Sustainability in product design

Sustainable Design

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Introduction

Why design with sustainability in mind?

Worldwide awareness of environmental issues has never been more acute. The impact of the massive quantities of waste plastics in the oceans offer just an example of how products, packaging and non-degradable materials can affect our lives. Every day more consumers choose products based on the environmental impact, forcing manufacturers to reconsider how they develop and market products. Sustainable design is fast becoming a matter of global corporate citizenship.

Product design

Taking on the challenge of incorporating sustainability into design means making decisions to ensure future environmental stability. As a designer you can be bold about using a sustainable model in product design and how designing for the environment sets you and your products apart.

GCSEs

GCSE students will need to consider sustainability as part of the core examination and the contextual challenge, the non-examined assessment part of the Design and Technology GCSE.

Sustainability is now an integral part of the exam and students should show how they consider all the factors involved in developing and manufacturing a product before they finalise its design.

Life cycle assessment

What is sustainability?

Definitions

While most people intuitively understand what is meant by sustainability, it's difficult to actually pin down since it can cover so many areas. The World Commission on Environment and Development created one of the best-known and often used definitions:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

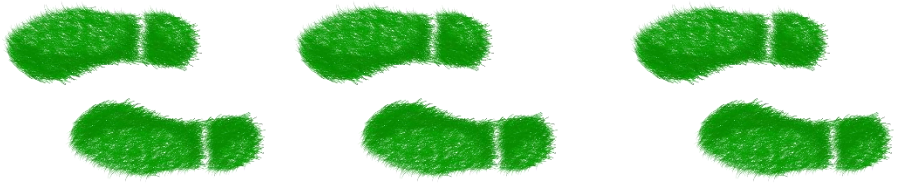
The Natural Step, in another widely-adopted framework, lays out four system conditions, derived from the laws of thermodynamics, through which such a state can be achieved:

In a sustainable society, nature is not subject to systematically increasing:

- *concentrations of substances extracted from the Earth's crust*
- *concentrations of substances produced by society*
- *degradation by physical means*

and, in that society:

- *people are not subject to conditions that systemically undermine their capacity to meet their needs.*



Designing in contexts – the GCSE specifications

Apart from a brief mention of the wider environment, the secondary Key Stage 3 2014 programmes of study for design and technology do not include sustainability specifically. However, each of the awarding organisations' specifications ask that students cover sustainability, life-cycle analysis and environmental issues in some depth.

Exam questions

Students should expect exam questions on aspects of the environmental impact of the use of materials and on sustainable design, either directly, or when the opportunity to answer a question widely is given. The ***design specification*** (a likely aspect of the exam paper and in the contextual challenge) should include reference to how environmentally friendly the product will be and the materials it is made from.

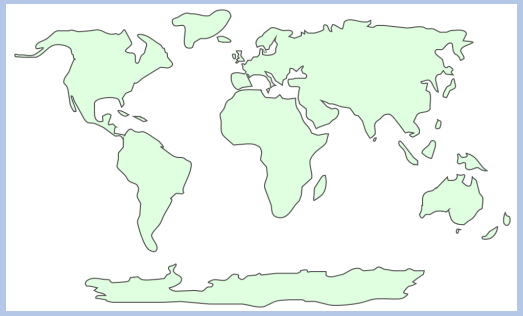
Climate change impact

The global climate results from a great many interacting systems and responds to other impacts such as pollution and natural resource depletion. However, the effect of global warming in particular has been identified as a key factor in shaping the future of life on Earth.

Global Warming

Carbon dioxide (CO_2), methane (CH_4), and other so-called greenhouse gases resulting from burning fossil fuels accumulate in the atmosphere, trapping solar heat which in turn increases the earth's average temperature. A product's climate change impact is often referred to as its '***carbon footprint***' because global warming potential is usually measured in units of carbon dioxide equivalent (CO_2e). It is widely accepted that global warming is the cause of such problems as loss of glaciers, extinction of species, soil moisture loss, changes in wind and ocean patterns, and more extreme weather.

Natural resource depletion



Human activity uses up the Earth's natural resources. Land use, mineral extraction, water and sources of energy are all in demand for industrial processes and '***depletion***' means quantities of these or access to them is becoming limited.

Land use

More land is given over to housing, roads and industrial use each year. Much of this is not reversible due to contamination and erosion, and mining and single-species farming limits biodiversity and human access. Building houses and roads on land that used to be available to soak up excess rainfall also has an effect on flooding and the water table.

Mineral extraction

Minerals, including metals, are a finite resource. Once a mineral deposit (like iron ore) is mined, it doesn't return to the earth as ore, no matter how much it's reused or recycled. Any minerals taken from the earth will not be available for future generations in this form.

Water

Once used fresh water must be processed back to its clean state. Salt water can be processed to help make land available for agriculture, but at a significant cost. While water is renewable, the condition it is in and its location can limit its usefulness as a resource.

Energy sources

Non-renewable natural resources such as oil, coal, and natural gas are used to provide energy. Even green products such as hybrid cars rely on the energy used during their manufacture and use.

