

Week 5 Lesson 2

Wind turbine blades

Aim: To carry out a biomimicry based investigation.

Keywords: drag, lift, turbine, vortex

Starter activities

The starter activities can be found on the PowerPoint 'Wind turbine blades'.

1. What am I?

A quick 'yes/no' game in which students should find out that whales are the inspiration for the rotor blades (slides 2-3).

2. Bumpy or smooth?

A brief introduction to research that has led to the discovery that bumpy edge fins are more efficient than the traditional smooth surface (slides 4-6).

Main activity

1. Investigation – Comparing designs for a helicopter blade

Students have the opportunity to try out their own investigation based on biomimicry.

Assessment opportunity

Assess students' investigation skills e.g. planning, taking measurements, drawing conclusions and evaluating the practical as well as working as a team.

Plenary activities

1. Investigation findings

Ask students to report back their findings from their investigation. This is an opportunity to assess their understanding of what makes a fair test and what reliable and accurate results are.

2. Recent rotor blade research

Find two short activities on the PowerPoint 'Wind turbine blades' (slides 9-12). They are both based on short videos about current research in rotor blades and wind turbines.

Starters 1 and 2 / Plenary 2

Wind turbine blades – PowerPoint

5.2: Wind turbine blades

Wind turbine blades

Starter and plenary activities

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5.2: Wind turbine blades

Starter activity 1

What am I?

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We have been looking at how scientists have taken inspiration from animals and plants.

What animal or plant has given inspiration for recent changes in the design of wind turbine rotor blades?

To find out each group can ask me a question which can be answered with a 'yes' or 'no'.

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5.2: Wind turbine blades

The answer is whales.



For further information about humpback whales:
www.bbc.co.uk/nature/life/humpback_whale#07m57am

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Starter activity 2

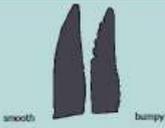
Bumpy or smooth?

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Whales and dolphins have evolved over millions of years to glide through water using the minimum amount of energy - less efficient animals would use up more precious energy to swim and would not survive as well.

Which type of fin do you think would be most efficient?



smooth bumpy

Engineers has always designed wings and blades to be as smooth as possible.

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5.2: Wind turbine blades

surprisingly, whale fins have a bumpy edge.



American, Dr Frank Fish (yes, really!) has investigated why whale fins have a bumpy edge.

His research has shown that the bumpy edge creates an unsteady flow of water over the fin and this actually increases lift and reduces drag (remember these from Week 1 Lesson 1), when compared to the smooth design.

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5.2: Wind turbine blades

This is to do with vortices. A vortex is a whirling pattern of fluid or gas. You see one whenever you pull the plug on a bath full of water - you get a whirlpool effect.

In the case of the whale fin, these vortices help produce lift and reduce drag.

www.bbc.com/1/yourlife/2014/08/140828_walves_get_the_subtle_video_fm

Examples of vortices

Watch the video clip which shows dolphins and beluga whales creating vortices, along with a volcano and hydrogen bomb.

www.youtube.com/watch?v=mt4YTDuIFP0

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5.2: Wind turbine blades

Plenary activity A

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5.2: Wind turbine blades

Watch the short clip about recent innovations in rotor blade design.

www.youtube.com/watch?v=ki-CxkRuAxY

As you watch it, think about how the design of the rotor blade helps it perform its tasks.

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5.2: Wind turbine blades

Plenary activity B

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5.2: Wind turbine blades

Watch the short clip which shows a young scientist talking about his research.

www.gizmag.com/dabini-fish-school-wind-farms/28355/

What behaviour in nature inspired his research team to group wind turbines together to make them more efficient?

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Main 1

Investigation – Teaching notes

This may involve students standing on tables to gain maximum height - you will need to carry out a risk assessment.

The investigation allows an opportunity to introduce/reinforce the terms repeatable, accurate and precise.

Differentiation

For students who need some support, provide pre-drawn or pre-cut helicopters to ensure the 'blades' are the same area.

Extension

As they begin the practical more able students can be asked what they are assuming as they start dropping their helicopters.

- Why is it necessary to drop from the same height? Can they make a prediction - explain why x is more likely than y?
- When they have results, can they explain them in terms of forces or air resistance?
- Could they test the whale fin design of a wind turbine blade in the school lab? If yes, how would they go about it?

Suggested answers

Questions

1. **a)** Repeat readings and take an average, check readings from other groups, have more than one person take the readings.
b) Dropping the helicopter from exactly the same height, using a stopwatch that is sensitive enough, taking readings that are to an appropriate number of decimal places.
2. Sycamore seeds need to carry the seed away from the tree a short distance to ensure the seedling grows in the light and not in the shade beneath the parent tree canopy. A helicopter is required to ascend, descend, hover and move forward and backwards.

Investigation – Comparing designs for a helicopter blade

You are going to investigate whether altering the design of a helicopter blade could enhance its performance. You will compare the performance of a traditional shape with a sycamore seed shaped blade.

Equipment

- graph paper
- scissors
- 2 paper clips
- stop clock

Method

1. Copy the template onto graph paper. You will need two.
2. Cut out and fold to build a model helicopter. Put to one side for now.
3. Look at the images of sycamore seeds you produced for homework.
4. Decide on a design for the 'wings' of your second model.
5. Draw this on both wings of your model, making sure each wing ends up the same shape and orientation, and cut out - collect all the pieces you have cut away.
6. Using the pieces you have collected, work out the area of paper you have cut away.
7. By cutting across the ends of the wings of your first helicopter model, remove the same area of paper.
8. You should now have two helicopter models; one with square ended wings and the other with sycamore seed shaped wings but the wings should all be the same area to make your test fair.
9. Test your helicopters by dropping from a height and measuring how long they take to fall, or by dropping both helicopters simultaneously and recording which reaches the ground last.

Questions

1. Any differences in the time taken will be small and difficult to measure. How could you increase the chances of producing results you can trust - i.e. that are a) reliable b) accurate?
2. Why do you think helicopter blades are not the same design as sycamore seeds?

Investigation – Template

