.

To help an on-going ethos for excellence, learners need to better understand their own current level and what they specifically need to do in order to progress and improve. Staff can create resources that give learners the ability to gauge their own level of achievement using ranked exemplars. These could be highly effective if broken down into a number of sheets based around the mark bands set out in Strand 3 (AO2) found on page 75 of the specification. Importantly for these bandings to work, teachers will need to dissect the evidenced skills and state what is shown or omitted. In doing so, learners will gain the understanding and insight for them to move forward.

To develop learner's ability to prototype, a series of short and extended modelling tasks can be in put in place. There can be various foci for the modelling sessions. Some can be to help promote fast, basic modelling skills to help understanding of a specific context. An example of this maybe modelling an item to fit on a user's face, such as a dust mask. A range of basic models can be created to improve understanding of fit and comfort. While highly valuable to learners, the freedom to cover-up mistakes will not necessarily improve their modelling accuracy. This can be done though extended tasks which centre on the accurate recreation of existing designs. See the 'Foam Modelling Exemplar' link in the activities section. This modelling assignment requires learners to use templates and higher-order precision to produce a highly accurate representation of a real-world glue gun.

Teaching learners CAD rendering software can be an excellent way to help them to showcase their ability and to allow the creation of professional quality final visuals for stakeholder feedback meetings. A range of tutorials can be found for differing software packages online or built into CAD program 'Help' files. Many CAD systems such as Solidworks and Creo, include a renderer. Often these give good results, but standalone rendering software like Keyshot can advance images to photorealistic standards. Centres with access can further benefit learners by introducing them to DTP (Desktop Publishing) and artistic software such as the Adobe Creative Suite to further enhance their final outcomes.

During the process of embedding core skills, teachers can proactively promote clarity of presentation in their chosen submission format. Often PowerPoint is used as a vehicle to present work for the NEA project and learners will quickly become accustomed to using it. The best learners use it with clarity and obviously carefully consider the final visual appeal of the slides, and look to achieve a professional level of finish. Consideration of overall layout, use of columns for text, raising awareness of unused space, image and font size should all be championed. Pages that are visually exciting are often packed with detail and clearly signpost information whilst avoiding large borders and titles.

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
CAD Tutorials (for staff)	Design Technology TV	https://www.youtube.com/channel/UCrEUBLZSlhI-8Dxx2pBfZRw	Examples of CAD tutorials running Solidworks. Useful for a range of introductions to concepts.	Key resources are missing so the curriculum cannot be simply embedded. However, resources are available to buy.	Content	4.2b
Foam modelling exemplar	Design Technology TV	https://www.youtube.com/watch?v=6n3u5i8Lf8g&t=40s	A breakdown in key stages of a blue foam model glue gun. Ideal for promoting good practice for learners.	A design task can be set for learners to push their skills and get them to engage more fully in high quality sketch model outcomes.	Content	4.1b
Promoting use of Marker Rendering	Design Technology TV	https://www.youtube.com/watch?v=N079MGHcLF0	A break down in key stages of a rendered glue gun. Ideal for promoting good practice for learners.	A design task can be set for learners to push their skills and get them to engage more fully in high quality final outcomes.	Content	4.1b
Resource for sketching techniques and rendering	Sketch-A-Day	https://www.youtube.com/channel/UCBtSgEZk914z5InEs_U2J3w	Daily sketches and videos from designer Spencer Nugent. A range of video tutorials that will inspire and promote high end aspiration.		Content	4.1b

Learner Activity

Introduction of sketching skills

Introduction

For this task you will draw a series of simplistic 3D cube shapes freehand. This is deceptively difficult to get right and requires a range of practice and understanding of how to break bad habits built up over time.

The activity

Learners will undertake a sketching session starting by drawing simple 3D cube shapes. There should be a focus on quality and accuracy in all aspects. This is a teacher led-session and needs constant critique and positive input. Teachers should look at:

- How learners use body geometry (e.g. sketching from wrist producing short arcs and curves) and raise awareness of how a learner's body position impacts sketch quality.
- Line quality
- Line weight
- Line length (straight)
- Angular accuracy.