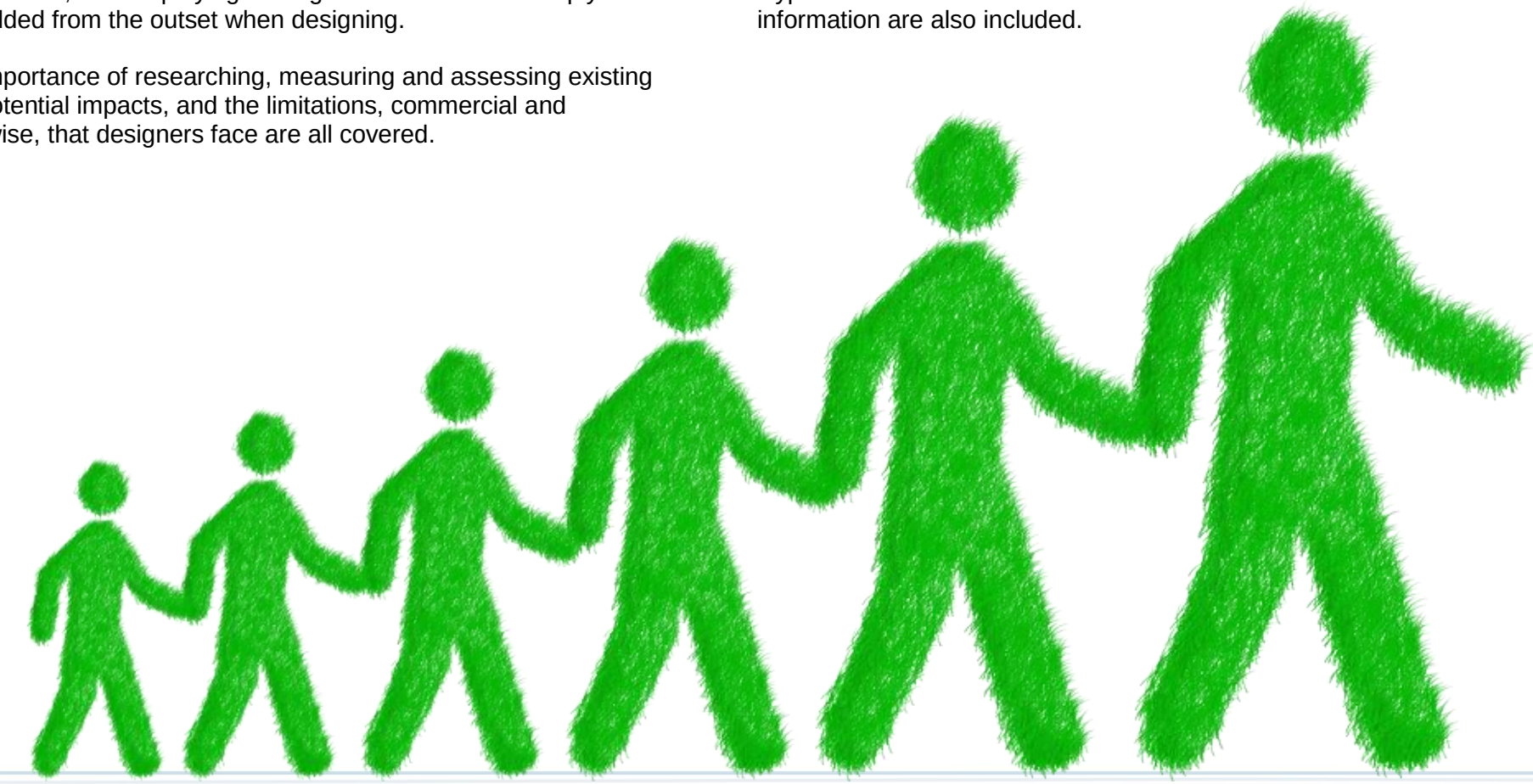
How to use this guide

The guide offers a wide-ranging look at sustainability in product design at an appropriate level for GCSE and A Level students. It explores the role of the product designer and the many factors they should be aware of when considering designs for users, particularly considering the impact of existing and new designs on the environment, and employing strategies that should be deeply embedded from the outset when designing.

The importance of researching, measuring and assessing existing and potential impacts, and the limitations, commercial and otherwise, that designers face are all covered.

Students can bring this knowledge to developing their GCSE and A Level designs for the contextual challenge and in written exams. Some examples and indications of how sustainability is included in the curriculum, and how this should be addressed in exams.

Hyperlinks to sections and to useful external sources of further information are also included.



Background

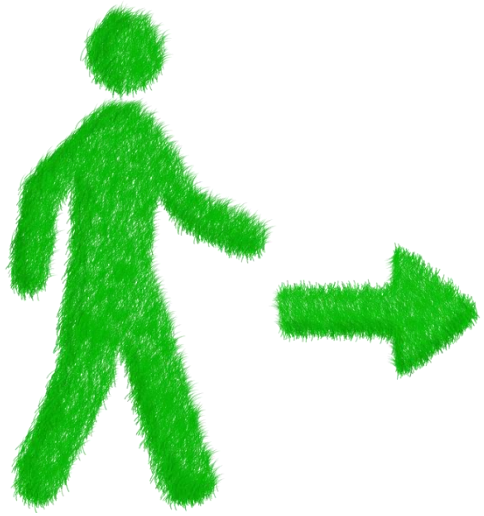
Designing with sustainability in mind – the role of the product designer

The role of the product designer

The product designer plays a critical role in ensuring that a product conforms to the principles of sustainability. They have an impact in the pivotal stage where decisions are made about what materials are needed, the processes, what the product's lifecycle looks like, and what its end-of-life, its ultimate disposal, looks like. Considering sustainability early in the design process means that the benefits can be locked in from the beginning, whereas leaving this for later stages may mean changing the process mid-way and a potentially costly clean-up needed.

Understanding the issues

From this early stage a good understanding of the issues is important for any product designer. For example, a product designed for easy disassembly requires much less effort to convert into recyclable and reusable components than one designed as a single unit. Extracting valuable metals and other components from mobile phones or computer chips should be made easy, where the alternative might be burning away plastics to leave the metals as a residue.



Sustainable design solutions

Sustainable design can be included in a wide range of solutions. This might involve low tech solutions such as reusing plastic bottles as roof lights and irrigation systems, reusing wooden pallets as furniture or bicycles as generators. However, designing sustainability into a product from the start also offers effective solutions to materials usage and waste disposal.

