THE JAMES DYSON FOUNDATION

WIND POWER

Design and Technology scheme of work

Key stage: 4

Duration: 4 weeks (approximately 10 hours)

Project overview: Design and make a prototype for a wind turbine which will produce enough power to meet specific needs.

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

dyson

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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

The expansion of wind energy as a power supply in the UK really took off in 2007 with the publication of the strategic environmental assessment. As the UK is one of the most efficient sites for wind turbines, future designs and improvements in efficiency are relevant topics for students.

Students are encouraged to consider the pros and cons of existing technologies. They are also challenged to understand some of the issues affecting the efficiency of generating power from wind energy. At a national capacity factor of around 32%, there is a role for design to suggest improvements to present techniques.

Autonomy

Please note that this project is designed to have open-ended outcomes. It does not set out to define products or systems which might make good designs. Rather it puts emphasis on the students working initially through experimentation and trial and error.

The variety of possible solutions enables students to retain a degree of autonomy over their design and decision-making. This may mean that some students create prototypes which do not achieve great functionality. It is important to recognise this as a normal and useful function of the design process, and students should be as interested in failures as successes.

The variety of possible design thinking and outcomes may put demands on skills teaching and resourcing the student prototypes. Teachers may want to draw on the expertise of colleagues in science for some of the testing and evaluation of power generation.

Scenarios

It is important for the success of this project that it goes beyond a simple exercise in making a basic turbine of tower, blades and a rotating shaft. The creation of measurable power is vital for students to understand that energy from the wind has to be turned into other forms to be useful.

There are three scenarios included in this project (see Appendix). These provide a basic variety of design considerations to be met – for instance, whether low or high torque is needed to achieve a successful outcome. Their aim is to bring a degree of realism to the challenges, but they are suggestions only and students should be encouraged to think of other scenarios based on their own experience and knowledge.

In the first week of the project, students discuss the pros and cons of wind turbines. Negatives raised by students (such as noise, visual pollution, dangers to wildlife or the intermittent nature of the energy source) can all be brought in to the project as design challenges rather than negatives.

Learning management

This is an open-ended design project. Students are encouraged to think in new ways about new solutions, so design outcomes will vary. They will also vary depending on the scenario followed. It can be a classroom management challenge in the sense that there are many possible design improvements that can be made and each will have its own skills and resource needs.

You should therefore make sure that the project is resourced in good time. There are items such as materials, resistors, motors and multimeters which need to be accessible, and the concepts of Ohms law, Betz's limit and the Bernoulli effect need to be explained (or sources made available). In addition, if you want to do more sophisticated electronics, Arduinos and Raspberry Pis or similar need to be on hand.

The wind itself can be used as the energy source, but to ensure a regular supply of air movement, fans, hairdryers or similar should be used. This is particularly true if students are experimenting with low wind velocity and a controlled source is required.

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 non-linear 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. The outcomes of students' work may be products or systems, but they will be prototypes and not finished products.

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 may be covered in more depth than others. You can use your 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 the 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

The UK is changing the way it produces energy. Fossil fuels come from finite resources and many of them are imported from other countries. They also produce greenhouse emissions and the UK is legally committed to reducing its carbon emissions over the next few decades.

Furthermore, the country is changing the kinds of energy it needs. More energy is now required in the form of electricity. Heating in industry and in peoples' homes is increasingly provided by electricity, and more cars are being powered by electricity.

Power from wind is cheap, clean and sustainable – and there is more wind available in the UK than in any other European country. However, there are many design and technology challenges in creating successful wind turbines. Towers and housing structures have to withstand wind forces, blades have to be designed for optimum performance, mechanical losses have to be minimised and actual electricity generation has to be effective.

Without some new design thinking, the country's power needs simply won't be met.

In this project, students will be challenged to design the best possible wind turbine for producing power.

Students will need to understand the nature of wind and how it can be measured – as well as how to measure the electricity produced and the subsequent work that electricity can do.

The project anticipates that students will apply a load to their wind turbines as a way to measure their ability to produce power, rather than just a voltage and, whether successful or unsuccessful, students should build a better understanding of the concepts of energy, work and power.

