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AS and A LEVEL
Teacher Guide

DESIGN AND TECHNOLOGY

H004, H005, H006, H404, H405, H406
For first teaching in 2017

The changes in terminology and language

Version 1

www.ocr.org.uk/aleveldesignandtechnology

CONTENTS

INTRODUCTION – A CHANGE IN EMPHASIS AND APPROACH

The new GCE AS and A level specifications are very broad in their scope, reflecting real world practice in the creative, manufacturing, and engineering industries. They involve a significant change in emphasis and approach, with many widely used design concepts and methods now included into the Design and Technology specifications.

The aim of this guide is to introduce the changes to the language and terminology used in the new GCE AS and A level specifications. It builds on and further clarifies key words and phrases from the glossary of both specifications (Appendix 5f). This guide contains the terms included in the GCSE guide of the same name, plus further terms found in the new AS and A level specifications.

The terminology and language in the AS and A level specifications are very similar to the GCSE specification, representing a significant increase in the use of industrial design terminology and greater application of commercial and professional design practices. At AS and A level a greater depth of understanding and application will need to be evident in students' responses. Higher levels of stakeholder engagement, project management and application of industrial and commercial principles and methods are expected.

The guide focuses on explaining new terms rather than explaining terms that are well known and established. It will help students to understand and be able to use terminology accurately and apply it appropriately in their written papers and non-exam assessments. The use of correct words and terms and the application of the principles they involve will give added value and depth to responses and in turn raise attainment.

A number of tips, teaching resources and student activities are included in this guide.

UNDERSTANDING THE KEY TERMS

The iterative design process of exploring, creating, and evaluating becomes the heart of design and technological activity, where products are developed in repeating stages to meet genuine needs.

Surrounding iterative design thinking are many innovative strategies, methods and techniques, now commonplace in the design industry. Many of these feature in the specification to give students authentic experiences of real-world design practices as they apply their knowledge and understanding, and develop their own skills.

Improvement and refinement are essential features of any iterative design process, where designs are worked and re-worked to make better and better solutions. The development of designs is purposeful and relevant, and focused to genuinely meet genuine need through a user-centred approach. Regular contact with users and stakeholders, and consideration of their needs throughout the process, have a central and crucial role in improving and refining designs, alongside skills in critical evaluation and systematic testing, and a clearer understanding of the design problem. These ensure that design solutions and prototypes progressively meet requirements, are fit for purpose and are better placed to be marketable.

Before moving to other new words and terms, two key terms need further explanation as they will occur repeatedly. They are STAKEHOLDERS and THE ITERATIVE DESIGN PROCESS.

STAKEHOLDERS

The word 'stakeholder' appears over 40 times in the new specification, and it is important that its meaning is understood before the iterative design process is explained in more detail.

In the business world, a stakeholder is a person or group who has invested in a company or enterprise, such as the owner or shareholder (they hold a 'stake' in the business). Other stakeholders include those who have an interest in or are affected by the business in some way, such as the people who work there, the customers, or the local community. Competitors are also stakeholders as they will have influence and will be influenced. Further stakeholders have influence in how the business operates and these include government (policies, laws, regulations) and local authorities.

When designing and manufacturing a product, the 'user' of that product is just one of many stakeholders in its development. In reality there will be many user stakeholders who have an interest in a product when all those who may come into contact with it are considered. Other stakeholders are designers, manufacturers, retailers and those involved in marketing the product; those who maintain, repair or recycle the product; material and component suppliers; those related to the location for use of the product; energy suppliers; experts or specialists in the product area; plus various organisations who monitor or control design and manufacturing processes (e.g. British Standards, local authorities).

Some stakeholders' input or influence is greater than others, but it is crucial that all are established at the start and that there is good communication between designers and stakeholders throughout the design process, to ensure that the design meets their needs and requirements and the product is a success for everyone involved.

Student activity

Think about the design of a mobile phone or a flight attendants uniform. Produce a mind map to include as many stakeholders that you can think of. Indicate how important you think their 'stake' is.

THE ITERATIVE DESIGN PROCESS

In the past, Design and Technology specifications have followed a linear design process. To more closely follow the design process used in today's creative industries, the iterative process has been adopted in the new Specification. A simple explanation of the change is that the design process is more cyclical and reflective, repeating over and over to improve and refine design solutions (design iterations) to best meet the needs of user and stakeholders.

Key aspects of the process are:

Explore

- Understanding the context and the opportunity/problem
- Identifying the stakeholders
- Investigating the needs and requirements of the stakeholders
- Learning from existing solutions and products
- Gathering relevant information about materials, components and wider issues

Create

- Generating design ideas that will meet the stakeholders' requirements
- Applying knowledge and understanding of the principles of design and technology
- Production of 2D and 3D models and prototypes (first prototypes as early as possible)
- Acting on feedback from stakeholders on prototypes leading to the next design iteration
- In a type of 'trial and error' process, design ideas that satisfy users and stakeholders continue iteration for further improvement and refinement, whereas those that do not are discarded.
- Following as many iterations as needed, the making of a final functioning prototype

Evaluate

- Analysing stakeholder needs and wider relevant issues
- Testing and evaluating prototypes by users and stakeholders
- Physical testing and analyse of the prototypes
- Suggesting modifications, further iterations and future developments

It is important to note that while the iterative design wheel (see diagram above) shows a direction of travel when designing, there is no single or correct entry point, route or direction through the overlapping processes of 'explore' 'create' and 'evaluate'. For example:

- The specific design context and the opportunity/problem may determine that 'evaluate' is the place to begin
- 'Create' may follow immediately after evaluation and testing
- Further 'explore' may be needed during the process of 'create'
- A simple prototype may be the starting point for 'explore'.

The iterative design process needs managing to make it as efficient and effective as possible. Key aspects of this are:

- Writing a design brief to capture the opportunity/problem and stakeholder's concerned
- Identifying stakeholder and technical requirements or specific details to give focus and direction
- Using design strategies and approaches to bring in fresh thinking
- Organising and facilitating to ensure systematic attention to all relevant issues
- Discovering design problems as early as possible by testing of prototypes as early as possible
- Accepting that some designs fail and initiating new thinking to move forward with designing
- Reviewing and reflecting to determine the next steps
- Emphasising regular and direct contact with stakeholders and products or prototypes to ensure appropriate input and feedback during the process
- Considering commercial, manufacturing and marketing aspects to create a high quality, ready-for-market product as far as possible

- Managing different opinions from users and stakeholders to establish their relevance and priority
- Responding to results of testing and evaluation of prototypes to clarify and refine stakeholder requirements
- Establishing clear criteria to define the level to which the design requirements must be fulfilled to allow the design to be considered complete

Teaching resources

A short video from James Dyson Foundation, explains the iterative design process: https://www.youtube.com/watch?v=8kxoMTMibFo

This short video by David Kelley of IDEO (international design and consulting firm) highlights the value of the iterative design process and the importance of early prototypes to the success of the product: https://www.youtube.com/watch?v=9NxWW4poljU

NEW WORDS AND TERMS

ACCURACY

Accuracy refers to how correct a measurement is.

The term 'accuracy' is often used alongside 'precision' so the difference needs to be explained.

Accuracy is how close a measurement is to the actual (true) value. The closeness to the correct value or a standard.

Precision is how close measurements are to each other.

