THE JAMES DYSON FOUNDATION

INDEPENDENT LIVING

Design and Technology scheme of work

Key stage: 4

Duration: 6 weeks (approximately 12 hours)

Project overview: Design a prototype that makes an everyday task easier for a person with a disability.

The James Dyson Foundation is a charity supported by Dyson Ltd.

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OVERVIEW

ABOUT THE SCHEMES OF WORK

The new GCSE for Design and Technology (D&T) was introduced in 2017. It has shifted the focus of the subject towards problem solving in different contexts while remaining relevant for students. It allows D&T to simultaneously engage students' creativity and imagination whilst grounding their learning in mathematics and physics.

Students will learn how to take risks, be resourceful, innovative and enterprising. This scheme of work has been designed to support you in delivering project-based, engaging and relevant D&T lessons that are mapped to the national curriculum. The aim is to introduce your students to design engineering and teach them the skills they need to become an engineer.

LEARNING OBJECTIVES

Objectives
Understand how to use real design techniques to solve real problems.
Analyse and apply iterative design processes.
Identify and master the technical skills needed to produce design solutions.
Produce a functioning prototype that could solve a relevant problem.

ABOUT THE SCHOOLS PROJECT

The UK faces an annual shortfall of 59,000 graduate engineers and technicians

Engineering UK, 2018

Students' closest experience of engineering in secondary education is through D&T. Too often the subject is taught through limited and irrelevant project work. This approach neither promotes student engagement in the subject, nor reflects the exciting reality of an engineering career.

The James Dyson Foundation believes that a D&T curriculum based on iterative design, problem-led and project-based learning is more relevant and engaging to students. As a result, students enjoy D&T more, their perception of engineering improves and more students choose to study D&T and pursue engineering as a career.

Between 2012 and 2018, we worked with five schools in Bath to test this hypothesis. We helped these schools to develop their D&T labs and worked closely with them to develop schemes of work that reflect our beliefs.

Thank you to the teachers and students at Writhlington School, Ralph Allen School, Wellsway School, Hayesfield School and Chew Valley School, who helped to develop the content for this scheme of work.

As a result of our intervention:

32% of students chose to study D&T at GCSE in 2017, against a national figure of 18%.

Over the course of the project, student uptake of D&T at GCSE increased by 37%, whilst the national uptake has decreased by more than a half.

7% of students across all the schools opted to study D&T at A Level in 2017, against a national figure of 1.7%.

Over the course of the project, there was a 156% increase in the number of students who would like to pursue a career in engineering.

Between 2012 and 2018, there was a 300% increase in the number of girls who would like to be an engineer.

TEACHER RESOURCES

TEACHER'S NOTES

Context

This project requires students to consider and prototype ways to extend the capacity of an identified person or group of people with a specific disability, so that they have more control over their own environment.

Other design tasks with similar themes often focus on ways to monitor activities in the interests of safety or security. In this instance, students are tasked to go beyond this brief. They are expected to invent designs which actively enhance the dignity and independence of people by enabling them to take more control of an everyday action or activity.

Autonomy

Please note that this project is designed to have open-ended outcomes. It is important for students to feel that they can think the unthinkable and try things which may or may not work. The ideas generated may not develop into well-finished artefacts and the prototypes may not achieve great functionality. It is important to recognise this as a normal and useful function of the design process and assessors should look for evidence of how functions could operate, given more time for further iteration, provided the evidence is based on sound evaluation and appropriately recorded.

The design journey should reflect students' own evaluations and decisions, but it is important that students also recognise the role of users and place suitable importance on user needs within their design brief.

Scenarios

It is likely that many students will tackle challenges that disabled people experience in and around the home. However, the project should not rule out designs which attempt to make activities such as shopping, driving or accessing facilities more feasible. A number of possible scenarios have been provided to support the project if required. These scenarios are based on activities which, evidence has shown, people with disabilities would like to participate in and where young design engineers with fresh ideas might make a difference.

Learning management

The best way to initiate design thinking for this project is for students to engage in conversations with disabled people and understand first-hand what they may want or need to achieve greater control over a particular area of their lives. If this is not possible, there are many organisations providing secondary information about living with disabilities and most of these are very willing to discuss barriers to participation and ways to overcome them. A number of websites have also been suggested as resources within the scheme of work.