Extension activities/questions:

Use the skills learned here to develop ability and draw more complicated forms and shapes. More-able learners can be moved rapidly onto using biro as this further develops their ability to use line weight and planning accurately.

Specification content (Sub Topic 2)

Sub Topic 2: Supporting design thinking and problem solving

Exam content

4.3 How do product designers use different approaches to design thinking to support the development of design ideas?

a. Awareness of different strategies, techniques and approaches to explore, create and evaluate design ideas, including:

- iterative designing
- user-centred design
- circular economy
- systems thinking.

b. The importance of collaboration to gain specialist knowledge from across subject areas when delivering solutions in design and manufacturing industries.

c. Understand how design teams use different approaches to project management when faced with large projects, such as critical path analysis, scrum and six sigma.

NEA content

a. Demonstrate an ability to identify and formulate appropriate technical and non-technical specifications reflecting their own investigations and considering stakeholder requirements, including:

- non-technical specifications that cover requirements
- technical requirements that outline the specific requirements needed to support the making of a final prototype.

b. Select and use appropriate methods of communication with stakeholders and users, understanding and applying the principles of user-centred design and other relevant design approaches throughout the iterative design process.

c. Understand how to use communication skills throughout a project, utilising a range of media and presentation techniques appropriate to the project which clarify, record and explain their thinking, and enable others to understand their decisions and intentions.

Thinking conceptually

General approaches:

'Design Thinking' should be embedded in all tasks set, whether explicit or not. There are many ways for learners to tackle design tasks and in early stages, formalising a process and applying a template will reduce the difficulties learners find in beginning or developing projects. As learners' progress they will have a wider breadth of knowledge and will be able to pick their own approach to projects. Fundamentally, the H406 Product Design specification focuses on the iterative design process which should become second nature to learners. Their understanding of the 'Explore', 'Create', and 'Evaluate' cycle will promote well throughout design solutions meeting the needs of stakeholders from all facets of the designed response.

Iterative Design

A cyclical process, focused on refining a design through a continuing process of 'Explore', 'Create' and 'Evaluate' leading to improved outcomes. Creating a series of iterations is a process learners can rapidly understand and implement and is one which dovetails with UCD (User-Centred Design). There is a need to guide learners through the principle of the process, while ensuring they actively participate in astute analysis. Learners should be taught to consider a range of stakeholders and then actively address their needs and requirements to improve the products. Creativity is at the heart of the process and the willingness to trial and experiment.

UCD

User-Centred Design can be placed at the heart of learners design solutions and can be hugely beneficial to avoid designing in isolation or focused on the learners' own priorities or skill sets which can limit/determine responses. The UCD methodology involves learners comprehensively engaging with end-users and using their regular on-going feedback to help iterations and the generation of design refinements towards a highly polished final outcome(s). Issues surrounding UCD often come from learner perceptions that it is hard work to identify, contact and interact with real-world users. Learners should be guided in this process and introduced to it early on to fully understand its wide reaching benefits.

Circular economy

Similar to iterative design, but based around team-led reflection. A focus on gaining the maximum value from the design process with a view to reducing wasted time, money and energy. This methodology is more often used in industry by larger teams, and has an industrial process slant. It can be utilised by groups of learners or in even by individuals, where they are considering design solutions from a manufacturing or financial stakeholder standpoint.

Systems thinking

'Systems thinking' is the cognitive process of studying and understanding a product in context or as part of a system. This will look at the external factors in play (or the environmental context) and how they affect the product. It can be seen that system thinkers act 'now' to improve a system in the future. This means that often, they will make small changes to a concept which they anticipate will have an overall positive impact on the product as a whole. This is then reviewed and repeated to further improve the system.

Common misconceptions or difficulties learners may have:

Learners should be encouraged to experiment widely and tackle issues from a variety of points-of-view. Following a linear approach to a preconceived idea or concept often appears to learners to be the easiest option. However, this often does not reflect or consider more creative outcome opportunities, fails to consider stakeholder needs and this leads to bland solutions to incoherent final designs.