If measurements are accurate and precise, all are close to each other and close to the actual value.

An excellent PowerPoint by Ashley Hilton clearly illustrates the terms Accuracy and Precision, and the difference between them: https://www.tes.com/teaching-resource/accuracy-and-precision-6256372

In the NEA Iterative Design Project, students will be expected to use appropriate marking out methods to ensure the accuracy and precision required for their prototypes and products to fulfil their intended purpose. Examples: reference/datum points, templates, jigs and/or patterns and working within tolerances. Efficiency and accuracy when making is likely to be evidenced by the use of methods such as tessellation, nesting; the use of CAD/CAM; care and attention to detail; and the use of hand and machine processes as appropriate. All should form part of an overall quality control strategy.

Student activity

A darts game at: http://interactagram.com/physics/PrecisionAndAccuracy/

Teaching resources

A helpful article about accuracy and precision on the 'Maths is Fun' website: http://www.mathsisfun.com/accuracy-precision.html

BLUE SKY THINKING

Imagine a blue sky in the morning, an empty sky. A games afternoon is arranged, so what will the blue sky suggest? Perhaps a clear day without any weather interruptions or restrictions …?

Blue sky thinking is thinking without any interruptions or restrictions, where there are no pre-conceived ideas or limitations, unhindered thinking with an open-mind. The focus here is on thinking outside the box, ideas flowing freely, often out of the ordinary, pushing back traditional boundaries.

Innovative and fresh ideas give a business a competitive advantage where their products stand out alongside similar products.

Blue-sky thinking can involve a group of people looking at a design problem with fresh eyes. As many ideas as possible are generated in an ideas generation session where no ideas are rejected as silly or implausible.

CIRCULAR ECONOMY

A circular economy is a country wide system where resources such as materials and products are 'made to be made again' in a 'return and reuse' cycle of ownership with products regenerated for their period of use. The life span of products is extended through maintenance, repair, and reconditioning. Waste is minimised. Alongside the use of renewable energy this represents a large scale change for the whole community.

Teaching resources

The headline on the website of the Ellen MacArthur Foundation: https://www.ellenmacarthurfoundation.org is '**Our mission is to accelerate the transaction to a circular economy**'. The website includes material and resources including videos and animations (also available on the Ellen MacArthur Foundation You Tube channel) explaining the circular economy and how it is being adopted: https://www.youtube.com/user/made2bemadeagain

STEM Circular Economy Introductory Kit: https://www.stem.org.uk/elibrary/resource/32618

Institution of Engineering and Technology (IET) 'Green School' resources: https://www.stem.org.uk/elibrary/resource/33102

Student activity

Study the graphic presentation of the social benefits of a circular economy produced by Green Alliance, found at: http://www.green-alliance.org.uk/resources/The%20social%20benefits%20of%20a%20circular%20economy.pdf

List as many potential benefits of a circular economy as possible.

COLLABORATION

In simple terms this means 'working with others towards a shared goal'. It is an essential but fun and rewarding part of the Iterative Design Challenge, collaborating will:

- bring different perspectives and viewpoints, increasing creativity and innovation
- avoid design fixation (fixed ideas) and encourage thinking about things differently
- help solve complex problems where specialist experience is needed
- speed up the process of design iteration because design thinking becomes 'smarter'
- share the load when things go wrong or become difficult
- increase confidence and progression to maximise the iterative process
- reflect industrial and engineering design practice

Collaboration is positively encouraged in the world of design, but where this is undertaken within the NEA, it is vitally important that the learners' interpretation following on from any collaborations appropriately acknowledge participants and reflect how that learner will take what they have learned from that collaboration forward.

Teaching resources

These two articles give an insight into online collaboration and the design process:
Craig Stewart '*The 20 best tools for online collaboration*': http://www.creativebloq.com/design/online-collaboration-tools-912855
Essi Salonen: '*A designer's guide to collaboration*': http://www.designingcollaboration.com

COMMERCIAL VIABILITY

The term 'viability' encapsulates feasibility, practicality, capability, sustainability, usability and marketability.

A product may be innovative and effective, but to be commercially viable it needs to be able to compete with other similar products on the market and be a product people want to buy at a price that makes a profit.

An assessment of a product's commercial viability will consider the market demand, existing competition, and the viability of the product itself.

During the Iterative Design Challenge, students will obtain opinions on their design ideas and prototypes from users and stakeholders. These views are likely to indicate the viability of the product and its commercial potential. Seeking an honest and objective opinion from others is a good way of accessing whether the design solution has what it takes to become a product.

Student activity

Think of a 'market leader' or a 'successful product' (for example, a standard BIC biro). Analyse its design and list the aspects of the product which have made it commercially viable. An internet search of 'market leader products' may help you choose one.

CRITICAL PATH ANALYSIS

Critical Path Analysis (CPA) or Critical Path Method (CPM) is a project management tool that lists then charts all tasks that must be completed as part of a project, and identifies the quickest route to completion. It is presented in a format similar to a flowchart.

The aim of CPA in project planning is to identify those activities whose completion is critical for the project to stay on time. Estimating the duration of each activity and establishing the order in which activities are undertaken, together with concurrent activities, allows a network diagram to be produced within which the critical path can be determined.

Teaching resources

Excellent resources by The OR (Operational Research) Society including a PowerPoint (includes 'Who wants to be a Millionaire' game to test students' understanding of CPA), student worksheet, and teacher notes: http://www.learnaboutor.co.uk/teachers_materials/ORAiS/teachers_ORAiS_CPA.htm

A presentation by Tutor2u at: http://www.slideshare.net/tutor2u/critical-path-analysis-10762045

A starter activity by Graham Prior on Tutor2u: 'The Big Breakfast - Delivering Critical Path Analysis': http://www.tutor2u.net/business/blog/the-big-breakfast-delivering-critical-path-analysis

Concise study notes on CPA with clear explanations of all terminology, by Jim Riley on Tutor2u: http://www.tutor2u.net/business/reference/critical-path-analysis

Student activity

See teaching resources above.

CRITICAL THINKING

Being 'critical' means asking questions, not just accepting things. It involves delving deeper to understand why things are the way that they are. It is finding both negative and positive viewpoints. It is carefully considering a view, not repeating others' views. It is challenging preconceptions, suggesting new directions and approaches and different solutions. It is reflecting on and adapting your own approach, learning from experience.

Teaching resources

An animated look at the principles of critical thinking: https://www.youtube.com/watch?v=6OLPL5p0fMg

Student activity

Carry out further investigation into what critical thinking means, particularly in the context of Product Design. Produce a word cloud (www.wordle.net) using words and principles associated with critical thinking.

CRITIQUE

Critique involves critical thinking. In design, 'critique' goes beyond 'evaluate' as it more directly and intentionally looks for problems and faults in design ideas, prototypes, or products as well as recognising positive features of value. It uses analyse and is structured and systematic, based on evidence.

Critique can take the form of a written document or chart. It can also be a record of a meeting of a small group of people who discuss and review a design. The aim of both is to identify areas for improvement and to identify any changes that will guide the next-steps moving forward.