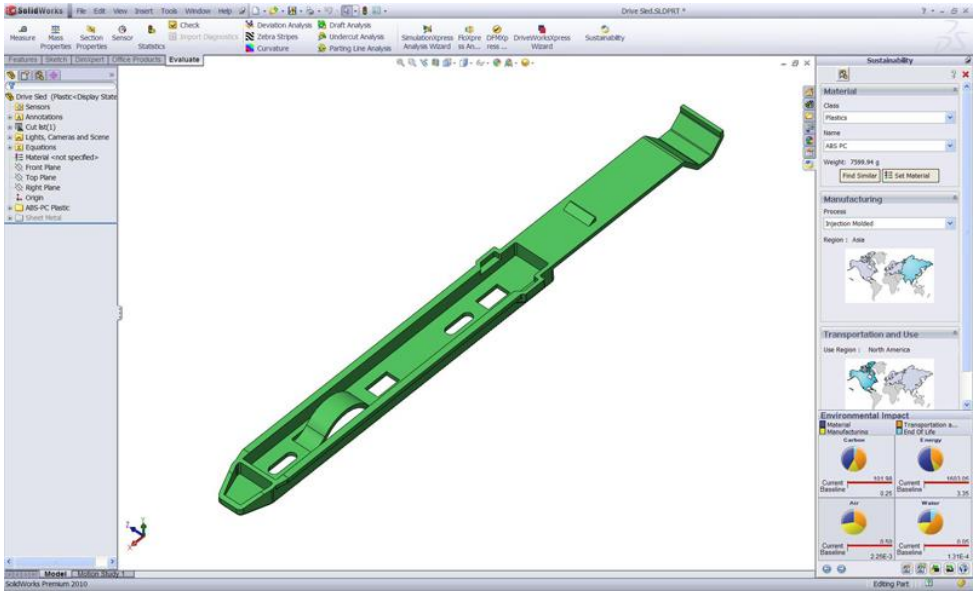
High tech solutions include the development of hybrid cars and minimising energy use in consumer products. The impact of the internet of things where products can monitor their own energy use and examples such as systems that check buildings' efficiency and irrigation water loss and immediately communicate information on the need for servicing and repair are also effective sustainable solutions.

Design decisions

There are many decisions over which design engineers have little or no influence however. For example, the designer cannot always choose where a component is manufactured, transportation modes, the materials that suppliers use, etc. However, designers can influence a product's environmental impact. The role of the designer is often highly valued and being seen to show awareness of a responsible route in production is increasingly thought beneficial to a company's reputation, as well as perhaps saving costs.

Design tools

There are many tools available to product designers, such as CAD packages, that can help with refining a design to minimise waste and testing structural viability and impacts. Prototyping designs and the iterative design process helps with developing and testing designs to ensure they meet expectations.



Life cycle assessment

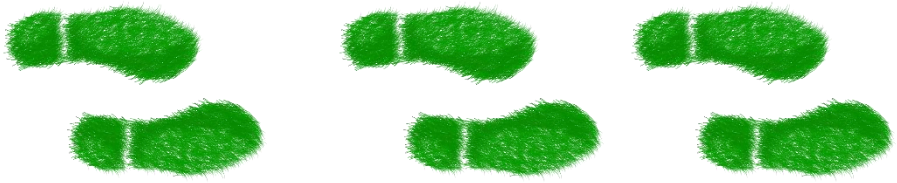
Life Cycle Assessment

Life Cycle Assessment (or Life Cycle Analysis) is the detailed analysis that gives you the information you need to make the most environmentally friendly decisions. It is a standardised way of measuring the environmental impact of a process, activity or product across its whole life. This can include ore extraction, material production, manufacturing, product use, end-of-life disposal, and all the transportation between these stages. It offers an objective way of evaluating the environmental impact by identifying the energy and materials used and wastes released to the environment. There are typically four steps:

- **Goal and Scope**: What are we trying to learn about the product or activity.
- **Inventory Analysis**: Identify all relevant elements in the product and gather data on energy and emissions etc.
- **Impact Assessment**: The effects of impacts upon the environment, humans etc.
- **Interpretation**: Assessing what this means in relation to the objectives of the study.

While formal LCA is thorough and gives a good bench mark, it is time consuming and expensive and there are less rigid approaches.

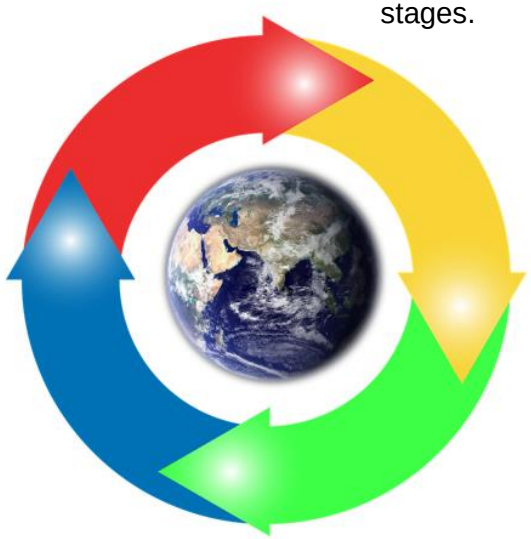
- **Qualitative Life Cycle Assessment** This approach involved a less stringent assessment by gathering a range of non-standard feedback but can offer a clear basis for understanding a product's impact across development, manufacture and use.
- **Life Cycle-Based Design** assessments are based on modelling products' environmental impacts, often based on existing data. Some approaches of this type are focused on particular industries or applications.



Sustainable thinking – the circular economy; embedding sustainable thinking

The Circular Economy

Traditional economic models follow a 'make-use-dispose' linear route. Moving to a circular economic model requires a significant shift in thinking about how products are designed to have a long and valuable life and be able to have components recovered and adapted to new uses without drawing upon further resources. Supporters of the model accept the need for new products and a growing economy at all levels but have changed the emphasis for technological products' life spans by incorporating reuse, repair, remanufacture and recycling from the initial stages.



Acceptance of the need for a sustainable model has its origins in the 1970s and 80s, through the 'Cradle to Cradle' model from William McDonough and Michael Braungart (2002) and more recently by the Ellen MacArthur Foundation (2012) in Towards the Circular Economy: Economic and business rationale for an accelerated transition. The European Commission introduced a Circular Economy proposal in 2015 and the British Standards Institution published BS 8001:2017 Framework for implementing the principles of the circular economy in organizations in 2017.