It is likely that students will engage with some technological aspects of the project more than others. This is anticipated in the range of design tasks to be carried out.

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
Describe the use of wind energy as a source of power.	Explain some of the key reasons for the increase in the use of wind energy.	Describe most of the key reasons for the increase in wind energy and investigate most of the benefits and drawbacks.
Recall the main components of a simple wind turbine.	Shape, form and put together, with guidance, the main components of a simple wind turbine.	Make a simple wind turbine, taking into account the key material and structural aspects of each component.
Act as part of a team.	Make an effective contribution to a team and understand the needs of other team members.	Understand roles and strengths in working as a team. Make a key contribution to achieving outcomes in a given time frame, taking into account the needs of all team members.
Assemble, with instruction, the materials and components of a straight turbine blade and fix to a hub.	Select, describe and assemble materials and components to make a turbine blade with some aerofoil properties.	Understand, select and describe a wide range of potential materials and components to make a turbine blade. Assemble a blade with aerofoil properties generating lift and some understanding of twist in blade design.
Demonstrate iteration or improvement to first designs through experimentation. Demonstrate why the iterated version is better fit for purpose.	Understand how ideas can improve through iteration and show clear evidence of innovation throughout the design process. Make changes to turbine designs so that they demonstrate one or more specific improvements over previous versions.	Use consistent design iteration to show clear and comprehensive progression. Show how iteration had led to several new technical ways to improve turbine effectiveness through lift, aerofoil section, blade twist or blade numbers.
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 and recognised theories to provide evidence of efficiency and priorities for further development.
Use taught technical skills required to carry out project tasks, but not always appropriately to the materials or systems being used.	Select and apply the technical skills required to complete the project. Demonstrate an awareness of when additional skills are required. Techniques are usually appropriate to the materials and systems being used.	Explain how technical skills have been used to enhance functions and outcomes. Skills are used effectively, consistently and appropriately for the materials and systems being used.
Produce a final prototype that is generally functional.	Produce a final prototype that is made with enough precision to demonstrate key functional aspects.	Produce a final prototype that is made with accuracy and precision. Functions are appropriately demonstrated and show the use of a range of appropriate techniques.
Make a contribution to a presentation.	Make a relevant contribution to a presentation which effectively explains the project process and outcomes.	Make a relevant contribution to a presentation which effectively explains, analyses and justifies the project process and outcomes.

WEEK 1: CONCEPTION

Overview

Students engage with the scale of wind power generation in the UK and the reasons why its development since 2007 has been so rapid. They get hands-on modelling what they perceive to be the main components of a modern wind turbine.

Resources

- Visit to wind turbine installation (if possible)
- Mount board
- Cocktail sticks
- Velcro
- Card
- Glue

Useful references

Heage Windmill – working flour mill video:
youtube.com/watch?v=6DnNcVwuelY

How Hill windmill near Ludham in the Norfolk Broads England video:
youtube.com/watch?v=6DnNcVwuelY

London Array wind turbine video:
youtube.com/watch?v=OMn4Sza2px8

Planning

Learning objectives	Teaching and learning activities
Understand the key reasons for an increase in the use of wind as a source of energy and power. Explain wind power generation in context. Assess and argue the main benefits and drawbacks associated with wind power.	Most students will have a good level of awareness of the increasing role of wind as an energy source to be harnessed, and many will have seen wind turbines in action. Students investigate wind power generation in UK. Students watch the **Heage Windmill – working flour mill** video and/or the **How Hill windmill near Ludham in the Norfolk Broads England** video, demonstrating the longevity of the concept. Heague windmill is a grain windmill built in 1797 and still operating. Ludham Windmill is a wind-driven pump used to drain land in Norfolk. **Table continued overleaf**

WEEK 1: CONCEPTION CONTINUED

	To observe a current example, students research information on the London Array – the largest windfarm in Europe. They might also watch the **London Array Offshore Wind Farm** video to see its development and design. Students discuss pros and cons of wind as a source of power generation. They are briefed to use some of the negatives, especially efficiency capacity issues, as design challenges.
Construct basic models to demonstrate understanding of the key functional parts of a typical wind turbine.	Teacher introduces the challenge: **To design and make a basic wind turbine.** In pairs, students make rapid initial wind turbine models from readily available materials to visualise and understand the main working components. They should concentrate on towers, blades and generators. If appropriate, students may also model devices to keep the blades facing the wind. Student pairs should sketch and annotate their models, identifying the key design requirements for the towers, blades and generators.