This approach clearly has an important role throughout the Iterative Design Challenge. Here are some possibilities:

1. When critiquing student's design ideas, this could involve a group of 3-5 students. The student with the design ideas prepares a list of questions or problem areas they would like the group to discuss and to make suggestions. Key skills here for the student are:
   - maturity to accept new thoughts and opinions and not to simply defend ideas they already have
   - guiding the discussion to keep it on track
   - obtaining objective and specific feedback rather than comments such as 'this works well'
   - taking notes and making sketches to record input from the critique
   - listening (above all).
2. When critiquing existing products, a student could disassemble* a product, analysing each component and asking questions as they do so relating to aesthetics, function, performance, influence of fashion, environmental impact, ergonomics, cost, and so on, identifying strengths and weaknesses. *Disassembly is sometimes called 'reverse engineering'.
3. When critiquing designs with potential users and stakeholders of the product, around a prototype, the student will need to prepare specific questions. These should be targeted to resolve on-going design problems, gain opinions and suggestions regarding issues around the use and look of the design solution. Critiques could be scheduled more than once with this group as part of the iterative process, where new design iterations can be presented.

DESIGN FOR MANUFACTURE AND ASSEMBLY (DFMA)

Also design for manufacture (DFM) and design for assembly (DFA).

DFMA is the integration of design with planning for manufacture and assembly into one activity. The primary aim is to design products in which economy and efficiency are achieved.

Students should understand and be able to apply principles of DFMA when designing and developing a component or product, and to include evidence of this in their Iterative Design Project. Relevant principles include

- Use of common parts across components and/or products
- Design simplification – reducing the number of different parts and processes
- Design for ease of assembly of parts, for example parts that fit either way round
- Compatibility of materials and processes, the correct processes for materials being used.
- Correct detailing of tolerances and surface finish
- Sustainable design – for example, maintenance, repair and replacement factors, reduction of waste

In the commercial setting, software is often used in the DFMA process. For example, DFA product simplification software is used to highlight areas for cost reduction in a product, and to identify components that can be changed or deleted while maintaining functionality. DFM concurrent costing software is used to optimise costs by suggesting alternative tolerances, surface finishes, and other details for the parts. Screen shots of these with further details can be found at: http://www.dfma.com/images/dfa10full.jpg

Teaching resources

'Eleven Principles and Guidelines in Design for Manufacturing and Assembly' on the Engineering Exchange website: http://www.engineeringexchange.com/profiles/blogs/11-principles-and-guidelines-in-design-for-manufacturing-and

Some examples and case studies showing commercial application of DFMA can be seen on Boothroyd Dewhurst's DFMA website: http://www.dfma.com/resources/studies.htm

The Principles of DFMA with worked examples giving an insight into professional design practice. An excellent presentation incorporating student activities. By David Stienstra: http://me.gatech.edu/files/capstone/L071ME4182DFA

Student activity

Suggest a simplification of the design of a component or product by reducing the number of manufacturing processes and/or parts used.

DESIGN OPTIMISATION

In our highly competitive world with complex and refined products and systems, it is essential to design the best products and systems. The smartest, most reliable and most efficient products succeed. Design optimisation is a means of identifying the best choices when considering design modifications in terms of optimum use of materials, manufacturability or ease of assembly that ensure optimum quality, performance, refinement of size and weight, design features, sustainability, and so on.

Creating an optimal or optimum design is the ultimate aim of an iterative design process. A design, which all things considered, is the most right or the best that it can be using the available resources. It is a design which most efficiently and effectively meets the needs of users and stakeholders.

Testing, simulating and modelling of design possibilities (design variables) within certain limits or boundaries (design constraints) reveal the solutions that provide the best outcome. Specialist optimisation software is used in the design and engineering industries along with computer aided design (CAD) simulations. Statistics and mathematical modelling are widely used to optimise designs, analysing results of testing, predicting performance, and using charts and graphs to represent data relating to possible design improvements.

On a very practical level, meetings are held regularly where teams of design professionals gather round a table where they look closely at a prototype component, an assembly of parts or a product to discuss ways that their design might be optimised. For example, a light switch for use in a car. It might be possible to change the material or surface finish, make the material thinner to reduce costs, reduce the number of component parts of the switch, use a different method of manufacture, replace threaded fasteners with plastic clips, and so on.

As part of their evaluation during their iterative design project, students should apply the principles of design optimisation through physical, digital and mathematical modelling to modify and refine their designs.

Tip

Science and Physics departments of schools and colleges will often have a variety of testing equipment ideal for testing materials and components as part of the design optimisation process.

Teaching resources

An excellent short video showing the use of Autodesk Inventor CAD software (available free to schools and colleges) and its Stress Analysis (FEA) tools being used to optimise the design of a component of a car seat: https://www.youtube.com/watch?v=1f-BnJnWpUY

Case Study showing how design optimisation has been used to reduce the weight of a bus frame: http://web2.altairhyperworks.com/reducing-the-weight-of-a-bus-frame-by-17-percent

DESIGN THEORY AND DESIGN STRATEGIES

Design theory is all about what the word 'design' means. It tries to describe or explain design activity and answer questions such as:

- What is design?
- What does designing involve?
- Why do we design?
- How do designers think?
- Is designing about actions as well as thoughts?
- What skills are needed to be able to design?
- When designing, what methods, techniques, strategies and approaches are used?
- Can we describe the design process?
- How has the process of designing changed over history?
- What are the principles that underpin creative design?
- What, if any, are the key aspects of the design process?
- What methods have key figures used in their practise?
- How can historic design movements influence 21st century design?

Of course there are many different answers to these questions, many different theories of design. Many different design strategies and design methods have developed alongside and from these theories.

Throughout the iterative design process an understanding and application of different theories and strategies will support creativity and assist students, for example, to:

- coherently structure their work
- systematically test and evaluate
- fully meet stakeholder requirements
- efficiently achieve fitness for purpose
- inspire the way they design

Student activity

Think about what designing is and what it involves. List as many words that you can, then produce a word cloud (www.wordle.net). Here are two words to start you off: analyse, reflect.

Teaching resources

Presentation entitled '*What is Design*' by Bas Leurs (2014) at: http://www.slideshare.net/Leursism/design-theory-lecture01 (see also further 'Design Theory' lectures in the series by Bas Leurs).

Book: William Lidwell, Kritina Holden, Jill Butler (2003, 2011) *Universal Principles of Design (125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design)* Rockport Publishers, Inc. ISBN: 978-1-59253-587-3. This excellent book, a type of design encyclopaedia, draws together key principles for design from many design disciplines into one resource. It covers a comprehensive range of design strategies, approaches and methods. Further details at the end of this guide.

ECOLOGICAL AND SOCIAL FOOTPRINT

Human activities (including using products and materials) consume natural resources and produce waste. This is a footprint – a mark that humans make on the planet, which needs to keep up with the demands being made on it. A sustainable planet is one which replenishes the natural resources used and is able to absorb the waste produced.

- ecological footprint refers to the measure of the impact of a person or community on the environment, on nature and natural resources
- social footprint refers to the impact a person or community has on other people

An understanding of the ecological and social footprint of materials is needed for the written examination. As part of the NEA Iterative Design Challenge, students will investigate and show their consideration of relevant factors, reflecting this in their designing.

Teaching resources

The organisation 'CottonConnect' works with leading clothing manufacturers and retailers to promote and implement large scale improvements in the industry, improving the environmental and social sustainability of cotton production and processing.