Teachers are not advised to offer simulations of disabilities such as visual or movement impairment as ways to encourage empathy in students. There is a risk that such exercises, apart from their short term nature, may produce emotions of fear, discomfort or embarrassment among students. Students are more likely to engage positively if they address the real experiences of a disabled person, learned about through conversation with the person in question.

The project asks for students' original and innovative thinking. Students may propose a range of possible design solutions, including some which are unexpected. Each will present its own skills and resource needs, which can pose a classroom management challenge for teachers. You will need to anticipate the skills and resource needs of students and deliver masterclass learning opportunities in context, as much as is possible.

TEACHER'S NOTES CONTINUED

Design iteration

While students should aim to create a high-quality final prototype, our goal is for students to practice a nonlinear and iterative design process. This ensures that students make improved versions of their designs within the project's time allocation and allows them to demonstrate skills in analysis, judgement and synthesis while simultaneously developing their technical skills. Students should understand that they need to master technical skills in order to realise good design solutions. Iterations will usually be justified by evaluation and may be accompanied by research. However, students may sometimes experiment in new directions even though the outcomes cannot initially be foreseen. The outcomes from students' work may be products or systems, but they will be prototypes and not finished products. Some systems, especially if students opt for electronic devices, may have many flaws in the detail but still demonstrate a good design overall.

Mapping

For convenience, this project has been mapped to the OCR J310 GCSE Design and Technology specification. Please note that this mapping is indicative only. You and your students will use a range of techniques and materials according to the needs of their design ideas, and some content maybe covered in more depth than others. Some project work will involve a significant degree of electronics but others may use none at all. You can use their professional judgement as to what masterclasses and other teaching is needed to ensure students can demonstrate their design and technical skills.

JDF project bone

This scheme of work has been created in line with a format that is applied to all James Dyson Foundation project work. This format is outlined below.

Phase one: Conception
Introduction to the contextual area and identification of problems, issues and user needs
Phase two: Development
Research into evidence and sources
Analysis of risks, scale, impact and affected people
Compilation of the design brief, project plan and evaluation criteria
Compilation of individual sketches and drawings
Phase three: Realisation
Early prototyping of possible solutions
Evaluation and iteration
Taught masterclasses to achieve technical skills
Completion of iterated and developed prototypes
Phase four: Explanation
Presented explanation of the prototype and design process
Portfolio

TOP TIPS FROM TEACHERS

Our resources have been created with the help of our champion teachers in our five Bath schools. Below are some of their hints and tips for running a James Dyson Foundation project.

Shift the focus to the design process, as opposed to assessment and producing a finished product.

If possible, arrange for students to present their work to an external visitor. This allows the students to take ownership over their project.

Teach technical knowledge through practical activities – this way students are more likely to retain this knowledge.

Remember these key words when planning lessons: Risk, failure, autonomy, iteration and prototyping

Teach failure as a technical term, not a criticism or opinion.

Create a habit of constantly documenting students' work.

Test, test, test – fail, fail, fail.

Avoid linear processes. Avoid fixation.

Be brave!

SCHEME OF WORK

OVERVIEW

Project overview

This project explores the contextual theme of extending human capacity.

There are about 11 million people in the UK living with a disability. That is about 18% of the whole UK population. The population is also ageing. About 18% of people living in the UK are now older than 65 and, as they get older, the likelihood of disability increases (ONS.gov.uk)

There is a great deal of equipment available to help people with disabilities monitoring their activity or informing support services if they fall or harm themselves.

The intentions behind these technologies are good, but sometimes assistance can actually result in reduced independence, taking power away from the person with a disability by limiting their autonomy and assuming that others can do better.

This project invites students to invent and prototype solutions to make some aspect of everyday life easier for disabled people, giving them control over their environment in a way they may not have had previously.

Real examples of challenges facing identified groups or individuals will work best and provide the most engaging design problems to overcome.

Curriculum mapping

This project has been mapped to the OCR J310 GCSE Design and Technology specification.

The specification identifies eight topic areas:

- Identifying requirements
- Learning from existing products and practice
- Implications of wider issues
- Design thinking and communication
- Material considerations
- Technical understanding
- Manufacturing processes and techniques
- Viability of design solutions

The scheme of work uses numbering that corresponds to the specification (e.g. 1.1, 1.2) to highlight which design and technical principles are being covered.