Learners can perceive the use of external stakeholders as difficult and time consuming, despite the very real and positive impact the feedback gained from this has. Sometimes learners will not have arranged regular access to or will simply not frequently communicate with the stakeholders of the project. As such, this means they often design in isolation or even manufacture evidence of feedback which can mean the creative edge of a project is lost. Academic honesty in this respect and a range of opinions when considering the correct path forwards is key in successful iterative design.

At times, the design process loses validity due to over-dependence on a single source of feedback. In some instances, learners may have access to a knowledgeable, primary client. While this access can be a hugely beneficial resource for learners, they need to consider potential bias or the possibility that the opinion of a single stakeholder may not reflect all those with a vested interest. Detailed and well thought-out planning of the design process, using the styles laid out in the 'General approaches' section can help learners to avoid or manage these issues.

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

3.1 Design thinking and planning are closely linked to feasibility study. Underpinning the design process, learners using creative approaches will regularly refer back to and keep track of core requirements through regular review.

6.2 The iterative design process is the primary design methodology laid out in the H406 Product Design specification and, as such, it permeates and impacts on all aspects of the NEA project. Learners who learn to embed and use this approach while taking into consideration other design practices laid out in the specification will likely create highly successful, fully considered projects.

Thinking contextually

Formalising approaches for designing can help learners in avoiding difficulty in formulating early concepts or solutions. Each different project from induction onwards can include a different design approach or include planning in differing formats to simulate different design thinking. This will build learners understanding of best practice and allow them to trial differing working methodologies, and determine which suits them in terms of working practice. In addition, learners who struggle with organisational skills can be set homework to embed a better, more logistical approach to their own working practice and submit evidence of time planning to meet course or mini project requirements.

Having learners undertake projects which follow the exemplar model of the Potato Peeler for an aging population, this can help learners consider and practice differing approaches and will lead to iterative and UCD being well practiced. The project in question requires learners to take on the role of user and 'experience' using the product from the position of an aging member of the community with motor and visual impairment issues. The process introduces learners to understanding stakeholders and will lead them through the UCD process. Other projects can be undertaken following a similar model and push learners to use different design thinking as desired.

Learners should be encouraged to work in collaboration with other learners through design projects and as their confidence and capability grows, they should start working with external stakeholders. Initially, this is likely to mean at a feedback level peers either critiquing their own work or group work. Further into the course, teachers can champion engagement with a broadening range of stakeholders to avoid designing in isolation. Learners can also work collaboratively to plan and manage project workload. In groups, learners could plan and use critical path analysis and then work independently within the targets set, to meet deadlines or outcomes.

Setting a series of mini projects where, having established the fundamental requirements of a product, learners work through a minimum set number of iterations. Adding timings to further structure projects and restrict over-elaboration can also help. For instance, a learner looking at the comfort of a craft knife could be required to block model x number of basic solutions in a given period. This helps learners to understand modelling within a timed context more fully (to understand what they can achieve) and to promote the idea of simplistic modelling to make rapid progress for stakeholder feedback.

Learner Resources – Activities

Title	Organisation/ Company	Web link	Summary description	Relevant chapter (i.e. Content, Thinking Conceptually, Thinking Contextually)	Mapping to specification level
Integrating Systems Thinking and Design Thinking	By John Pourdehnad , Erica R. Wexler , Dennis V. Wilson	https://thesystemsthinker.com/integrating-systems-thinking-and-design-thinking	A document outlining systems thinking and how it sits in the design thinking as a methodology.	Content	4.3a
Six Sigma in Plain English	Six Sigma Money Belt	https://www.youtube.com/watch?v=tj8Saa1MbrI	A video showing how businesses large and small, service and manufacturing can use Six Sigma to cut costs and boost profits.	Content	4.3c
Introduction to Scrum – 7 Minutes	Uzility	https://www.youtube.com/watch?v=9TycLR0TqFA	What is Agile Scrum? This video will get you started with the details to you need to start working with Scrum.	Content	4.3c
Bee Business Bee Critical Path Analysis (CPA)	Bee Business Bee	https://www.youtube.com/watch?v=-EqWGSdQSvI	This tutorial looks at the concept of critical path analysis (CPA). This example is business studies based but clearly outlines the fundamental basics.	Content	4.3c

Learner Activity

Climbing carabineer – understanding UCD

Introduction

In this task, you will understand the use of a climbing carabineer for the stand point of the user. What does the primary user require from the product during use?