Follow the link to an article entitled 'The environmental and social footprint of cotton' which gives detail of the impact of cotton production and steps being taken to reduce that impact:
http://www.cottonconnect.org/why-manage-cotton-sustainably/the-environmental-and-social-footprint.aspx

The World Wide Fund for Nature (WWF) aims to stop the degradation of the planet's natural environment, conserving biological diversity, promoting renewable resources and a reduction in pollution and waste. Follow the link to an article entitled 'The ecological and social footprint of paper' which gives detail of the impact of paper production and steps that can be taken to reduce that impact:
http://wwf.panda.org/how_you_can_help/live_green/fsc/save_paper/paper_toolbox/ecologicalsocialfootprintpaper/

Sustainability terms and definitions produced by Practical Action: https://www.stem.org.uk/elibrary/resource/30111

ENTERPRISE

From a design context, the term enterprise relates strongly to innovation. It captures brave and courageous decision making, initiative and resourcefulness, making the most of opportunities to earn money, create or support new businesses, new and energetic undertakings, adventure and challenge. Businesses are often referred to as enterprises, particularly those breaking new ground.

Venture capitalists are people who invest money into small companies trying to expand their business or people with great ideas needing finance and funding.

Crowdfunding websites encourage people to donate to designers to enable them to develop products, to fund projects. Details of projects are posted to a website where people invest in projects they are interested in and would like to see progress. For example, 'Kickstarter' provides resources and support to designers in all fields, bringing innovative ideas into reality. Examples from 61,000 launched products so far include a selfie broom, a smart tape measure, and smart surfaces: www.kickstarter.com

ETHICAL TRADE INITIATIVE (ETI)

ETI is a UK-based organisation that unites businesses, companies, trade unions, charities, and professional associations to promote respect for workers' rights across the world.

Retailers, suppliers, and companies signed up to ETI are committed to improve the working conditions of disadvantaged people involved in the supply chain for the products they sell. A large number of household brands are full members of the organisation.

The ETI Base Code is an internationally agreed code of labour practice, specifying in detail the requirements applicable to all areas of employment, for which members are responsible. See the code at: http://www.ethicaltrade.org/eti-base-code

Teaching resources

ETI's website is: http://www.ethicaltrade.org and contains useful resources and links.

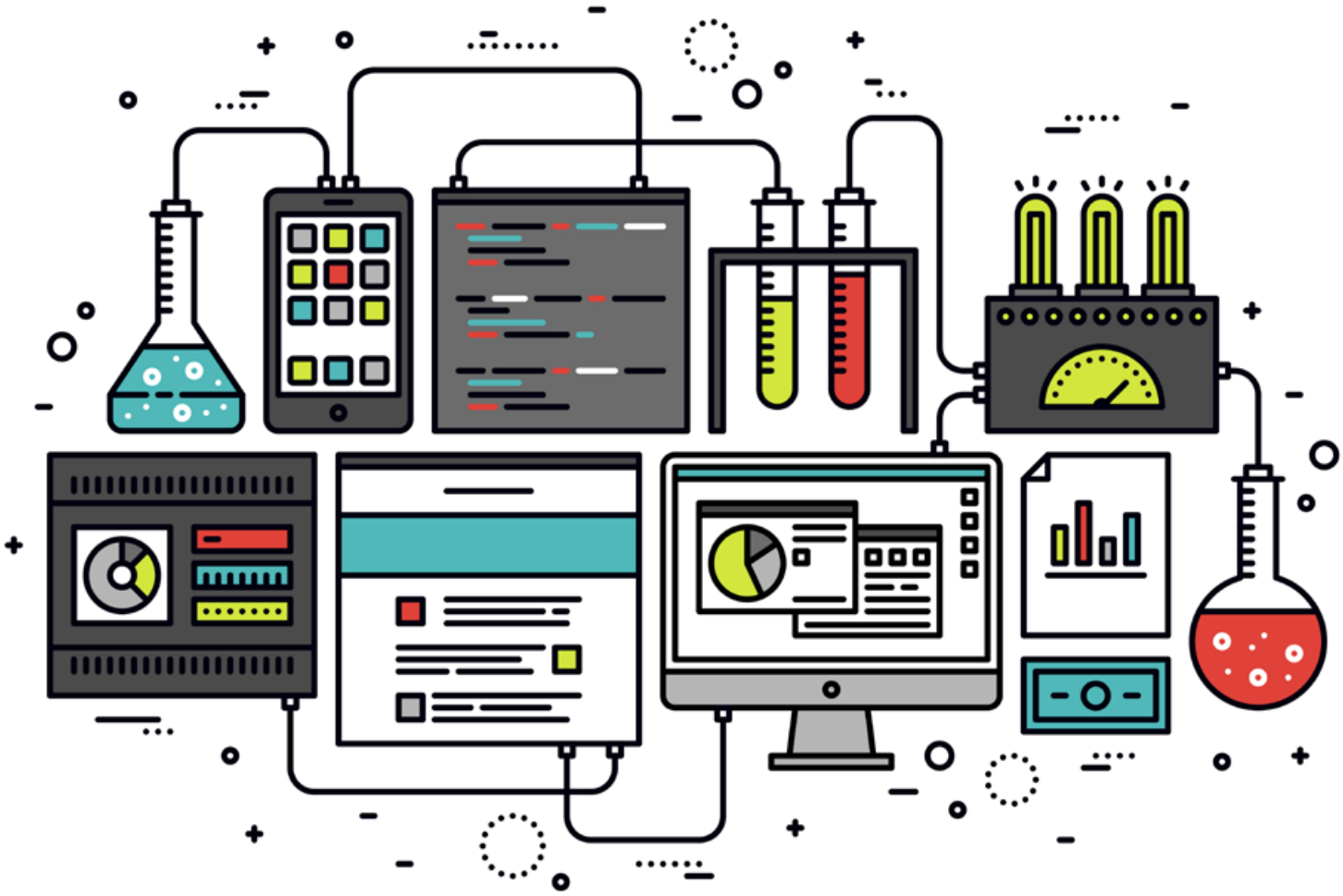
FEASIBILITY

If something is feasible, it is capable of being achieved. It is possible. It is doable.

The word 'feasibility' features in both the subject content and the NEA content sections of OCR Specifications.

A feasibility study investigates the positive and negative outcomes of a project before investing too much time and money. An example might be a school or college wanting to extend their facilities with new buildings. A feasibility study will look at alternative sites for the buildings, how much the work will cost, the likely disruption to the day-to-day running of the school while work is in progress, the views of parents, students and other stakeholders about the project, any local government planning restrictions and regulations that might affect the plans, implications for deliveries and traffic, environmental impact and so on. Based on the information gained, final decisions can be made.

In the iterative design process, the feasibility of proposed designs can be assessed through experiments, trials, mock-ups, testing and modelling. This may be physical and/or digital. The feasibility of different techniques and processes for manufacture can also be assessed through trials, tests and experiments.



FIXATION

Fixation is a mental state where a designer can become completely focused on one idea or concept and be 'blind' to alternatives. This hinders creative and innovative thinking, blocking progression through the process of design development. Students will be expected to use appropriate design strategies and approaches in their iterative designing to avoid fixation.

Looking at things differently and imaginatively without preconceived ideas is key to problem solving; thinking 'outside the box' can deliver innovative solutions.

Many studies have been carried out to explore how fixation occurs and how it can be avoided.