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. **3.3. Influences on the processes of designing and making:** a. Environmental, social and economic influences. iv. Global sustainable development.	**1.2. Useability:** a. Considerations in relation to user interaction with design solutions including: i. User lifestyle. iv. Aesthetic considerations. **2.2. Developments in Design and Technology:** a. Critical evaluation of new and emerging technologies: – Ethics and the environment. **3.1. Impact of new and emerging technologies when developing design solutions:** a. Exploration of impacts on: ii. People, in relation to lifestyle, culture and society. iii. The environment. iv. Sustainability. **3.2. Sources of energy and power:** a. How energy is stored and transferred. b. The appropriate use of renewable and non-renewable sources including: ii. Wind	**Strand 1:** Investigations of the context. Design brief. Exploration of materials and possible technical requirements. **Strand 2:** Design developments. Development of final design solutions. Critical thinking.

WEEK 2: DEVELOPMENT

Overview

Students start to develop an understanding of the wind force acting on objects, what the limitations are and how air movement can be turned into rotational movement. They experiment on the key factors which can affect the efficiency of the process.

Resources

Design engineering and iteration (page 23)
Tachometer
Low voltage electric motor
iOS/Android wind tunnel simulators
3D Printer and/or laser cutter, if available
Domestic cooling fan or hair dryer
Low voltage electric motors

Planning

Learning objectives	Teaching and learning activities
Formulate improvements to design ideas through observations and categorisation.	**Wind turbine blades masterclass** Understanding the basic principles of how blades perform is a great way for students to understand how the energy from wind can be captured to do work. Students now need to develop their initial models and add simple functionality to their first iterations. They should experiment with different blade designs and different numbers of blades to test efficiency. Refer students to Design engineering and iteration (page 23) to help them understand the importance of iteration to improve their designs.
Investigate effects of inputs on outputs. Appraise the best ways to develop ideas into applications. Consider a range of factors in making more complex decisions. Compare and make conclusions from experimental prototyping.	Students evaluate their designs. At this stage, the simplest test is for students to assess which blade designs rotate fastest in a given velocity of airflow. Rotational speed can easily be measured with a non-contact tachometer (at blade tip or at the rotating shaft) or by driving a small electric motor and measuring the volts produced. Students experiment with blade designs using either trial and error or wind tunnel simulation apps (iOS or Android). **Table continued overleaf.**

WEEK 2: DEVELOPMENT CONTINUED

	They will need to consider: – Aerofoil shape – Pitch – Number of blades – Blade twist – Thickness/mass of materials used – Surface texture of materials used. Students, still in pairs, will need to mount their experimental blades on a shaft or directly to a motor on top of a vertical tower. Air movement can be provided naturally or by forced air from small appliances, such as domestic fans or hairdryers. The results of these evaluations should be noted and recorded.
Identify and prioritise aspects of design in terms of objective outputs.	Students individually identify the key features of the turbine that produce the fastest rotation. They share their views in a short whole-group session. Student designs so far have only demonstrated which arrangement of blade designs and numbers produce the fastest rotation. The test is useful as a design milestone, but the next stage is for students to make their wind turbines do some useful work.

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
2.1. Opportunities and constraints: a. Initial critique of existing designs, systems and products. iv. Impact on society. v. Impact on usability. vi. Impact on the environment. **4.1. Communication of design solutions:** a. Use of graphic techniques including: – Clear 2D and 3D sketches with notes.	**5.1. Categories of design materials.** As used in prototypes. **5.2. Select appropriate materials:** b. Physical and working properties. **7.6. New and emerging technologies in production:** a. Evaluation of the benefits and implactions of: iv. 3D printing (if used).	**Strand 3**: Quality of chronological progression. Quality of design developments. **Strand 5:** Ongoing evaluation to manage design progression. Evaluation of final prototype(s).

