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GCSE (9–1)
Teacher Guide

DESIGN AND TECHNOLOGY

J310
For first teaching in 2017

The changes in terminology and language

Version 1

www.ocr.org.uk/gcsedesignandtechnology

CONTENTS

INTRODUCTION – A CHANGE IN EMPHASIS AND APPROACH

The new GCSE specification is very broad in its scope, reflecting real world practice in the creative, manufacturing, and engineering industries. It is a significant change in emphasis and approach, with many widely used design concepts and methods now included into the Design and Technology specification.

The aim of this guide is to introduce the changes to the language and terminology used in the new GCSE Design and Technology specification. It builds on and further clarifies key words and phrases in the specifications Glossary (Appendix 5e).

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 paper and non-exam assessment. 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 in any iterative design process, where designs are worked and re-worked to make better and better solutions. This is to make sure the development of designs is purposeful and relevant, through a user-centred approach. Regular consideration of users and stakeholders' needs throughout the process are important in improving and refining designs. It is also important to build skills in critical evaluation and planning in order to have a clearer understanding of the design problem and know what to do next. These ensure that design solutions and prototypes are progressive and meet the requirements they are intended for.

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

STAKEHOLDERS

The word 'stakeholder' appears over 30 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. Further stakeholders have influence in how the business operates, 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 that are present at the location where the product is used; energy suppliers and many more.

Some stakeholders' input or influence is greater than others, but it is important to know who the potential stakeholders are at the start and that there is good communication between them and the designer throughout the design process, to ensure that the design solution is successful for everyone who has a stake in it.

Student activity

Think about the design of a child's toy. 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 design processes 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 challenge
- 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
- Suggesting modifications, further iterations and future developments

After exploring the initial context and writing a brief, there is no set order to the iterative design wheel. A project may begin with the creation of a simple prototype to obtain comment. Continually managing and planning the 'next-steps' of iterative designing are vitally important.

Teaching resources

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

NEW WORDS AND TERMS

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

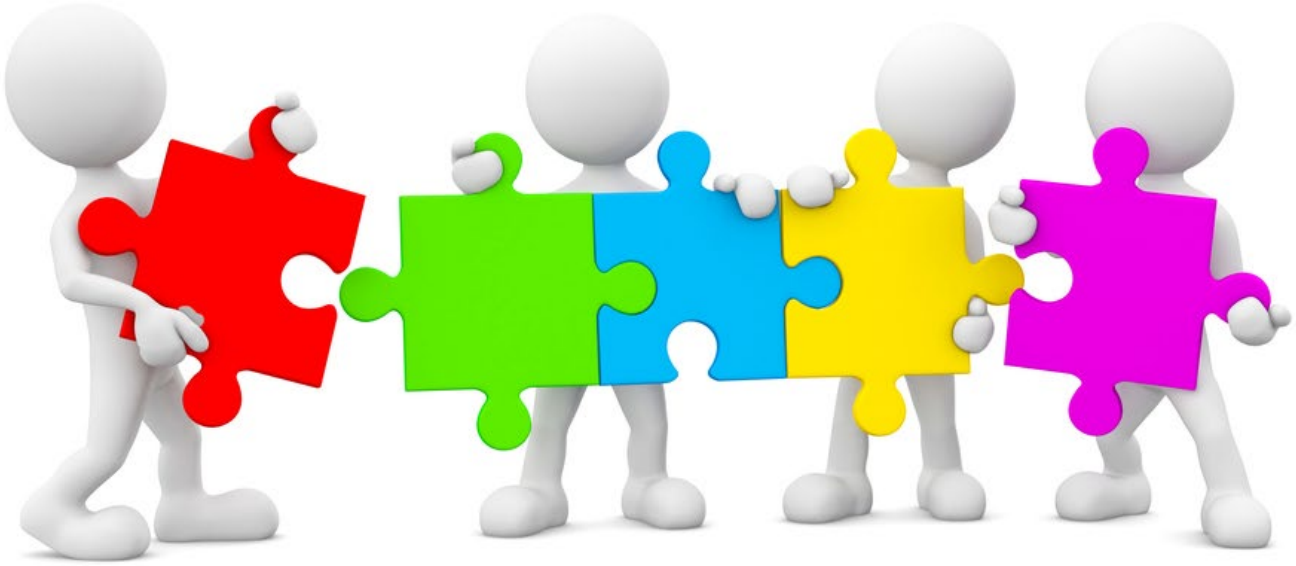
List as many potential benefits of a circular economy as possible.