The following have been shown to increase the tendency to fixation or to decrease the ability to create novel and unique solutions:

- Designers having contact with established ideas and solutions to a problem
- Designers having difficulty accepting that their early ideas can be improved upon
- A companies putting in constraints with time and cost, making it hard to seek better design solutions
- Being risk adverse to learning through failure and mistakes, and not recognising how risk taking can foster creativity
- Working with stakeholders and users that are very fixated on ideas
- Designers working in isolation are likely to lack the knowledge and experience of a broader design team

Design strategies and approaches that can avoid design fixation include:

- Collaboration with others who will challenge stereotypical thinking and support innovative thinking
- Adopting a 'user-centred' focus to eliminate personal preferences and preconceptions
- Focussing on tackling a problem rather than designing an object
- Seeking inspiration beyond the immediate design field
- Considering the combination of two or more concepts to create a new and unique concept
- Working with stakeholders to ensure all viewpoints and requirements are considered
- Using brainstorming techniques such as 'SCAMPER' to refine and improve designs
- Using systems thinking to understand the design of the product or system as part of a larger system of other products and systems
- Incorporating inspiration from other areas, such as biomimicry

Teaching resources

An approach to designing where fixation is minimised is outlined on the 'Producttank' You Tube channel, in a short video entitled 'Innovation'. When designing focusses on tackling a problem rather than designing an object the opportunity and scope for innovation is greater and design fixation is likely to be avoided. See: https://www.youtube.com/watch?v=CnKeVs-_9zs

Nathan Crilly of the Engineering Design Department, University of Cambridge, carried out research 'Fixation and creativity in concept development: The attitudes and practices of expert designers' (2015) and published the results in the Design Studies journal. This is found at: http://www.sciencedirect.com/science/article/pii/S0142694X15000137

Student activities

Choose a design that you have worked on, or find an existing product in an area you are familiar with.
In a small group, use the 'SCAMPER' brainstorming technique to suggest improvements to the product. Details of the technique are found at: https://www.mindtools.com/pages/article/newCT_02.htm

Design Brief: You are to design a chair.
In what ways might this design brief encourage design fixation?
How could this design brief be reworded to avoid potential design fixation?

FOCUS GROUPS

A focus group is an organised discussion led by a moderator where people are asked about their views and experiences, perceptions and attitudes of a product, brand, service, idea, advertisement or packaging. The group is normally between 6 and 10 people and the informal discussion normally lasts between 1 and 2 hours. The group will represent people from a variety of backgrounds and careers, and the moderator ensures that everyone participates as fully as possible. The moderator poses a series of questions and often uses images and objects to gain views and opinions.

In the group setting, people's comments are often prompted by others in the social gathering and interaction that takes place. A focus group is qualitative research because participants give open-ended responses which will convey thoughts or feelings.

Focus groups often form part of feasibility studies and market research.

Teaching resources

B2B International have published 'Using the Focus Group in Market Research' by Carol-Ann Morgan. This gives a helpful overview at: https://www.b2binternational.com/publications/market-research-focus-group/

Student activity

Study how focus groups work. Set up your own focus group to obtain views on your design ideas and prototypes.

MARKETABILITY

Designing real products for the real world; products that will appeal to buyers and will sell with enough profit to make a successful business.

Marketing is a massive area in today's consumer society. Considering marketability throughout the iterative design challenge will ensure the design solution is ready-for-market as far as possible. Identifying the products Unique Selling Proposition (USP) is a good starting point.

Understanding the market for a product, those who will potentially buy the product; and understanding users and stakeholders and their requirements, is essential if the product is to be marketable.

With constantly developing digital communications and social media, new models of marketing are being developed, for example the SAVE framework, details at: https://www.youtube.com/watch?v=H_bqCocvrH4. Digital marketing is considered in an article by Matt Egol, Michael Peterson, and Stefan Stroh at: http://www.strategy-business.com/article/00241?gko=20aae

Student activity

Choose any everyday product, preferably small enough for you and a small group to gather round.
Why do people buy this product? Look at it very closely from all angles and make a list of the features of the product that make it marketable, the features of the design and its packaging that give it marketability, that give it commercial potential and value. If you know the manufacturer and supplier of the item, it may be helpful to look at their websites to see how the item is sold and marketed.

Teaching resources

Lesson plans and videos on all aspects of marketing – excellent. Includes definitions of marketing terminology:
http://www.marketingteacher.com

Case studies, teaching materials, video based exercises:
http://www.greatideasforteachingmarketing.com

MATHEMATICAL MODELLING

Models in their broadest sense are produced to represent something, they help to show what something looks like or to explain how something works. They help to identify and solve potential problems and enable predictions to be made.

Think about a model constructed from cardboard, strips of timber, and foam. This is a representation of a real product using 3D materials, and the model will help to explain the product and how it functions, the role of different components, and predict how well it will work. In the same way a mathematical model is the representation of a real situation, but using mathematical concepts and language. Some of the ways mathematical modelling might be used in the iterative design process are:

- Graphs and charts to communicate aspects of the design in different situations
- Application of mathematical principles, formulae, equations, and theories in the design process
- Translating a practical problem into a mathematical problem to interpret or visualise a problem in a different way – using a different language to communicate or resolve an issue
- Simulations and predictions
- Evaluation and comparisons of performance

Teaching resources

'Mathematical Modelling with Calculus'. A booklet containing an explanation of the mathematical modelling process, and a number of case studies showing mathematical modelling with calculus:
https://www.stem.org.uk/elibrary/resource/28789

Some practical examples of Mathematical Modelling with application to D&T:
https://www.tes.com/teaching-resource/mathematical-modelling-6336152
https://www.mathsisfun.com/algebra/mathematical-models.html

PERSONA

To help when evaluating designs as part of the iterative process, a persona is often created as a means of representing users or stakeholders. A persona is similar to a user profile that students may be familiar with. Information about users or stakeholders is gathered together early in the project, this can be used to create a collective persona, a 'typical' person, with their views, attitudes, preferences, lifestyle, skills and so on.

Student activity

Imagine you are designing sports safety wear (e.g. goggles, gloves, head / body protection)
In small groups, create personas to represent users and stakeholders.

PLANNED OBSOLESCENCE

If something is obsolete it is no longer used or useful. Obsolescence is the condition of being obsolete, when a product or service is no longer wanted, even though it may still be in working order.

Obsolescence brings a decline in the value and competitiveness of a product or service. It happens because more desirable alternative products or services become available, or because user styles, preferences and requirements change. The fall in value is not due to physical wear and tear but simply due to it no longer being what the majority of people want. The product or service becomes 'out of date' or 'unfashionable'.

Planned obsolescence, sometimes known as 'built-in obsolescence' is where a company decides to manufacture consumer products in a way that they become obsolete within a known time period. The aim is usually to ensure sales of their next new product, a continuing market, thus keeping the company in business.

Fashion clothing is often subject to planned obsolescence as new styles, trends and patterns are introduced to entice buyers, making last year's clothing no longer desirable, but not worn out. The design of technology items such as mobile phones is improved with new features frequently, and many users want the latest design with the latest features to replace their old model.

Medical equipment such as sterile surgical gloves or needles are disposable and cannot be reused. They have a planned life and planned obsolescence, and this is for reasons of health and hygiene. Other products have a limited working life to ensure that safety factors can be incorporated into later versions of the product.