WEEK 3: REALISATION

Overview

Student teams now apply their design skills to creating power from wind in specific situations where high or low start-up velocities might be needed. They use their understanding of lift and drag to develop and prototype more efficient designs.

Resources

Scenarios for wind turbines (page 28)

CAD software (if available)

3D Printer and/or laser cutter (if available)

Useful references:

Renewable Energy UK Betz limit:
reuk.co.uk/wordpress/wind/betz-limit/

Bang goes the theory: Bernoulli's principle:
bbc.co.uk/bang/bernoulli_principle.shtml

Planning

Learning objectives	Teaching and learning activities
Understand design as an activity which operates in a context.	See Scenarios for wind turbines (page 28) These scenarios are for guidance only – students or teachers may want to consider other scenarios to test their wind turbines. The scenarios provided make it possible to design for low, variable or high wind velocities.
	The second design challenge for students is to design and make a more efficient wind turbine in light of specific design requirements. Students form into groups of 4 or 5. The increased complexity of the design task will put teamwork demands on students. Student teams choose a scenario to work with, or negotiate a scenario of their own. Each of the scenarios will require different design features.
Solve problems through experimental techniques. Validate experimental techniques through use of scientific constructs and methods. Select appropriate criteria to make useful judgements.	**Advanced wind turbine blades masterclass.** Each team's turbine blades will need to be designed and made for maximum performance. To do this, students will need an understanding of the forces of lift and drag, the Bernoulli Effect and Betz's Law. They will also need to understand blade tip speeds, the trade-off between structural strength and aerofoil efficiency, and differing wind velocities. **Table continued overleaf.**

WEEK 3: REALISATION CONTINUED

	This can be achieved by both research and theory, and by experimentation and testing. Full understanding is most likely to result from students trialling their ideas first. Their observations and responses can then be linked to the associated scientific concepts. Each student team should now produce a set of success criteria from which to judge the outcomes of their prototyping.
Apply conceptual learning to practical applications. Rework and rephrase designs through an analytical, logical and structural approach.	Student teams should now start to build their functioning prototypes to a standard where they can work under load. This will enable the power they generate to be measured. They should apply their learning from the masterclasses to the following factors in their designs: – Aerofoil shape – Pitch – Number of blades – Blade twist – Properties, thickness and mass of materials used – Structural functionality – Their chosen scenario Students make notes and produce sketches of their final design ideas.

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
2.1. Opportunities and constraints: a. Initial critique of existing designs, systems and products. i. Materials, components and processes used. **4.2. Information and thinking when problem solving:** – Systems thinking. – Importance of collaboration.	**5.2. Select appropriate materials:** a. Characteristic properties of materials, including density, hardness, durability, elasticity and resistance, as appropriate. **5.2. Selecting appropriate materials:** b. Physical and working properties of materials. c. Other factors including: i. Required functionality of design solution.	**Strand 4:** Quality of final prototype(s). Use of specialist techniques and processes. Use of specialist tools and equipment.

WEEK 4: REALISATION AND EXPLANATION

Overview

Students finalise their prototype wind turbines and test them under load to see if they are successful in producing actual power. They adapt their prototypes in test conditions to optimise their efficiency and present their designs back to the class.