Sustainable thinking has rapidly become recognised and accepted as vital the future of the planet as the impact of population growth and consumers' desire for and ability to pay for new products increases.

Links

- https://www.ellenmacarthurfoundation.org/circular-economy
- http://www.mcdonough.com/cradle-to-cradle/
- https://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/becoming-more-sustainable-with-standards/BS8001-Circular-Economy/

Sustainable technologies – technologies that reduce the impacts of designs

Positive impacts

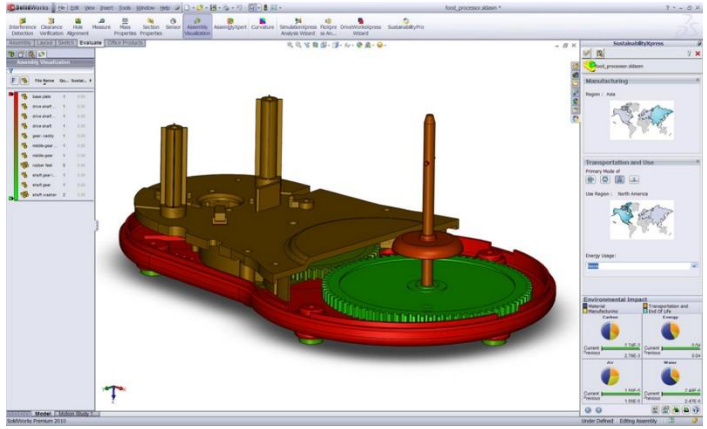
We can see the positive impact of emerging technological solutions as electronic vehicles, household appliances and mobile devices make use of more efficient, longer life batteries. Lighting is another area where the development and introduction of more efficient LED lighting has begun to replace power greedy halogen lights.

The pressure for developments in areas such as rechargeable, longer life batteries has aided their development and reduced the costs through mass production. Although this has a short-term negative impact on the environment as new production techniques are implemented and research and development undertaken, the longer-term use helps reduce the drain on natural resources.

Advances in technologies

Advances in technologies also allow for new products to be designed and developed for a wide range of uses. 3D printing can reduce the levels of waste produced through alternative production methods, while CAD modelling and the introduction of virtual and augmented realities means that there is less need to manufacture prototypes where testing can be carried out on computer models instead.

There are negative sides to new technologies also: the production of 3D printers itself uses raw materials and energy, and the constant requirement for faster computer systems to cope with new demands also puts strains on material and energy costs.

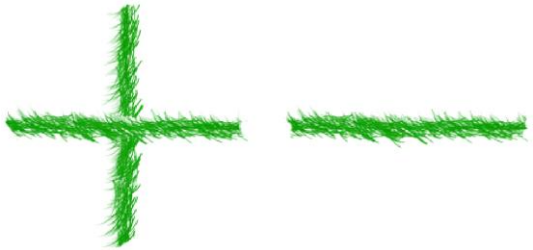


Discussion: positive and negative effects of sustainable design

It is tempting for product designers to include sustainability in designs without it being a central aspect, or to consider the real need for these products before embarking on a project. In her 2009 book '***Design Revolution***' Emily Pilloton calls on product designers to "*stop making stuff and start building solutions... design for the greater good isn't automatically good design, we have to be critical and create great systems that work*". This doesn't reject the need for new products but asks that we have a wider view that includes all aspects before designing.

Sourcing materials and manufacture locally, while sustainable, can exclude communities who have come to rely on demand for their (often cheaper) labour and skills. The impact of trying to be sustainable can therefore hurt as much as it heals. Charging for supermarket plastic bags and a reduction in their use put some manufacturers out of business.

Limiting the choice of materials to sustainable sources also offers less choice for the consumer, and quality may also be affected if, for example, plastics are rejected in favour of less resilient alternatives.



Developing products

Lifecycle stages

The principle areas to consider when developing designs for products are:

Raw material extraction
Including the energy and other resources needed to acquire the basic materials used in the product. This may be through mining, timber harvesting, oil extraction, etc.

Material processing
Raw materials are converted into forms used for manufacturing. Includes the processes required to make steel, copper, plastic feedstock, paper, petrol, and natural fibres for spinning and weaving etc. Chemical processing is often a part of this conversion process.

Part manufacturing
This stage covers single part manufacturing. Common processes include injection moulding, metal stamping and machining, spinning and fabric construction.

Assembly
Products often need to have individual components sub-assembled using different processes. This is often the first stage that brings together different materials (e.g., a plastic handle and a metal container), so environmental impact assessments can be more complex.

Product use
Any energy and emissions as well as other resources affected by the product during use are included here, including waste such as discarded packaging.

End-of-life
This usually means a product is no longer useable but there are many examples of disposable products with an end-of-life coming before end of usability (e.g. drinking straws and paper cups).

Measuring sustainability – counting the costs and impacts

To measure how much environmental impact a product has or how sustainable it is, we need to do so against known criteria. What, exactly, are we measuring? This can be done by comparing a product against previous, similar products, alternative designs or a fixed benchmark. To compare two products we can measure the function of the systems that operates in both. For example, for a coffee maker it might be the number of cups brewed, or for paint it could be surface protection over time. This way, it's possible to assess the impact of various ways to perform a specific function, without being constrained by differences in the forms of the designs.

Choosing what to measure

Three areas are worth considering:

- Impacts – are we looking at toxicity, water use, CO_2 equivalents etc?
- The scope of the assessment – how far up and down the supply chain does it go? How much of the product's lifecycle should it reflect?
- The types of metrics that are appropriate – what will the information be used for, and by whom? How much detail is needed?

Human health

The materials and processes used in product development, manufacture and disposal are often measured in terms of their impact on the wider environment, but they can have a more direct impact on humans too.

Toxic materials

Manufacturing process can release chemicals into the air, water, and soil and these can enter the human body through breathing, ingestion, and the skin. These may include cancer-causing agents (carcinogens), substances that can cause birth defects (teratogens), or other pathogens.

Respiratory infections

Burning fossil fuels and releasing chemicals into the air can potentially cause breathing difficulties or pulmonary infections due to the presence of hard particles or liquid aerosols.