The iterative element of this scheme of work corresponds to the 'Iterative Design Challenge' marking criteria in the specification, covering strands 1 to 5.

OVERVIEW
CONTINUED

Success criteria

All	Most	Some
Take part in a knowledge-sharing event about disabilities and list the key features of the scale and range of disabilities in the UK.	Take an active role in a knowledge-sharing event about disabilities and demonstrate an understanding of the scale and range of disabilities in the UK.	Take a leading role in a knowledge-sharing event about disabilities. Show evidence of individual and original research into the scale and range of disabilities in the UK.
Demonstrate a knowledge of at least two examples of barriers to participation experienced by people with disabilities.	Demonstrate an understanding of the features of, and reasons for, the existence of at least two barriers to participation experienced by people with disabilities.	Demonstrate a critical understanding and explanation of the existence of at least four barriers to participation experienced by people with disabilities.
List three categories of activities where design engineering could improve the experiences of people with disabilities.	Discuss four categories of activities where design engineering could improve the experiences of people with disabilities and suggest at least one area for further design work.	Discuss and agree four categories of activities where design engineering could improve the experiences of people with disabilities. Suggest one area for possible development within each category.
Evaluate a series of design ideas using a set of evaluation questions.	Evaluate a series of design ideas using a range of evaluative tests and reach conclusions for further development.	Use a range of appropriate evaluative techniques to provide evidence and priorities for further development.
Take part in a prototyping exercise to help identify design ideas which may be relevant to users with disabilities.	Construct some early prototype models exemplifying potential design ideas to develop and give reasons why they might succeed in meeting the requirements of users with disabilities.	Design and make a range of early prototype models which promote and extend design thinking, giving clear evidence of the ways in which they would meet named requirements of users with disabilities.
Carry out technical tasks to achieve a given outcome.	Identify most skills needed to carry out a technical task required to achieve a team outcome.	Identify all skills needed to carry out a technical task, negotiate how to master skills and achieve a team outcome.
Make a final prototype which is generally functional.	Invent a final prototype which is novel and made with enough precision to demonstrate key functional aspects.	Create a final prototype which is made with accuracy and precision. It has many original and relevant features. The key functions are appropriately demonstrated and show the use of a range of appropriate techniques.
Make a contribution to a presentation and show some ways in which user needs have been met.	Make a relevant contribution to a presentation which effectively explains the project process and outcomes. Demonstrate an understanding of most of the key user needs and how they have been met.	Make a relevant contribution to a presentation which effectively explains, analyses and justifies the project process and outcomes. Show a full understanding of all user needs and how they have been incorporated into design and evaluation.

WEEK 1: CONCEPTION

Overview

All students engage with an agenda which discusses the nature of ability and disability. It shows how wide the range of abilities can be and how many people in the UK are defined as having a disability. First-hand experiences of students may make a positive contribution to awareness.

Resources

If possible, opportunities to visit or communicate with users or potential users with a disability

If possible, visit from a local authority representative

Useful references

Disabled Living Foundation (DLF) Key facts:
dlf.org.uk/content/key-facts

Social model of disability:
scope.org.uk/our-brand/social-model-of-disability

Planning

Learning objectives	Teaching and learning activities
	The project is introduced to students. Where possible, a local authority representative may present on the topic of equality for people with disabilities. Additionally, or alternatively, students view the **Social model of disability** video.
Demonstrate awareness of the scale and scope of people with disabilities in UK. Carry out basic categorisation of national statistics.	Students individually research the numbers and variety of people with disabilities in UK (**Disabled Living Foundation key facts** webpage can be used for additional support if needed). Students make notes and compile a table of the numbers or percentages of people with disabilities, categorised by individual type of disability.
Listen to and discuss one model of perceptions of disability. Compile a descriptive matrix of disabilities combining inputs from a number of participants.	A seminar session is held with the whole group of students to discuss the social disability model. The whole group builds a composite class matrix from their individual findings, comprising: – Numbers of people with a disability – Type of impairment/disability – Barriers likely to be experienced At this stage, the involvement of people with disabilities will enhance the realism and accuracy of student perceptions. First hand experiences can introduce some unexpected examples of real-life barriers to equal access. Local authorities may be able to help facilitate this involvement. Many students will have some direct experience of living with disability – either their own, or that of someone known to them. Sharing such knowledge can be positive, but safeguarding and consent issues will be paramount.