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.



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.

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 OPTIMISATION

In a highly competitive world with more complex products and systems, the smartest, most reliable and most efficient products succeed. Design optimisation is the identification of the best choices when modifying a design in terms of optimum use of materials, manufacturing process 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.

There are various ways to consider design optimisation, though generally testing, simulating and modelling possible design modifications to find their limits or boundaries reveals solutions that provide the best outcome. Specialist software is used in the design and engineering industries. Results of testing are analysed, predicting performance, and using charts and graphs to represent data relating to possible design improvements.

In industry, meetings may be held regularly where teams of design professionals gather to look closely at a prototype, considering its efficiency and effectiveness to discuss ways that the design might be optimised. For example, when looking at 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, use a different method of manufacture, replace component parts with simpler alternatives, and so on.

As part of their evaluation during their iterative design challenge, students could 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

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

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?

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.

Student activity

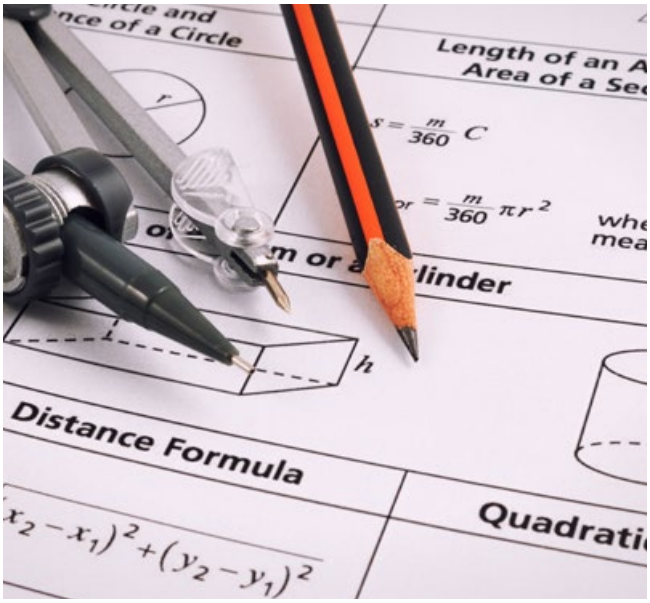
Choose any everyday product, preferably small enough for you and a small group to gather round.
Why do people buy this product? Look at it very closely from all angles and make a list of the features of the product that make it marketable, the features of the design and its packaging that give it marketability, 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
- 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 product or service becomes 'out of date' or 'unfashionable'.

Planned 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.

The morals and ethics of planned obsolescence 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.

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 challenge 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'?

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.

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

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 tolerance states the acceptable variation in size for each component, and would normally be indicated in specifications. 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.

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

1. List examples where tolerances are critical and particularly relevant to the function or performance of a product.
2. 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

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 how the user interacts with and relates to the product; creating products with a good consideration of usability.

One of the underlying principles is that the design of a product should match its intended users' behaviour patterns, attitudes and preferences, rather than the user adapting their behaviour and attitudes to 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 the environments the they will be performed in.

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: http://www.uxmatters.com/topics/process/user-centered-design/

USABILITY

'Is the product user-friendly?' 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 design should 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 Challenge, user testing will highlight any usability issues. These can then be considered problems to note and be solved through the design process. The user experience is central. Observing what a user does, how they perform activities, along with consideration of ergonomics and anthropometric data, is important.

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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