Radiation

Exposure to high levels of radiation has the potential to damage living tissue, resulting in cancer, radiation sickness, mutation, and even death.

Establishing the likelihood of any of these occurring in product's lifecycle, and to what extent, can be a lengthy and difficult process.

Product analysis

Product analysis is all about studying how well a product does its job. It involves looking closely at different features of the product, for example the materials, aesthetics, manufacturing and environmental impact.

Why use product analysis?

Product analysis can help designers to identify problems or flaws in a product and develop new ideas by evaluating products already designed. It can help us understand how and why design decisions about a certain product have been made and can help us develop and improve our own ideas.

ACCESSFM

An effective and popular model for product analysis is ACCESSFM. While it includes a far-reaching analysis of: Aesthetics, Cost, Customer, Environment, Safety, Size, Function and Materials, each can help focus the analysis in considering the sustainability of a new or existing product.

Impact on the environment – plastics

A growing awareness of the impact of plastics has highlighted the impact of (often poor) design and a lack of consideration for end-of-life of products. Plastic products are cheap to produce, offer a good range of choice for the consumer and are durable, but it is this durability that causes harm to wildlife and pollutes the oceans, air and land.

With a global population of nearly eight billion and growing demand for products, the tons of plastic now in the oceans seems likely to increase, killing wildlife and polluting beaches and the seas. Products that are not easily broken down into their constituent materials has meant that disposal has often involved burning, polluting the air and land.

Plastic products come in many forms – from micro particles to plastic bags, packaging and bottles, and the very slow degradation means that we have to seek a solution both in using plastic as a material, and when considering its reuse and disposal. Sometimes this may involve designing in components that can be reused at a product's end-of-life or considering designs that use less or alternative materials.

CAD design packages often include features that allow designers to test for strength and flexibility in designs whilst using less material or trying out alternative structural solutions.

Research

A tool such as ACCESSFM can help you to develop a design idea to ensure the product is appropriate for the user and purpose, that it is functional and acceptable in terms of the look and feel, and safe and sustainable in its use of materials.

It is important to research the target market for your product carefully. The end user may have particular concerns about the materials used and the processes involved in production, as well as wanting a product that meets their needs. Think about the age, gender, socio-economic etc factors of the person you aim to market your product to.

In 2015 the UN published 17 Global Goals (also known as Sustainable Development Goals), aimed at ending world poverty by 2030. These include several that should be considered when designing products, including Sustainable Cities and Communities, Responsible Consumption and Production and Affordable and Clean Energy.

When considering the environmental impact, the 'six Rs' (Reduce, Reuse, Refuse, Rethink, Repair and Recycle) offers a practical and useful tool for analysis. The exam boards' GCSE specifications now include this approach to help students in developing designs.

Hidden costs

Transportation

Transportation is an important consideration to account for in the environmental impact of a product. There may be many stages in sourcing materials and manufacture of the product, as well as post-production stages where transportation takes place.

Delivery of raw materials to processing plants could be considered a part of the processing stage for example. In the motor vehicle and aircraft industries it is common for separate components to be manufactured in different countries and brought together for final assembly towards the end of the process.

There may be efficiencies and economic reasons for this, however the long-term effects of added pollution and warming should also be accounted for.

Results of research

Having completed an assessment on the design's likely environmental impact you need to decide what to do in response. If you have looked at previous data from other products you should have different means of compare your design against:

- **Standards**: These may be certain thresholds or impact profiles that have been accepted as industry or company standards.
- **Previous designs**: The aim may be to make each generation of a product more sustainable than the previous one.
- **Competitive products**: It is sometimes helpful to compare your product to others on the market or to seek your own solutions.
- **Alternative designs**: You may wish to consider and compare variations on a design to help decide upon development of the most sustainable options.

Decide which differences in the sets of data are worth considering. There may be significant cost implications of choosing a particular route or solution, for example.

80/20 rule

Try using the 80/20 rule, with 20% of the design contributing 80% of the impact. For example, in decreasing the impact of an electric coffeemaker the temptation might be to remould the plastic housing, since plastic is generally considered a non-sustainable material. However, something as simple as shortening the electric cable or decreasing energy use may significantly decrease its overall impact.

The use of components that use composite parts of materials is a significant factor when considering disposal. Products should be easily dismantled and have few component parts, ideally made from compatible materials that can be broken down together.

Designing in contexts – considering sustainability

The Contextual Challenge

The Contextual Challenge (Non-Examined Assessment) part of the Design and Technology GCSE offers wide scope to show an understanding of the sustainability factors involved in developing and manufacturing a product. Challenges will be different each year. They are broad in scope and allow students to use iterative design practices to develop their prototype whilst considering all relevant contexts and aspects of design. The exam boards' challenges include wider contexts such as smarter living, sustainability and the future, improving people's lives, recreational activities, social interaction, sport and leisure, educational development and a creative solution for a greener world.

To a varying degree these contextual challenges allow for sustainability issues to be a core part of design solutions. The specifications say they must:

- offer a broad range of real-world contexts, representing contemporary issues and concerns
- be open-ended, avoiding predetermining the materials or processes to be used to achieve a design solution
- focus on needs, wants and values of individuals and groups, leading students to address problems and/or opportunities

The product that students decide upon as a solution to the issues they have researched is not predetermined but in-depth research into all aspects of the context may result in a sustainable solution, and should in any case consider sustainability in the outcome.

See the section on Designing for success at GCSE and A Level for more details.

Designing in situ – localised solutions

Choosing to manufacture products close to the source of materials and markets may seem obvious in terms of limiting transport and waste, but the product designer may not have influence over these aspects. With food and products with a limited lifespan there may be less of an environmental impact in producing locally but also less choice for the consumer.

However, product design should consider and try to influence where and how materials are sourced and ensure that ease of manufacture and disassembly minimise excessive additional costs and impacts. The design is critical in affecting the inputs (including packaging), processes and end-of-life of a product and where these might occur.