WEEK 1: CONCEPTION CONTINUED

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
1.1. Explore a context: a. Considerations for exploring a context should include: i. Where and how a product is used. ii. Identifying user and wider stakeholder requirements. iii. Understanding social, cultural, moral economic factors.	**1.2. Usability:** a. Considerations in relation to user interaction with design solutions including: i. User lifestyle. ii. Ease of use and inclusivity. iii. Ergonomic considerations. iv. Aesthetic considerations.	**Strand 1:** Investigations of the context.

WEEK 2: CONCEPTION

Overview

Guided by a set of example situations, students work in groups to identify the top-priority challenges facing disabled people and create a design brief.

Resources

If possible, opportunities to visit or communicate with users or potential users

Useful references

Living made easy:
livingmadeeasy.org.uk

Disability Rights UK:
disabilityrightsuk.org

Being disabled in Britain: A journey less equal:
www.equalityhumanrights.com/sites/default/files/being-disabled-in-britain.pdf

Planning

Learning objectives	Teaching and learning activities
Assimilate and understand the key components of a brief.	The class is split into separate design groups of 3–4 students each. The groups are briefed on their design challenge in the light of the social model of disability: **To design and make an engineering prototype which meets the needs of people with a disability, while supporting them to control their environment and retain independence.**
Rank and prioritise real-life information and evidence relating to disability issues.	Students use their composite class matrix to identify their top priority issues. In addition to the existing categories of: – Numbers of people with a disability – Type of impairment/disability – Barriers likely to be experienced Groups can include a further category – impact on day to day life – to assist them in their prioritisation. **Note:** If students work with real users, the needs identified by them should be top priority. **Table continues overleaf.**

WEEK 2: CONCEPTION CONTINUED

.	If it is not possible to work with real users, the project should be constrained to a limited number of design challenges. This still allows a degree of student choice and autonomy, but keeps resourcing and assessment within practical limits. Suggested categories of activities include: – Working in the garden – Keeping fit/using the gym – Controlling things in the home, like doors and windows – Use of stairs Other categories can also be negotiated.
Discuss, argue and assess categories of activities. Learn to consider a range of opinions to reach an agreed decision.	Student groups select a category that interests them for their design challenge. The groups make a rapid initial design brief for the project. It should include: – Objectives of the design task – Key criteria of the design task Including requirements to enhance control and extend independence e.g. must-haves and must-not-haves – A pen picture of the user or users – Any ethical dos and don'ts

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
3.3. Influences on the processes of designing and making: a. Environmental, social and economic influences. iii. Social and ethical awareness. **4.2. Information and thinking when problem solving:** a. Awareness of different design approaches. b. Collaboration to gain specialist knowledge.		**Strand 1:** Design brief. Investigation of user and stakeholder needs and wants and the outlining of stakeholder requirements. **Strand 5:** Analysis and evaluation of primary and/or secondary sources.

WEEK 3: DEVELOPMENT

Overview

Student teams generate first design ideas. They are not constrained at this stage by the feasibility of their designs. They make quick prototypes of their ideas to help visualise and develop their thinking. Students then start to think like engineers and apply some objective evaluation to their potential design solutions.

Resources

Card, paper, glue, tape

Masterclasses

Suggested scenarios (page 32)