Resources

3–12v high torque m3j7 motors
0–12v mr03 motors or geared low rpm motor
Selection of resistors (5 and 10 ohm) or variable resistor/Arduino
Multimeters
Top tips from Dyson engineers: Giving presentations (page 25)
Top tips from Dyson engineers: Providing peer feedback (page 26)

Useful references

O-Wind Turbine: The James Dyson Award National UK Winner:
youtube.com/watch?v=m8O6CugLTww

Planning

Learning objectives	Teaching and learning activities
Interpret and refine test results through the use of formulae and laws of physics. Make iterations justified by evaluation and measurements.	Student teams should be briefed that their turbine blade assemblies should be made to fit the shaft of a small electric motor (2mm or 3mm shaft). By applying a resistance to the electrical output from the motor, students can test the power of their prototypes. A resistor should be fitted to the positive wire of the motor. A series circuit should then be made through the addition of a multimeter. This will measure the current produced by the turbine blades when wind energy is applied. By applying Ohms Law, the watts produced under load can be measured for each team's prototype. This will demonstrate the power each wind turbine design is capable of generating. Student teams can now make detailed adjustments to their wind turbines, to maximise power according to the conditions of their chosen scenario.

WEEK 4: REALISATION AND EXPLANATION CONTINUED

Explain and justify design process and final prototypes. Discuss design outcomes with others and compare design objectives with outcomes.	Student teams demonstrate their functioning prototypes in a plenary session. They should explain their scenario and justify their prototype against the design objectives. They should also be able to show how their designs could meet specific needs. The evaluation, testing and iterations made should be highlighted alongside any outstanding issues or breakthroughs that occurred in the team's design journey. Refer students to Top tips from Dyson engineers: Giving presentations (page 25) and Top tips from Dyson engineers: Providing peer feedback (page 26). To conclude the project, students can watch the video: **O-Wind Turbine: The James Dyson Award National UK Winner.** This invention won The James Dyson Award in 2018. Students should draw comparisons with their own work and consider the advantages and disadvantages of the O-Wind turbine.

Curriculum mapping

Design skills	Technical skills	Assessment of iteration
	2.2. Developments in Design and Technology: a. Critical evaluation of new and emerging technologies: – Ethics and the environment. **6.1. Structural integrity:** a. Reinforcement to withstand stresses and forces. **6.3. Controlled movement:** a. Types of motion. b. Effect of forces i. Load **6.4. Electronics systems providing functionality (if used):** c. Programmable components.	**Strand 3:** Quality of design developments. Quality of final design solution. **Strand 4:** Quality of final prototype(s). Viability of final prototype. **Strand 5:** Feasibility 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.

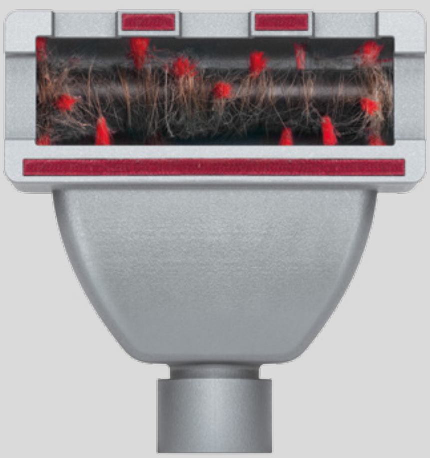
Design engineers thought about the fact that rubbing hair in a circular motion creates a ball – easy to suck up and no tangles. With this theory in mind, they tested dozens of ways to simulate the circular motion. The result was two counter-rotating discs, each with sturdy bristles, enclosed in polycarbonate 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.

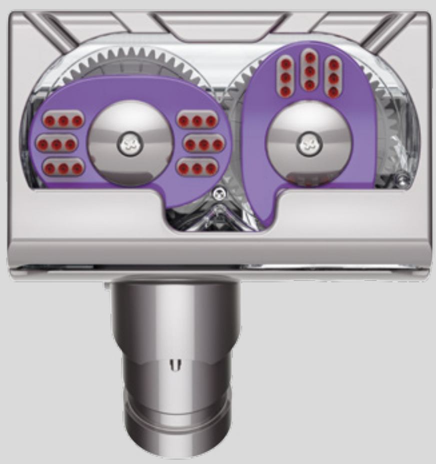
Repeat:

1. Explore
2. Create
3. Evaluate

Regular brush bar.
Tangles.