Production processes will affect resources and land use such as water use and air quality impacts as well as waste disposal, and appropriate facilities close to manufacture need to be thought about when considering the design process.

Hidden costs

Packaging

Packaging is another area for consideration, closely linked to transportation. Perishable and fragile products need to be able to withstand the knocks that can potentially damage the products and cause waste or lower their value. However the packaging itself needs to be thought about in terms of its sustainability, whether it be cardboard boxes, plastic containers or materials used to protect objects from damage such as expanded polystyrene or bubble wrap. Thinking about reuse and ease of breakdown of packaging is a part of the design of a product as much as the product itself.

Packaging is also used to help sell a product and needs to be engaging and attractive, perhaps using inks, laminates and other finishes that may have an impact when considering their disposal.

Sustainable design strategies

In organisations sustainability manifests itself at a variety of levels, including:

- **Strategy** – companies may choose what to make or do based on sustainable business ideals.
- **Supply chain and value webs** – There is now increased attention to 'industrial ecology', which analyses material and energy flows. Some supermarkets require their suppliers to evaluate the full environmental impact of their products.
    - **Operations** – Decisions about how to make and move products increasingly reflect environmental impacts. Environmental Management Systems (EMS) in some companies track, document, and report the environmental impacts at each stage.
- **Product development and design** – Incorporating sustainability into new product development process range from specifically creating 'green' products to the reduction of the environmental impact of existing products.

Making savings

In the design challenges students will meet at GCSE and A Level, once the impact of a potential design is assessed they will be faced with options to include (or not) a more sustainable end product.

Optimising through a reduction in material and energy impacts often offers a significant and visible saving. This may be through locally sourcing materials and labour, thus cutting the transportation costs and effects; choosing different materials, but sometimes compromising on quality of longevity; and redesigning, perhaps using the tools available in CAD programmes, to measure the effects of reducing material weights by improving strength through geometry.

Other approaches may include fundamentally changing the design, including or discarding some aspects of the design, or considering how the product fits into a wider system (delivery of drinks through vending machines for example).

Designing for success at GCSE and A Level

The main focus here will be on the GCSE Contextual Challenge (Non-Examined Assessment) which forms 50% of the overall marks in the D&T GCSE. However, the skills and learning here should be carried forward to A Level where the same principles apply. The marks are largely awarded in the phase where the design solution that is selected from initial research and generation of design ideas is developed and refined. It is here and in the initial design concept stages that sustainability and the environment are significant considerations.

Sustainable design challenge and example case studies

The contextual challenges for the GCSE are released at the beginning of June and will be different each year. Design solutions will depend upon which context is chosen and the research into the user, purpose, feasibility, available materials and other factors that help students make these design decisions.

To illustrate some of the challenges that may be faced when considering sustainability, and the iterative process of developing designs to meet the challenges, two examples follow of designs that have been selected for development.

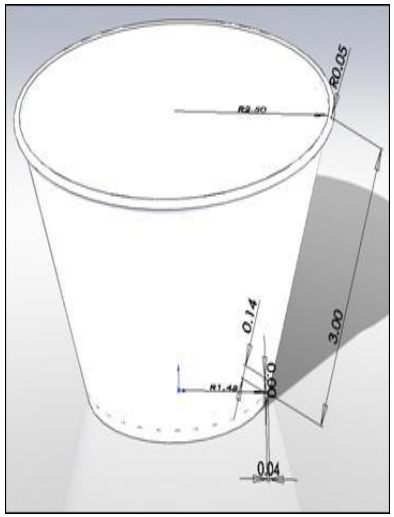
Greener disposable cups

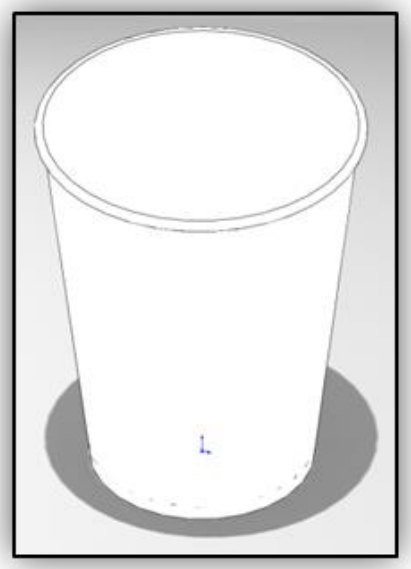
A context may require minimising waste in the use of everyday objects. The initial phase is to explore the needs and wants of the different parties: designing **Something for Someone for Some purpose**. You might look at existing examples and consider alternative approaches (perhaps switching to reusable cups or changing the delivery method from vending machines) and conduct an environmental impact assessment on existing products and your initial design solution idea.

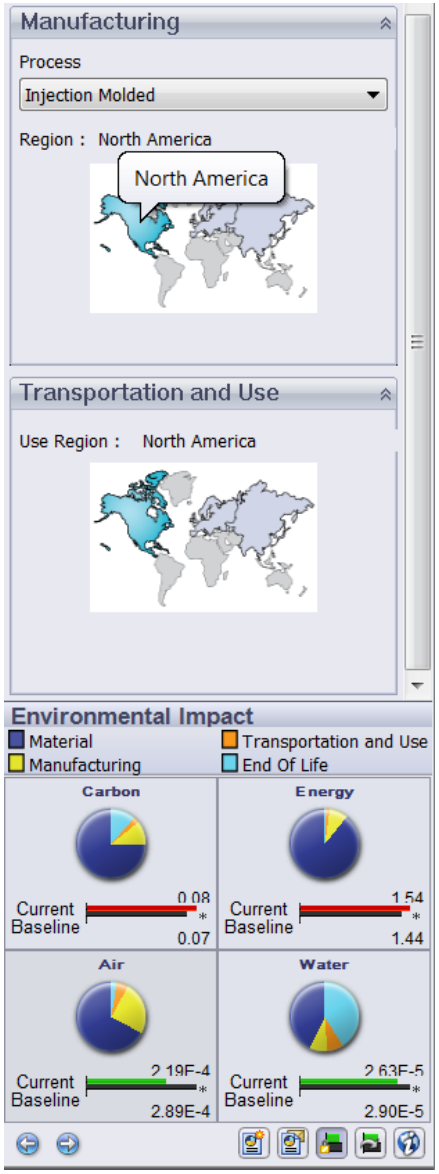
The next phase will be to select one design idea that is feasible but challenging and inspiring and develop and refine the idea through decisions about the technical, aesthetic, construction and marketing aspects. Here consideration of the nature and quantity of materials used, the manufacturing process, life-cycle analysis and end of life disposal all need to consider the potential environmental impact.