The activity

Learners in groups interact with the product at hand. They determine a list of key requirements and discuss improvements to the design.

They should consider:

- What do they think of the product in use?
- Who is the target market/primary user for the product?
- Where will the product be used?
- Why would the user purchase it rather than other options?
- What are the key requirements for the product?
- What improvements would be desirable but unessential?
- How will they interact with it/what will they need to understand?

Required here: gloves and goggles fogged with tape or similar.

Learners now repeat the process but now as a climber on a cold mountain in white out conditions.

Learners consider the original questions and in addition:

- What problems have arisen?
- How has the use of the product changed?
- What are the new requirements?
- What can be improved?

Learners could now write a brief for the product and then undertake an iterative design project.

This can be used as a standalone task or as the starter for a longer project. Learners can recreate the user-centred experience repeatedly by using the above process to determine iterative changes and successes. The length of the task will be dependent on centre SOW.

Extension activities/questions:

Learners now are given key dates to complete a project within. Learners could then be tasked to use Sixth Sigma or Scrum to plan a project and the key requirements.

Specification content (Sub Topic 3)

Sub Topic 3: Planning design solutions

NEA content

e. **Use project management tools and production plans as appropriate during the project to ensure all phases are managed efficiently.**

Thinking conceptually

General approaches:

For learners to produce their best work, they need to be well prepared and planned to meet all targets and deadline dates. Learners that think critically, manage time planning perceptively and with consideration of all components are likely to have a smoother and arguably more successful NEA experience. Several approaches to design thinking and project managing are outlined in the H406 specification.

marking criteria for the NEA covers a range of aspects associated with planning throughout the project. High quality planning will help learners to meet specification requirements and ultimately create a well-produced final prototype(s). Learners should aim to fully evidence their detailed plans with supporting documentation such as CAD and cutting lists. Key areas within the marking criteria are:

- **Quality of chronological progression (Strand 3 – AO2)**
- **Quality of planning for the making of the final prototype (Strand 4 AO2)**
- **On-going evaluation to manage design progression (Strand 5 AO3)**
- **Risk Assessments (Strand 5 AO3)**

Numerous project management tools exist and allow learners to implement time and task-planning. Gantt charts are a commonly used planning tool which visually illustrates a project schedule. Gantt chart methodology indicates start and finish dates of the planned tasks for a given project. This style of planning is easily accessible for GCE learners and allows them to quickly put in place a time plan and list of hierarchical tasks within a time frame. Critical path analysis is another method used for planning project work. Details for this can be found in the 'Activity' section.

Alongside schedule planning, learners may also consider supporting planning materials and additional evidence. Linking closely to other aspects within the NEA design specification, CAD planning will help learners determine all key components and allow them to gain a realistic understanding of the tasks at hand. Learners who break down their product using CAD orthographic drawings of its constituent parts, will be able to identify appropriate modelling options and if well practiced define likely time frames for construction. As learners drill down into the details of the prototype components, they will also be able to outline a detailed cutting list which can evidence further levels of planning for the modelling requirements. Once these aspects have been understood, learners can go on to undertake and evidence risk assessments for the planned tasks which, in turn, will evidence health and safety in the NEA project.

Common misconceptions or difficulties learners may have:

Problems with schedule planning can mean learners miss opportunities to consider and understand task length, often due to inexperience or over-confidence. Learners often do not fully understand or appreciate the length of time tasks are likely to take, especially when asked to consider longer more complex projects. Learners often do not include time to mitigate for potential manufacturing issues, design problems or construction errors which require rebuilding components.

Learners will often create time plans purely to fulfil NEA requirements and then fail to use them effectively or revisit them to check or confirm progress. This not only means that the document was produced to fulfil a requirement, but also means that learners will not benefit from the structure this brings to help identify and alleviate potential issues in their NEA project.