The morals and ethics of an economic system and a consumer society continuing to purchase goods and then purchase more goods are increasingly under question when the environmental implications are considered. Continually replacing instead of being able to repair or upgrade items contributes heavily to waste and pollution and this makes the practice of planned obsolescence difficult to support.

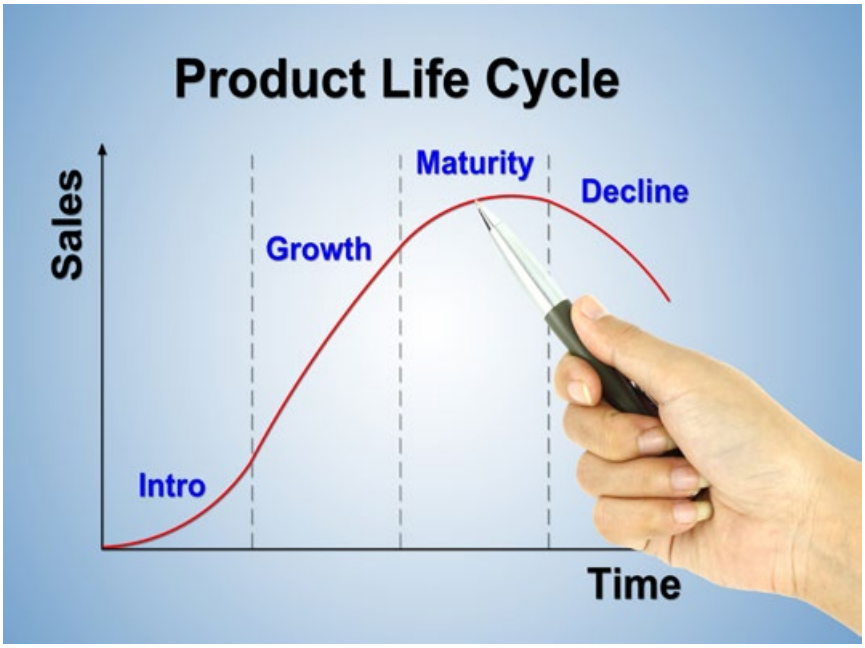
Teaching resources

A helpful overview of Planned Obsolescence at: http://msc-technology.wikispaces.com/Planned+Obsolescence

PRECISION

See Accuracy.

PRODUCT LIFE CYCLE



The product life cycle is an important marketing concept, describing the stages of a product's life from when it was first thought of through to when it is finally phased out of the market, when the demand for the product drops to a low level. Some products do not reach this final stage, with some continuing to grow and others rising and falling.

There are four stages in the product life cycle:

- Introduction – where a new product is launched into a market. Includes research and development.
- Growth - the market has accepted the product and sales begin to increase.
- Maturity - sales will reach their highest. Competitors enter the market.
- Decline - sales will begin to decline as the product reaches its saturation point.

A number of strategies can be used by businesses to manage or extend the product life cycle. These include advertising and promotion to new audiences, price reduction, upgrading the specification of the product, e.g. introducing new features, revitalising the packaging, and making styling changes. The development of the next new product begins during the growth stage of the current product to ensure a steady business. Product life cycle management is crucial for the on-going sustainability and viability of a business.

Teaching resources

www.boundless.com publish a wide range of marketing resources including PowerPoint templates and quizzes. Their article 'Stages in the Product Life Cycle' (2016) gives a helpful summary: https://www.boundless.com/marketing/textbooks/boundless-marketing-textbook/integrated-marketing-communications-12/selecting-the-promotion-mix-for-a-particular-product-84/stages-in-the-product-life-cycle-420-896/

A video explaining the product life cycle produced by tutor2u is found at: http://www.tutor2u.net/business/reference/product-life-cycle

A more detailed chart of the Life Cycle is found in the book: William Lidwell, Kritina Holden, Jill Butler (2003, 2011) *Universal Principles of Design (125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design)* Rockport Publishers, Inc. ISBN: 978-1-59253-587-3.

Student activity

Identify the different ways in which television can be watched and recorded. Put each of the different products you have listed into what you think is the right stage of the product life cycle. (For example video cassette would fit into the 'decline' stage') Explain your decisions. You may need help from your teacher or tutor to complete this activity. Think of other ranges of products and fit them into the stages of the product life cycle?

PROJECT MANAGEMENT TOOLS

Project Management is the act of defining, initiating, planning, executing, monitoring and completing the work of a team to meet a specific target. It is the planning and control of everything involved in delivering an end result to meet the stakeholder requirements; 'getting the job done' in simple terms.

The diagram below summarises the purpose of project management:
Projects must be within acceptable cost.
Projects must be delivered on time.
Projects must be within scope.
Projects must meet stakeholder quality requirements.

Project management tools are the tools, techniques, procedures and activities that are used to set out and track the individual tasks in a project, and to manage the overall project successfully. Most of these use computer software and use charts and various types of diagrams similar to flow charts. Three examples of project management tools are covered separately in this guide: critical path analysis, scrum and six sigma.

Gantt charts, sometimes referred to as bar charts, which students and teachers are likely to be familiar with, are also used in project management. In a gantt chart, each project task and activity is represented by a bar. The left edge of the bar displays the predicted start date of the activity and the right edge of the bar indicates the planned end date.

Students should mirror commercial practice and methods by using appropriate project management tools during their iterative design project. This should ensure all phases are managed efficiently and the end result is achieved. Key areas for inclusion are likely to include the specifying and monitoring of tasks to specific targets, managing the input from others, working systematically and logically to progress through successive design iterations, and the management of resources to minimise waste.

Teaching resources

The Association for Project Management's website contains useful information, including a short animated video entitled '*What is Project Management*': https://www.apm.org.uk/WhatIsPM

A video entitled '*Crossrail Programme Controls Overview*' gives an insight into the Project Management of a very large project: https://www.youtube.com/watch?v=ZlC1pF-Lja8

A video entitled '*Project Management in under 8 minutes*' produced by Chris Croft (2013): https://www.youtube.com/watch?v=qkuUBcmmBpk

A video entitled '*Excel Gantt Chart Tutorial - How to Make a Gantt Chart in Microsoft Excel 2013*' by VideoDefinition: https://www.youtube.com/watch?v=_u_jm1211D4

QUALITATIVE

This word is widely used in market research, and when referring to information and data. It is often confused with quantitative.

Qualitative research gives non-numerical data, information that is descriptive, often giving people's reasons or opinions.

Qualitative data usually measures or describes the quality of something rather than its quantity. It describes the quality of something in terms of size, appearance, value, in adjectives rather than numbers. e.g. medium in size and very costly to purchase. In a Design and Technology context, qualitative data is often non-technical.

QUANTITATIVE

This word is widely used in market research, and when referring to information and data. It is often confused with qualitative.

Quantitative research gives numerical data, or information that can be converted into numbers and then used in a statistical way.

Quantitative data usually measures or describes the quantity of something rather than its quality. It states the quantity of something in terms of size, weight, capacity, in numbers rather than words. e.g. 40mm long and 50Kg in weight. In a Design and Technology context, data is often technical.

REAL-TIME EVIDENCE

Evidence refers to anything that is presented to support a statement or claim. The strongest evidence proves that the statement or claim is true.

The portfolio for the iterative design project is presented in chronological order, in the order it actually happens, the first thing carried out at the beginning and the latest thing to be done at the end.