The design can be developed through manipulating the design models in CAD to minimise the materials used whilst retaining the necessary strength and insulating properties of the cup. Plenty of sketches and examples of CAD modelling will help show the iterative process. Alternative materials might be tested, and the delivery and disposal aspects considered.

A working prototype and a written or illustrated clarification of the full impact of design decisions will demonstrate what has been learned and understood. A final CAD or drawn model (including working specifications and CNC data where appropriate) will ensure that the prototype can be reproduced and the solution manufactured by a third party. Branding and marketing information will illustrate the proposed end-product and context for the solution.





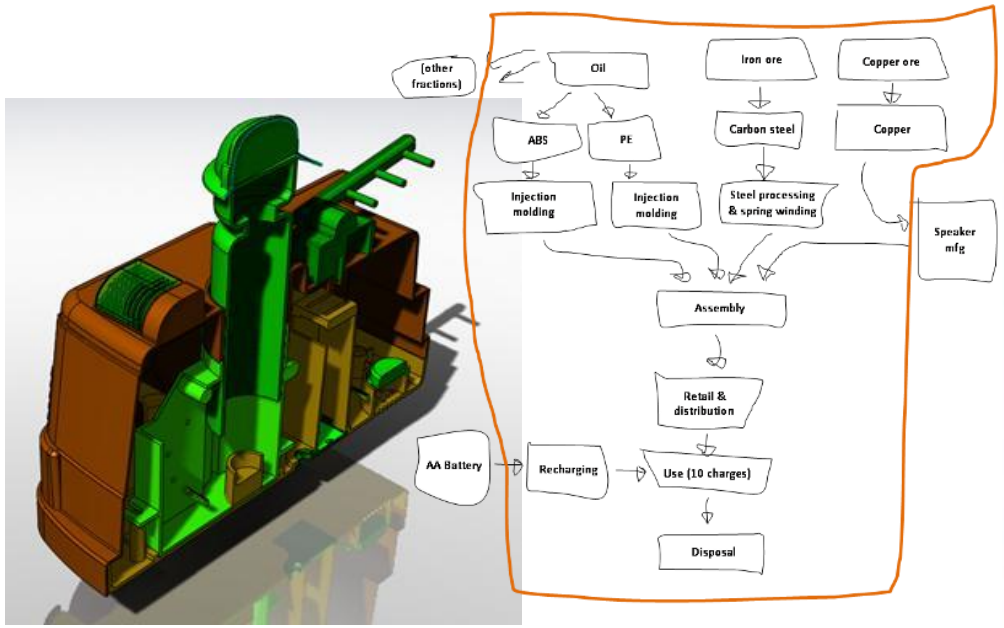


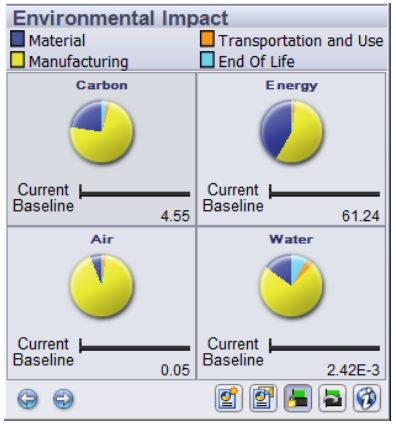
Greener programable toy

From a context of providing a child with a rewarding activity a programable toy may be selected as a potential solution. Initial research into existing products and the materials and process used in manufacture will provide data on the environmental aspects of these. They might use plastics, metals, batteries and other electrical components, all of which will need to be considered when deciding how the design will lessen the environmental impact. Think also about the associated transport and packaging requirements when it is manufactured and assembled.

Once an initial design has been selected, refinements such as choosing rechargeable batteries over disposable ones can be assessed. The choice of materials and structure of the toy can be adapted to minimise waste and the amount of materials calculated. There may be restrictions on the space required to house the microcontroller and other components, so alternatives should be considered also.

As with the drinking cups, plenty of evidence in the form of CAD and drawn examples, data charts showing the comparison of materials and options for using rechargeable batteries over disposable ones, etc will assist in showing how much has been understood in the development of the prototype.





National Curriculum specification on sustainability

GCSE

At GCSE, the specification requires students to build on their Key Stage 3 knowledge and understanding of sustainability in the areas of Technical Principles, selection of materials, through the critique of historic and present-day design and technology activity and, of course, in the contextual challenge.

A Level

The A Level specification requires students to develop knowledge and understanding of, amongst other things:

- the main features of manufacturing industries, including stages of production, quality assurance and quality control, modern manufacturing methods and systems when combining or processing materials, sustainability, and services to the customer including legal requirements.

and

- the environmental factors affecting disposal of waste, surplus materials, components and by-products, sustainability, and costs.

Changing attitudes

Businesses are traditionally valued in terms of their economic worth in numbers that can be easily discovered and assessed. The acceptance by many companies of their Corporate Social Responsibility, or more simply companies interested in sustainability, now focus on the triple bottom line of people, planet, and profit.

In the West, earlier generations often employed more sustainable habits: recycling glass milk and cola bottles, using less packaging, using more locally grown perishable foods, etc. This was often due to availability and cost. A global economy has benefits for, for example, growers in Africa to supply markets in Europe, but at the cost of additional transport and the need for better packaging in transit.