Planning

Learning objectives	Teaching and learning activities
Develop a range of design ideas as a team using creative design techniques. Express and elaborate ideas through 3D modelling.	The design brief will inform students' initial ideas about possible design solutions within their selected category. However, it is recommended that student groups take time to consider a broad range of ideas, unconstrained by practicalities or preconceptions at this stage. A list of possibilities can be created through the use of a wide range of ideas-generation techniques. It will help student thinking if these go beyond the well-used techniques of thought showers or mind mapping. Consider the following: – Personal analogy – Biomimicry – Redefinition – NUF (new, useful, feasible) Students use their list of ideas to make some initial, experimental sketches and models, using everyday materials such as card, paper, glue and tape, to illustrate possible designs that might meet the design brief.
Devise evaluative tests and techniques to reach design decisions. Understand how to incorporate a range of views and inputs into design decisions.	Student teams will now have constructed some early prototype models of possible design solutions which might help disabled people gain greater independence or control over their environment. These design ideas are now subjected to a gateway process to determine the best idea to take on to the next stage of the design process. Student teams will design their own evaluative gateway criteria, but to pass the gateway, prototypes should also demonstrate some design engineering features. If real users are involved, they should be key influencers in judging the potential of the early prototypes. In addition, students can consider evaluation against the original matrix, the design brief, peers and/or experts. Teams now decide which of their ideas to take forward for further development, individually making further sketches and design notes. **Table continues overleaf.**

WEEK 3: DEVELOPMENT CONTINUED

	Note: At this point student teams should have decided on their final design idea. It should have a design engineering focus and solve a problem for an identified person or group. If any groups need additional support, or if proposed designs are not likely to be feasible, students can be referred to **suggested scenarios** (page 32) for a further list of relevant and appropriate design topics.
Illustrate design ideas through a presentation and evidence-backed arguments. Respond positively to constructive commentary on design thinking.	Each team makes a 5-minute presentation to the class outlining their design idea and the justification for taking it forward for further development. Constructive discussion and feedback should be used to provide additional design information.
Identify, negotiate and master technical skills relevant to achieving design engineering goals.	**Masterclasses** Student teams should identify the skills they need to make effective, functional prototypes (these will vary according to the proposed solutions). At this stage in the design process, the learning will be relevant and in context. **Suggested scenarios** (page 32) provides examples of the likely breadth of design ideas. Technical skills requirements might include: – Selection and properties of materials – CAD/CAM – Ergonomics/aesthetics – Fixing/joining techniques – Finishing techniques

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
2.1. Opportunities and constraints: a. Initial critique of existing designs, systems and products. vii. The work of past and present professionals and companies. **4.1. Communication of design solutions:** a. Use of graphic techniques, including: – Clear 2D and 3D sketches with notes. – Sketch modelling. – Exploded drawings.	**1.2. Usability:** a. Considerations in relation to user interaction with design solutions: i. User lifestyle. ii. Ease of use and inclusivity. iii. Ergonomic considerations. iv. Aesthetic considerations. **7.1. Materials and processes to make iterative models:** a. Processes and techniques used to produce early models to support iterative designing.	**Strand 2:** Generation of initial ideas. **Strand 3:** Quality of design developments. **Strand 5:** Ongoing evaluation to manage design progression.

WEEK 4: DEVELOPMENT AND REALISATION

Overview

Student teams now carry out some classic design tasks. They set up a project plan and look at existing designs in a product analysis exercise to identify key features of other products. Teams also start work on their developed prototypes and apply some technical criteria to their designs.

Resources

- 3D printer
- Laser cutter
- Router
- Drills
- Hand tools
- Sanding and finishing equipment

Planning

Learning objectives	Teaching and learning activities
Order and organise a sequence of design tasks to achieve objectives.	Student teams produce a simple project plan to coordinate activity over the remainder of the project. As a minimum, this should include details of: – Each task to be done – Person responsible – Resources needed – Skills required – Estimated time required
Carry out a systematic analysis of existing designs. Deconstruct, classify and rank features and weaknesses of products.	Students can now identify and analyse any existing products which are similar or relevant to their design ideas. They should carry out a simple product analysis covering the following attributes: – Purpose of the product – What parts it contains – Its shape and appearance – How it has been made – Who its users would be – What its weaknesses are **Table continues overleaf.**

WEEK 4: DEVELOPMENT AND REALISATION CONTINUED

Create and build iterative design models and appraise their performance against criteria at each stage. Assess and record evaluative findings.	Teams should now have the resources they need to start making developed prototypes. Students should refer to their project plan as a dynamic document to track their tasks, roles and resource needs and ensure they achieve successful prototypes within the time available. When making developed prototypes, students should refer to the initial gateway process and the feedback they received at this time. They should devise evaluative tests which measure their prototype against: 1. Other products examined in their product analysis, i.e. is theirs different, and better? 2. A range of technical criteria, such as: – Selection/use of materials – Appropriate fixing/joining – Aesthetics/ergonomics – Finishing techniques Tests and test results should be noted and recorded by each student.