The requirement for students to provide real-time evidence means recording activity, events or processes immediately (at the same time) as they happen. Strong evidence (e.g. video, photograph or authentic document) is needed to demonstrate that the activity, event, or process actually happened as stated or claimed.

REFLECT

Reflect appears several times in the NEA content of the Specification. What does it mean for a student to 'reflect on their investigations', or 'reflect on feedback'? 'reflect on chosen manufacturing methods' or 'reflect on quality of outcomes'.

In this context, reflect means firstly 'to think deeply about', 'to contemplate', to 'identify successes and failures', 'strengths and weaknesses'. Then secondly reflect means 'to take into account', 'to follow' or 'to mirror'. So where a student sees 'reflect' it means to look back closely and incorporate what needs to be brought forward. Reflecting within the design process will help them to identify what to do next.

SCRUM

Scrum is a project management tool (see separate section 'Project Management Tools'). It is used extensively in software development but increasingly in consumer product design and development. The name comes from the scrum (or scrummage) in the game of rugby, where a scrum is used to restart the game.

Scrum uses the iterative design process, each design iteration taking typically 2 - 3 weeks and called a Sprint. Scrum as a project management tool or method involves collaboration, use of software, teams organising themselves, and flexibility to adapt to changed stakeholder requirements.

The features of a product or system to be designed are prioritised in rank order and then the highest priority is designed first. Daily Scrum meetings are held to monitor and manage progress. The design of each feature is tested, refined and completed before starting the next. In this way the turnaround time is optimised and stakeholder feedback incorporated.

Teaching resources

Video '*Introduction to Scrum*' by Michael James, plus other videos and resources at: http://scrummethodology.com

A '*Scrum Reference Card*' produced by Michael James is available at: http://scrumreferencecard.com/scrum-reference-card/

SIX SIGMA

Six Sigma is a project management tool (see separate section 'Project Management Tools').

Sigma is a Greek letter, and means 'variation from a standard'. Six Sigma is a set of tools and techniques to ensure consistent output in manufacturing, where there is as little variation from the required standard as possible. This will reduce the number of faulty products manufactured, and will increase stakeholder satisfaction. The aim of Six Sigma is to ensure the highest quality of manufacturing by identifying and removing the causes of defects. The approach focuses on using statistical data and analysing results to minimise variability in the processes of manufacturing, to get as close to 'zero defects' as possible.

Six sigma recognises that people are at the centre of a business or company, and gives certification and rewards to recognise people's training and experience. Training in statistical thinking is important at all levels and key people are given extensive training in advanced statistics and project management to be designated 'Black Belts'. Other six sigma belts include the Green Belt and Master Black Belt.

Teaching resources

A series of six sigma project management tools can be found at: https://www.isixsigma.com/methodology/project-management/

The article 'Six Sigma' at: http://searchcio.techtarget.com/definition/Six-Sigma explains two six Sigma methods.

SKETCH MODELLING

The communicating and presenting of many design proposals is an essential part of the iterative design process, enabling users and stakeholders to engage with designs and give feedback for the next iteration.

In the early stages of creating designs it is important to produce something tangible as soon as possible that can be interacted with and seen in 3D. This only needs to be 'enough' to show what the idea or concept is, with little detail, so that the general idea can be accepted or rejected, and suggestions made for the next iteration. Sketch models are not quick sketches but quick models, often of just parts of a design, made from easy-to-work and low cost materials such as cardboard or foam.

Sketch modelling skills are important in architecture. Architects use sketch models to show first ideas. More refined models are referred to as presentation models.

Teaching resources

Video 'Curved Joint in Cardboard for Design Modelling': https://www.youtube.com/watch?v=9xHAbRAXBko

Many excellent resources, videos, tutorials, tips and inspirational material: http://www.judepullen.com/designmodelling/700-2/

Video 'Top tip for cardboard modelling produced' by James Dyson Foundation: https://www.youtube.com/watch?v=z0nhQonMbH8

Student activity

(A selection of materials and usual modelling tools will be set out ready before the task).
You have just 45 minutes to create a sketch model for an innovative new design for a means of transporting people over short distances in a town centre. No need to draw anything first, although you can if you wish. Then explain your sketch model with your group, and obtain feedback to create a second iteration in your next 45 minute session. Then share your second sketch model and see just how much your design has progressed. Also discuss your thoughts and experiences during the two sessions, and how useful the process was.

SPECIFICATIONS

Specifications are used extensively in all fields of real-world designing and manufacturing. They form an integral and important part of the iterative design process, listing requirements or specific details as required at any point of the process to give focus, structure and direction to the next steps. In industry different types of specifications are used at different stages, but all are supported by real knowledge and understanding. Until the point that this specific knowledge is clear enough the focus is on identifying requirements that may need to be outlined in a specification. **Requirements** that may be considered are:

- User or stakeholder requirements - compiled following discussions/investigations with users and stakeholders
- Technical requirements such as:
  - Materials – requirements to be satisfied by the material selection
  - Functional – listing what a product or system must do
  - Performance – specifying the structures and operations a product or system must be able to perform

In the iterative design project, as designs and prototypes are tested and user and stakeholder feedback obtained, it is likely that the requirements for the product or aspects of it will become clearer, more defined, or may need to change.

As designs make their way through the design and manufacturing process in industry a variety of different specifications, as relevant to the product and manufacturing processes being undertaken, these include:

- **Product specifications** – Information specifying a product's required characteristics and features documented in a manner that facilitates its procurement or production.
- **Manufacturing specifications** – all the information needed to manufacture the product
- **Maintenance specifications** – for regular servicing and care of the product

In order to offer conformity and clarity, these different specifications should be understood, though in relation to the NEA content of the Specification, students are required to deliver a **Technical Specification**. This is an opportunity to offer sufficient and specific information as to how their design solution would be made, what it is intended to do and what materials, components and manufacturing processes are required in order to fulfil its production.

Delivering a specification in iterative designing should be:

- centred on identified requirements (both stakeholder and technical)
- clear and specific (not vague or generic)
- explicit (can't be misunderstood)
- measurable (will normally include numerical /quantitative data, e.g. dimensions, tolerances)
- justified (include reasoning)
- approved by users and stakeholders

Teaching resources

A list of typical headings and areas to be covered by a Product Design Specification (PDS) in an Engineering Design context: http://homepages.cae.wisc.edu/~me349/lecture_notes/product_design_spec.pdf

An example of a requirements specification for an Ambulance Dispatch System:
http://www.slideshare.net/indrisrozas/example-requirements-specification

An example of a Product Design Specification (PDS) for a Portable Winch:
https://ay12-14.moodle.wisc.edu/prod/pluginfile.php/104561/mod_resource/content/1/eg_product_design_specification.pdf

SWOT ANALYSIS

SWOT is an acronym for strengths, weaknesses, opportunities, and threats.

A SWOT analysis can be carried out on any subject (e.g. a product, person, business, industry or place).The analysis starts with an aim and then identifies the strengths and weaknesses of the subject (e.g. product, person, etc.) to achieve the aim, and the opportunities and threats to achieving the aim.