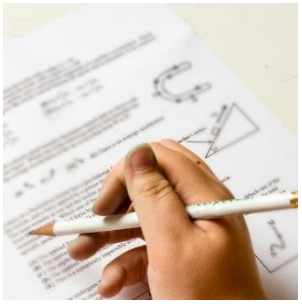
People today are recognising that access to a wide range of products comes with a cost and this has driven product designers to adopt appropriate considerations when designing for a public that often choses to put sustainability before other considerations.

Awarding organisations

All the examination boards' specifications have sustainability and environmental awareness as important considerations in both the written exam and when designing and making.

In the core content of the GCSE exam, Section A has a broad materials focus which includes types of materials, their sources, uses and properties rather than detailed knowledge about manufacturing with that material. Section B allows students to demonstrate specialist knowledge of one or more material area.

The awarding organisations' GCSE specifications all include ecological issues, social responsibility and ethical factors as well as the knowledge and understanding of social footprints left when designing. Sustainability is now central to product design in industry and the wider world as well as in exams and should be given due emphasis when answering questions appropriately.



AQA

Sustainability and the environment are covered in terms of the impact of resource development on the planet, disposal of waste and the positive as well as negative aspects of different ways or working and continuous improvement. Materials selection and the potential impact on deforestation, increased carbon dioxide levels, global warming and pollution, as well as fair trade principles, are also addressed.
AQA D&T GCSE specification

Edexcel

Sustainability is referenced in the impact of new and emerging technologies; aspects of materials selection: ecological footprint; designing and making and evaluation. In the core learning, what pupils need to learn is included in sections on the environment and environmental perspectives when evaluating new and emerging technologies; Choosing appropriate energy sources; the processes of designing and making; and materials.
Edexcel D&T GCSE specification

WJEC/Eduqas

Environmental issues and sustainability are considered in the core knowledge, impact on new and emerging technologies, engineering design and product design sections of the specification. These include awareness of the impact upon future generations; social, cultural, ethical, economic and environmental responsibilities including life cycle analysis and carbon footprints; generation of energy, including renewable energy, when making products; selection of materials, and the responsibilities of product designers with regard to a range of environmental factors.
Eduqas D&T GCSE specification

OCR

Global sustainable development, life-cycle assessment, social footprint and upcycling are all given prominence in OCR's specification. In product design, consideration of the wider environmental, social and economic influences and implications are considered, including: environmental initiatives, fair trade, social and ethical awareness and global sustainable development.
OCR D&T GCSE specification

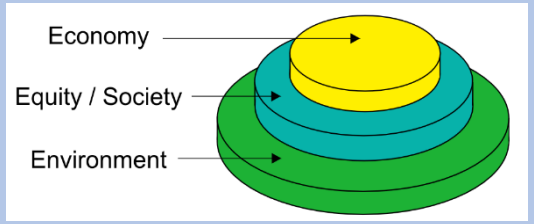
Discussion: Who benefits from sustainable design?

One answer to this is clear: we all benefit if the planet's natural resources are not exploited to excess. Changing design processes to incorporate renewable materials, recyclable components and manufacturing process that do not use excessive energy all help to lessen the impact of developing new products on limited resources.

Capital growth?
Some people question the need for new products to feed consumers' needs at all. While this grows the economy and sustains jobs and lifestyles, developing any new products has an effect on the environment. 'Do we need this?' is a question that might be asked before any product is considered for development at all.

Other alternative viewpoints such as those of supporters of the Circular Economy feel that new products, while providing for consumer needs, can be designed sustainably and now have the potentially draining effects some might fear.

Sustainability represents a balanced interaction between the human-built and natural worlds, often expressed as having three components: environment, social equity, and economy.



A healthy economy depends on a healthy society, both of which rely on a healthy environment. Sustainability occurs when all three are thriving.

Awarding organisations' exam questions

Awarding organisations tackle sustainability in slightly different ways, with different emphases on materials' origins, and greater detail given to some aspects, but they all include sustainability at the core.

GCSE

At GCSE, some examples of how sustainability will be addressed include short answer questions around:

- Offering reasons why manufacturers choose corrugated cardboard for pizza packaging.
- Identifying parts of a product made from sustainable materials.
- Identifying, from a list, which material is resistant to corrosion.
- Explaining one disadvantage of relying on wind power to produce energy.
- Choosing which energy saving components to incorporate into products to make them energy efficient.
- Explaining how to go about reducing waste when cutting shapes from a fabric roll.
- Assessing the impact of developments in materials technology on a named household product.
- From a list, identifying which energy source is a fossil fuel.

And more in-depth questions:

- When developing new products, explain why is it important to consider environmental issues in the design and manufacture phases?
- Evaluating a product's environmental footprint based on its component parts, sources of raw materials, energy use and manufacturing history.
- Evaluating how designers can lessen the impact on our environment when designing new textile products made from natural materials.
- Explaining how developing a new product might cause or increase deforestation.
- Using supplied information to make design decisions about which material to use for a new product.

A Level

A Level exam questions may have an associated resource booklet with information about a product or system which students are asked to critically examine and assess and provide a design solution. OCR has specimen papers and resource booklets covering designs for a rucksack for gap year travellers and another on built-in obsolescence of products at music festivals. Questions will be wide ranging and include materials, processes and users and may refer to the effects of these or a product's disposal on the environment.

Questions are often framed for the student to 'discuss' or 'evaluate' allowing for detailed answers and examples within the scope of the paper, for example:

'Discuss the effect on the environment of developing products using plastics and what designers can do to limit this. Include examples to support your answer.'

'A chain of shoe retailers wishes to extend their range and employs a designer to meet a new market for active, young people. Critically evaluate the choice of materials outlined in the resource booklet and the impact of this choice on the wider environment.'

Answers might include the choice of possible alternative materials and the positive and negative aspects of each, the potential of reusing existing materials, designing for disposal, minimising waste, careful labelling, etc.

Useful links

Practical Action – practical innovations to combat poverty

Government's policy on sustainable development

UN Sustainable Development Goals

Ellen McArthur Foundation – circular economy

BSI – circular economy

SolidWorks Sustainability website

Certified SolidWorks Associate certification

Design and Technology Association