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
2.1. Opportunities and constraints: a. Initial critique of existing designs, systems and products. iii. The influence of marketing and branding. iv. The impact on society. v. The impact on usability. vi. The impact on the environment.	**1.2. Usability:** a. Considerations in relation to user interaction with design solutions: i. User lifestyle. ii. Ease of use and inclusivity. iii. Ergonomic considerations. iv. Aesthetic considerations. **5.1. Categories of design materials:** As used in prototypes.	**Strand 1:** Investigation of existing products and design practices. Exploration of materials and possible technical requirements. **Strand 3:** Design developments. **Strand 5:** On-going evaluation to manage design progression. Feasibility of the final prototype.

WEEK 4: DEVELOPMENT AND REALISATION CONTINUED

3.3. Influences on the processes of designing and making: a. Environmental, social and economic influences. iii. Social and ethical awareness.	**5.2. Selecting appropriate materials** a. Characteristic properties of materials, including density, hardness, durability, elasticity, resistance, as appropriate. c. Other factors including: ii. Aesthetic attributes. v. Social, cultural and ethical considerations. **6.1. Structural integrity:** a. Forces and stresses. b. Processes to ensure structural integrity. **6.3. Controlled movement:** a. Types of motion. i. Rotary. ii. Linear. iii. Oscillating. iv. Reciprocating. b. Mechanical devices i. Cams. ii. Gears. iii. Pulleys and belts. iv. Levers and linkages. **6.4. Electronics systems providing functionality:** a. Response of sensors and control devices b. Use of devices to produce outputs. c. Programmable components. **7.4. Digital design tools:** a. Use of 2D and 3D digital technology: – Rapid prototyping. – Image creation and manipulation software. – CAD/CAM.	

WEEK 5: REALISATION

Overview

As their prototypes are developed through iteration, students attempt to build in the functionality that will enable them to produce working final versions. They apply a functional analysis, giving them a structured rationale for each of their developments.

Resources

Design engineering and iteration (page 27)

Specialist tools (for moulding, soldering)

Electronic testing equipment

Programmable devices as required

Motors, gears, pulleys, as identified in project plans

Planning

Learning objectives	Teaching and learning activities
	Developed prototypes will continue to go through as many iterative cycles as necessary. Some may be short, making only minor changes many times over, while others will be longer and more formalised. Refer students to **Design engineering and iteration** (page 27) to help them understand the importance of iteration to improve their designs.
Combine new tests and analyses with existing ones to make more sophisticated judgements. Make decisions about final refinements based on set criteria.	In addition to the previous set of analyses, student teams identify what each component of their prototype is expected to do. The teams then map the design functions of their prototypes to the physical components. This analysis will assist teams in judging whether the intended design functionality can be achieved in their prototypes.
	Teams work to complete the structural and functional features of their prototypes. It is likely that some teams will not achieve full, or even partial, functionality in their prototypes. If this is the case, they should be able to demonstrate the intended functionality of their prototypes, using further models, sketches or systems as necessary.

WEEK 5: REALISATION CONTINUED

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
7.3. Accuracy when making prototypes: a. Use of appropriate and accurate marking out methods including: i. Measuring and using reference points, lines and surfaces. ii. Templates, jigs and/or patterns. iii. Working within tolerances. iv. Efficient cutting and how to minimise waste.	**1.2. Finishing materials and products:** a. Processes used. i. Function such as durability and added resistance to overcome environmental factors. ii. Aesthetics. **7.2. Manipulating and joining materials.** a. Specialist techniques, hand tools and equipment used to shape, fabricate, construct and assemble high-quality prototypes.	**Strand 1:** Technical specification. **Strand 2:** Development of final design solution. **Strand 4:** Quality of planning for making the final prototype. Use of specialist techniques and processes. Use of specialist tools and equipment.

WEEK 6: PRESENTATION

Overview

The purpose of the presentation is to conduct a two-way process of conversation and dialogue, explaining the ambitions and design thinking inherent in the prototypes and receiving commentary and feedback from the audience. The most valuable feedback is likely to come from observations made by potential users. If this cannot take place in person, another option might be for potential users to try out student inventions elsewhere and submit their reactions as feedback.