Teaching resources

A helpful article explaining how a SWOT analysis can be applied as a method of reflecting in creative subjects: '*SWOT Analysis in Art, Design and Media*' by Daniel Freaker at: http://www.pearsonportfolio.co.uk/teaching/swot-analysis-in-art-design-and-media/

Article and video 'SWOT analysis' by Tim Friesner: http://www.marketingteacher.com/swot-analysis/

Student activity

Using an internet search engine, find examples of SWOT analysis. An image search will quickly reveal many examples, Try adding other relevant criteria to the search such as 'student', 'design', 'technology' and 'project', and hopefully you will find interesting and relevant examples.

Carry out your own SWOT analysis of a project you are working on at this time.

SYSTEMS THINKING

This is mentioned in the NEA content requirements, and it has an important place there. It refers to the understanding of a product or component as part of a larger system of other products and systems. In the iterative design process, consideration of the role of all components and sub-systems of the product or system, including the user experience and the marketing of the object being designed. It ensures all aspects of the product are given the attention to detail required.

Teaching resources

Don Norman is known for his books on design, especially '*The Design of Everyday Things*' (MIT Press Revised 2013 ISBN 9780262525671) which has a strong focus on user-centred design. The link below is to his essay in the Society for Interaction Design magazine (October 2009) entitled '*Systems Thinking: A Product Is More Than the Product*'. It explains the meaning of systems thinking really well with examples from everyday products such as cash machines, digital cameras, iPods, BMW Mini Cooper, and Amazon Kindle. The iPod story is particularly helpful:
http://www.jnd.org/dn.mss/systems_thinking_a_product_is_more_than_the_product.html

Student activity

In groups, disassemble an everyday product and carry out a design critique, including a list of the systems in and around the product.

TOLERANCES

When manufacturing products and components it is important to ensure they are uniform in size. This requires precision in manufacture and checking for accuracy. It is often accepted that there may be very slight variations in size, but the percentage or amount of variation will have to be agreed to ensure the product or component meets it's requirements.

The components of a mechanical device such as a paper punch are manufactured separately, and it is important to know that they will fit together when they are brought together, avoiding any modification to make them fit. To enable this to happen, the component parts need to be manufactured within a specified tolerance, and this would normally be indicated in specifications. The tolerance states the acceptable variation in size for each component. Tolerances may also refer to other characteristics such as weight, capacity, quantity, or hardness.

The correct use and application of tolerances is crucial. Today's products, whether they are car engines or mobile phones, clothing fasteners or cardboard containers, are made to close tolerances, ensuring reliability and efficiency.

Quality control measures during manufacture ensure the specified tolerances are attained.

When working with textile materials, production often refers to a **seam allowance**. This should not be confused with tolerance. Seam allowances refer to material added to the shape of a pattern to allow for the accurate joining of parts.

Student activity

- List examples where tolerances are critical and particularly relevant to the function or performance of a product.
- Use the internet to find out
  a) how tolerances are shown on the dimensions of a drawn component
  b) the different types of 'fit'

The following presentation should help if needed:
http://www.slideshare.net/shrikantdokhale/ppt-fits-tolerances1?ref=http://www.advice-manufacturing.com/Limits-Fits-and-Tolerances.html

USABILITY

'Is the product user-friendly?' is a question often asked, and this is what usability refers to: how easy the product is to use, how clear and obvious the functions are.

Functionality has a similar meaning, but asks whether the product performs its intended function, rather than how capable it is of serving its purpose.

Inclusive (or universal) design should already be a familiar term, meaning the product is accessible to (can be understood and be used by) everyone, regardless of age, ability, status, including those with some sort of disability, without special adaptation.

Assessing the usability of a product involves thinking about the people who will use it (e.g. their background and culture), different ways in which people interact with the product (e.g. opening, closing, operating, carrying, adjusting, or switching) and the different situations (e.g. bright or dark, outdoors or indoors) in which the product will be used.

In the Iterative Design Project, user testing of early product prototypes will highlight any usability issues. Problems should be noted, the design changed, and this process repeated until the problem is fixed. The user experience is central. Observing what a user does, how they perform activities, along with consideration of ergonomics and anthropometric data, is important.

Teaching resources

ISO (the International Organisation for Standardisation) prepare international standards. International Standard ISO 9241 (1998) '*Ergonomic requirements for office work*. . . .' includes a concise and helpful definition of usability and other associated terms. Look at the definition of usability in the Introduction, then Section 3 defines the terminology used in that definition: https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-1:v1:en

USER-CENTRED DESIGN

Sometimes called 'human-centred design', user-centred design (UCD) is a design strategy, or design approach, with the aim of making products and systems usable. It focuses on the user interface, how the user interacts with and relates to the product; creating products with a high level of usability. It draws from many different subject areas and disciplines. Students will be expected to apply UCD principles as appropriate in their iterative design project.

One of the underlying principles is that the design of a product, or a specific task with a product or system, should match its intended users' behaviour patterns, attitudes and preferences. This is rather than the other way round where the user is required to adapt their behaviour and attitudes to learn and use a product or system. The end result is a product that gives a more efficient, satisfying, and user-friendly experience for the user, which in business and commercial terms will translate into increased sales and brand loyalty.

UCD involves users throughout an iterative design and development process, evaluating the complete user experience, testing prototypes with actual users, basing design iterations on a thorough understanding of users, the tasks to be performed, and environments.

Student activity

The User Experience Professionals Association (UXPA) has created 'Designing The User Experience, a board game': http://www.mprove.de/script/00/upa/_media/upaposter_11x17.pdf

Teaching resources

Pascal Raabe's information graphic poster 'The underlying lifecycle, methods, principles and techniques in a user centred design process where the visual part is only the tip of the iceberg', complete with cute characters and penguins: http://paznow.s3.amazonaws.com/User-Centred-Design.pdf

UXMatters has published 59 articles on user centred design, at: http://www.uxmatters.com/topics/process/user-centered-design/

OTHER TEACHING RESOURCES

(not specific to any area above)

Many useful videos on all aspects of design, designed for students of design. Producttank YouTube channel exemplifies different and innovative design terminology, thinking and approaches: https://www.youtube.com/user/producttank

Some useful online quizzes and games re. Design and Technology Terms: https://quizlet.com/5854306/ib-design-technology-terms-flash-cards/

Three inspirational websites showing enterprise, ingenuity and innovation, and exemplifying new design terminology, thinking and approaches:

Quirky is a collaborative invention platform where ideas are shared, developed, refined, branded and marketed: www.quirky.com

Core77 is an online publisher of all things design for design students and professionals. Many useful resources and inspirational design thinking and approaches relevant to all Design and Technology Specifications at GCSE and AS/A level: www.core77.com

Kickstarter provides resources and support to designers in all fields, bringing innovative ideas into reality. Examples of products include a selfie broom, a smart tape measure, and smart surfaces: www.kickstarter.com

Book: William Lidwell, Kritina Holden, Jill Butler (2003, 2011) *Universal Principles of Design (125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design)* Rockport Publishers, Inc. ISBN: 978-1-59253-587-3

This excellent book, a type of design encyclopaedia, draws together key principles for design from many design disciplines into one resource. It covers a comprehensive range of design strategies, approaches and methods, many of which can be applied to OCR's GCSE and GCE Design and Technology qualifications to satisfy the requirement to use different design strategies.

A series of videos are available to cover each design topic in turn. For example, Universal Principles of Design - Iteration: https://www.youtube.com/watch?v=WsMjqSVHffI

The small print

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