More-able or aware learners will reflect on time planning throughout the process to confirm they are on track. However, it is noted that in some cases, while the learners are aware that they are missing deadlines, they do not undertake additional planning to rectify the issues. Teachers should be aware that, in some cases, learners repeatedly missing deadlines can become demotivated by failure to meet the goals. Strategies to address this should be used to ensure learners stay on-track or set more realistic time planning with more achievable goals.

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

Careful planning can help ensure learners create high quality, final prototype(s) to meet marking criteria requirements in this area. Effective use of time, avoiding waste and misplaced energy will help learners to produce testable prototype(s) within the available timeframe.

Aspects covered within this delivery guide section will link closely to the product technical specification and dovetail with CAD orthographic drawings. Learners demonstrating comprehensive understanding of the component parts for their own products will come from well-practiced product analysis skills and previously undertaking detailed and perceptively thoughtful iterative designing.

Thinking contextually

Clearly an ideal approach to introducing planning is to ensure that learners have opportunities to undertake regular practice using differing methodologies. Planning aspects can be brought into the majority of tasks and the level of rigor can be determined by depth, outcome and style of planning. For instance, simplistic planning can be undertaken by using a Gantt chart for a short project with pre-determined tasks and key dates. More rigorous options are to undertake the same task but with only the holistic goals for a longer project and an final deadline. Learners will not only have to organise tasks, but to determine task length and dependencies and could also be asked to demonstrate critical path analysis.

Standalone planning can be undertaken during modelling tasks. Learners can break down a modelling task into its constituent manufacturing and machining tasks. With these in mind, they can then allocate time planning, undertake risk assessments and cutting lists within a given timeframe or by a certain deadline date.

Over the duration of a project, learners could keep a 'time diary'; this will help learners' understanding of task length and range of constituent parts undertaken. The process of doing so allows learners to reflect on their time spent on individual tasks which can help inform future planning.

Goals that help planning will likely include tasks that allow learners to become independent learners. The transition towards this within a planning context, can be achieved by actively engaging learners in setting weekly smart targets. This can be time consuming at the beginning, but will rapidly gather momentum as learners become more familiar in the process. Learners should actively monitor and review their targets before setting new ones. If they do this in a meaningful way, they will become better at planning and understanding the time implications of their plans and, in doing so, set more realistic and workable goals. This will see a very real beneficial impact on NEA planning later the course.

To support all aspects of planning, learners can be introduced to deeper understanding of parts and material requirements during the CAD and product analysis phases of the course. These outcomes, if introduced correctly, will promote learners' understanding of all components within a designed product and will encourage them to better understand possible material solutions. CAD orthographic drawings can include dimensioning and specified material parts lists to fully engage learners in understanding the required characteristics needed for parts to function and work together cohesively. This will benefit all prototype- planning later in the NEA project.

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
Bee Business Bee Critical Path Analysis (CPA)	Bee Business Bee	https://www.youtube.com/watch?v=-EqWGSdQSvI	This tutorial looks at the concept of critical path analysis (CPA). This example is business studies based but clearly outlines the fundamental basics.		Content	NEA e.
What is a Gantt Chart? – Project Management Made Easy	Project Management Software – Easy Projects	https://www.youtube.com/watch?v=ADK58IRPKh8	What Gantt charts are and why they are great! A short movie looking at Gantt planning.	This video is primarily based around a software package. However, the basic aspects and explanation of schedule planning are accessible for GCE learners.	Content	NEA e.

Learner Activity

Schedule Management

Introduction

For the NEA, you will need to plan the production of your prototype. In this task, you will plan a project from start to finish. You may at this stage of the course need to make some educated guesses or assumptions about task length.

The activity

Learners should break down the prospective project into tasks. For differentiated learning, this may have already been completed by the teacher.

Review and understand key dates (Start, deadline, modelling etc.)

What tasks need to be undertaken to deliver a complete project?

Assign number of hours for each task.

What order do task need to be completed in?

Are there dependencies? (Do some tasks need to be complete before others can be started/ finished?)

Produce a project plan in a Gantt chart format.

Consider whether tasks need to be completed consecutively or concurrently.

Extension activities/questions:

Extension tasks can focus on learners considering where task length can be reduced and determining the critical path for the project.

The small print

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