Resources

Top tips from Dyson engineers: Giving presentations (page 29)

Top tips from Dyson engineer: Providing peer feedback (page 30)

Appropriate setting for presentation and demonstration of student prototypes.

Planning

Learning objectives	Teaching and learning activities
Explain, justify and demonstrate the effectiveness of the design solutions produced. Demonstrate and validate the functions or functionality of the design prototypes produced.	Student teams present and explain their prototypes. They should be able to show a prototype which performs or models the functionality of a finished design engineering product. Each student group should be ready to explain their design ideas, evaluation, testing and decision making, justifying the choices and functions of their final prototype. If there are alternative products or systems in existence already, the teams should be able to explain how their design is different and better. Refer students to **Top tips from Dyson engineers: Giving presentations** (page 29).
Receive and understand feedback on design solutions and discuss potential improvements.	Ideally, students will present to an audience which contains experts and potential users of the designs as well as their peers. A two-way conversation, with feedback and commentary on the designs and some suggestions for adaptations or improvements, as well as some comparisons with existing products, will greatly enhance the value and realism of the project. Refer students to **Top tips from Dyson engineer: Providing peer feedback** (page 30).

WEEK 6: PRESENTATION CONTINUED

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
4.1. Communication of design solutions. a. Use of graphical techniques including: – 2D/3D sketching. – Sketch modelling. – Exploded drawings. – Flow charts.		**Strand 2:** Critical thinking. **Strand 3:** Quality of design developments. Quality of final design solution. **Strand 4:** Quality of final prototype. Viability of final prototype. **Strand 5:** Evaluation of final prototype.

STUDENT WORKSHEETS

DESIGN ENGINEERING AND ITERATION

Design engineers are problem-solvers. They research and develop ideas for new products, and think about how to improve existing products.

Everything around you has been designed, from the smart phone in your pocket to the pen in your hand. Design engineers work on lots of different products. Their day-to-day job is varied but centres around the design process. Tasks may include brainstorming, sketching, computer-aided design (CAD) or prototyping new ideas.

An important design process is iteration. This is the repetitive method of prototyping, testing, analysing and refining a product.

Consider Dyson's vacuum cleaner tools.

Dyson engineers noticed that the spinning action of the brush bar on Dyson's Carbon Fibre Turbine Head could cause hair or other long fibres to wrap around the bar, slowing it down or stopping it altogether.

Instead of ignoring this problem, Dyson engineers set out to design a solution. The design brief: Create a cleaner head that doesn't tangle hair or fibres.

Design engineers thought about the fact that rubbing hair in a circular motion creates a ball – easy to suck up and no tangles. With this theory in mind, they tested dozens of ways to simulate the circular motion. The result was two counter-rotating discs, each with sturdy bristles, enclosed in polycarbonate casing. The spinning discs ball the hair, then it is sucked straight into the vacuum cleaner bin. Hygienic – with no mess.

Iterative design processes result in better solutions and better technology.

Repeat:

1. Explore
2. Create
3. Evaluate

Regular brush bar.
Tangles.

Counter-rotating discs.
No tangles.

MEET THE DYSON ENGINEERS

Laura
Design Engineer at Dyson

I found engineering through a combined enjoyment of art and maths. While I loved both, I didn't want to spend my time solely doing one. Engineering is a great combination of the two, with the logic of maths but the creativity of art. I wasn't aware of engineering as a potential career option until I applied to the Arkwright Scholarship as a teenager. At this point, I realised how many different engineering specialities there were to choose from – some of them technical, but some much less so than I had originally thought. The wide range of possibilities available through engineering became clear, and I saw the potential to make a real difference to the world. Dyson gives me the opportunity to be creative, whilst still being backed up by the logic of maths and physics.

George
Senior Design Engineer at Dyson

When I started secondary school, my Grandfather took me to Coventry Transport Museum and I saw Thrust SSC (the current holder of the World Land Speed Record and first to break the sound barrier). I was fascinated by its design and aerodynamics. I started researching engineering feats: The Shinkansen (Bullet) train, Concorde, International Space Station and more. I wanted to find out everything about them – how they work and what technologies they use. I can't think of any other profession that would give me the freedom to design and build multiple prototypes, to learn through failure and success, and to create iterative changes and see their effects first-hand. Engineers are always pushing the limits, finding new materials, technologies and methods to solve problems that are important to society. I wanted to be a part of that community, inspiring through STEM (and design!) and making a difference with my career.