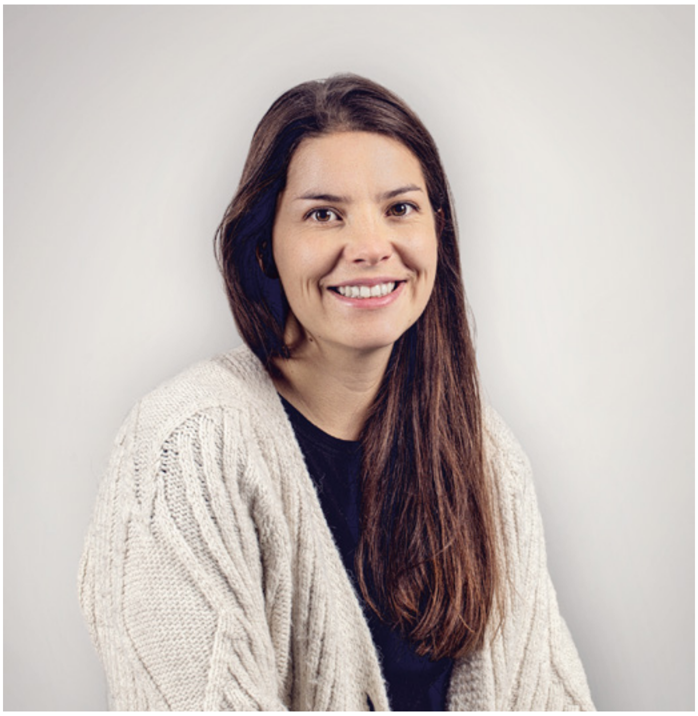
Counter-rotating discs.
No tangles.



MEET THE DYSON ENGINEERS

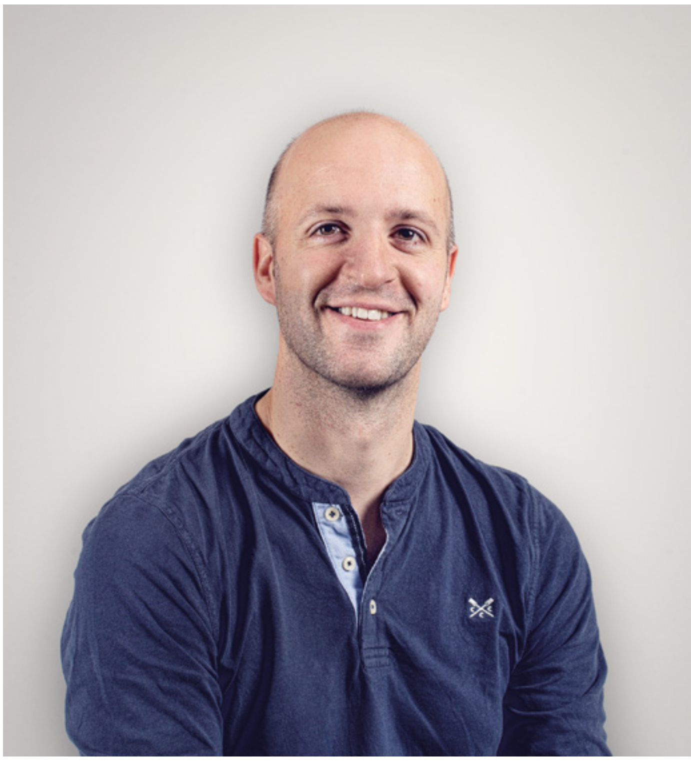
Laura
Design Engineer at Dyson

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 Reed, 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 Oram, 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

SCENARIOS FOR WIND TURBINES

Scenario 1: Power a smallholding.

In this scenario, wind speeds vary from very low to ideal. The average speed will need to power the holding fully. It is very unlikely that sufficient wind will be available for more than 3 days. The smallholding has a battery system which allows power to be stored for a period of a week.

Scenario 2: Generate power on an oil rig.

Here, the wind is always strong. High power output at high wind levels and reliability are the key requirements.

Scenario 3: Power a buoy in the middle of the ocean.

In this location, the air can be still for days on end followed by only a few hours of gentle air movement. In this scenario you need to design a turbine that can start at the very lowest wind speeds and generate a small amount of power to keep the batteries topped up.