TOP TIPS FROM DYSON ENGINEERS

Giving presentations

Laura, Design Engineer at Dyson

Being able to present your work is an incredibly valuable skill for engineers. It allows engineers to explain how their ideas have developed and how their prototype will function. This then prompts feedback from the stakeholder on the work done so far. This guide will help you to present your work successfully to your stakeholders.

Tip	Actions	Examples
Make your presentation attention-grabbing.	Welcome your stakeholders with a thank you. State how you would like to deal with questions. Maintain eye contact and smile.	'Hello, welcome and thank you for joining us today!' 'We would like you to ask questions at the end of the presentation.'
Clearly state the purpose of your presentation.	Summarise the aims of your presentation in one or two sentences. Your presentation must make sense to anyone who watches it.	'We're going to present our prototype…' 'It solves the problem in this way…'
Be concise.	Follow a simple structure. Organise who is speaking and when.	'We chose this **design** because…' 'We used these **techniques** to develop it…' 'Our prototype **functions** in this way…'
Be confident.	Practice beforehand to ensure you are clear on what you want to say and can deliver it with confidence. Speak loudly and clearly. Believe in your design and prototype. If you are using PowerPoint, use pictures rather than words to make sure you are talking to your stakeholders, instead of reading your PowerPoint out loud. Keep on topic! Time yourself, practising your presentation to make sure you don't overrun.	

TOP TIPS FROM DYSON ENGINEERS

Providing peer feedback

George, Senior Design Engineer

Giving and receiving feedback is incredibly valuable for engineers. Constructive criticism offers insight that the designer may not have considered and provides direction for future iterations. This guide will help you prepare your insights and suggestions so that they are well received and highly valuable to your design team.

Tip	How to...	Examples
Ask questions!	Prepare as many questions as possible. Make sure to begin by praising the team for their efforts. If you are struggling, think about how you would do things differently. Ask what their next steps are.	**Don't:** 'We don't think the prototype works very well.' **Do:** 'Please could you explain to us how your prototype functions? Have you thought about another way it could function?'
Put yourself in their shoes.	Think about how and why they may have done things a certain way.	**Don't:** 'You should have done it like…' **Do:** 'Why did you choose to do…?'
Prioritise your feedback.	Focus on the most pressing issues first. Don't look to show up the designers. Instead, ask questions and offer solutions.	**Don't:** 'What colour is the on/off button going to be in the final prototype?' **Do:** 'The user said she can only carry up to twenty pounds at a time, so how can you make your design lighter?'
Feedback should be informative and educational.	Give specific examples and, when possible, context for what you like or dislike about a design and why. Use the word 'because'.	**Don't:** 'I don't like this.' **Do:** 'I don't think this will work because…'
Don't focus on only the positive or the negative.	Be sure your critique of the team's work is balanced and sensitive.	**Don't:** 'This looks ugly' or 'this looks good.' **Do:** 'I like the changes you made to the handlebars, but I think a different material might make the grip more comfortable and look better.'
Provide constructive criticism.	Don't use words like 'always,' 'never,' 'best,' 'worst,' etc.	**Don't:** 'This feature will never work.' **Do:** 'The Wi-Fi-activated alarm wouldn't work well, because it means you need to have access to Wi-Fi at home, which some people don't.'

APPENDIX

SUGGESTED SCENARIOS

Suggested activities where designing could make things better for people with disabilities

Working in the garden:

- Access: Mats for wheelchairs
- Garden tools: Functions, handling, ergonomics, shape, form
- Physical support: Posture, kneeling, handholds

Keeping fit or using the gym

- Exercisers or rollers
- Cross trainers
- Control of equipment (talking or touch controls)
- Fishing rods
- Bicycles

Controlling things in the home

- Opening of doors and windows
- Lighting
- Bathing or showering
- Brushing hair or cleaning teeth

Use of stairs

- Lighting
- Foot placement
- Foot grip
- Hand grip
- Sound, touch, light signals