Teacher notes – KS2 Gliding and wing design

This unit builds students' ability to work scientifically, investigating properties of materials to design a wing spar of a specific strength.

Essential prior knowledge:

- Calculating average values
- Constructing a results table
- Drawing a chart

Introduction

Use the introduction to establish what a glider is and what it can do. Elicit experiences from the class. Has anyone been gliding? Seen a glider in the air? Are there any gliding sites local to the school?

You will see how gliders get airborne. Winch launched gliders are attached to a cable. This cable is pulled in rapidly by a winch at the other end of the airfield. At the top of the launch the glider pilot releases the cable from inside the cockpit and is flying free. Aerotowed gliders get dragged behind a powered aircraft until they are at the height they want and then release the cable and fly free.

To fly, you need wings – and you will be able to glide with or without an engine. Wings need to be strong, light and flexible so that they can cope with extreme weather and air currents. Most wings have a central spar to give them strength with the aerodynamic shape made of a light material such as fibreglass or cloth.

Student activity

Students will use spaghetti to examine strength of different spar size and construction including laminating – the video works through the experiments to be made, which are 1, 2 & 5 strands – held together with rubber bands at the end for 2 & 5 - and 5 strands laminated - glued together with white glue.

If it is not practical to let the students do the experiments themselves, they should use the student notes as the teacher works through the experiments to record the results in a table, draw a graph and predict how many strands are needed to achieve specific loads and/or what loads 3 & 4 strand spars will carry.

INFORMATION

WING DESIGN:
Wings generally have a central spar to give strength, flexibility and lightness. Modern glider wing spars are usually fibreglass or carbon fibre. Traditionally the wing profile was made with D-shaped wing ribs of wood or metal mounted along the spar which were covered in cloth or metal sheet to produce the aerofoil shape (most model aircraft are still made this way.) Newer designs use composite construction with layers of fibreglass and fewer ribs.

GO GLIDING:
With around 80 sites throughout the UK stretching from the Highlands of Scotland to the south west tip of England, wherever you live you'll never be far from a gliding club. You can find your closest gliding club on the BGA website www.gliding.co.uk

AWESOME FACT: after completing your training you can fly a glider solo at age 14!

CAREERS INFORMATION:
Students can learn more about the breadth of aviation and careers in aviation and aerospace at **stem.caa.co.uk/careers-in-aviation-and-aerospace**

In this case, the teacher should do at least two of each experiment so that the class can calculate average values. Based on the 5-strand laminated version, estimate how much additional load laminated versions of each will carry. It will make no difference with 1 strand.

If time permits, the students should carry out experiments to verify their predictions on 3 and 4 strand spar strength, and of additional strength through lamination.

Wing test to destruction…. (But not quite!!)

This is a video of the wing test of a Jonkers JS1 – a high performance glider made in South Africa. This high performance glider will glide further than 50km starting from 1000m up.

Wing strength is measured by a J number, with a requirement of 1 and a design expectation of J = 1.5 at least. In fact the wing proves to be stronger than the test rig, which breaks!! Elicit ideas on how to strengthen the rig – the students' thinking should build on their learning from the spaghetti – eg use two beams, laminate the beams.

What else is laminated?

We give some examples. Elicit discussion on what everyday objects are laminated and why.

Students can find out all about gliding at the British Gliding Association website www.gliding.co.uk and the Junior Gliding and Women Gliding communities at the links below. There's information about flying with and without an engine and all types of aviation at https://stem.caa.co.uk/ & www.airleague.co.uk – aviation is not just about being a pilot! The CAA STEM site is particularly good, showcasing the breadth of aviation and associated careers.

We hope you found this useful and a fun way to encourage young people into the world of STEM and aviation. Girls in particular are under-represented in these areas and we are working to change this. Inspire them with videos of our STEM role models along with other exciting gliding-based STEM resources covering various elements of the National Curriculum on gogliding.uk and at www.gliding.co.uk/STEM. You can contact the Go Gliding team at gogliding@gliding.co.uk.

Student notes are shown overleaf.

Gliding – Designing a Wing Spar

Do you know about gliding?

Do you know what a glider can do? It's an awesome way to fly, and glider pilots fly hundreds of kilometres at speeds of over 100kph just using renewable energy from the sun and the wind. But how do we make a glider light but strong enough to withstand the loads on it when it takes off or lands or flies through strong air currents? Most glider wings use a **spar** – a strong central beam the length of the wing to take the loads, which has an aerodynamic form around it. Fibreglass and carbon fibre are often used to make wing spars, however today we'll use another material which is more easily available but has some similar properties – spaghetti! You will carry out a number of tests to see how strong different spars will be using different numbers of spaghetti strands, and you will explore how to make them stronger by **laminating** them. We're going to show you a video telling you what you need to know about gliding and about wing design and then it's over to you for….

Your challenge: to design a wing spar to support a particular load.

Materials needed:

- For the spars: spaghetti, rubber bands, white glue
- For the variable load: paper cup or plastic drinks bottle, string, paperclip and sand or water to load the test rig.
- Test rig: something to form the supports for your wing spar – such as cereal boxes or piles of books - and a set of scales.

Method:

- Make your variable load by cutting down a cup or drinks bottle, supporting it with string in 3 places around the perimeter to keep it stable and using the paperclip to make a hook to suspend the load.
- Build a test rig – two flat topped pillars - to support the spar. Make sure it's tall enough to let the spar flex without the weight touching the desk.
- Glue 5 strands of spaghetti, assemble with rubber bands on the ends and leave to dry while carrying out the rest of the experiment.
- Measure the breaking load of 1, 2 and 5 strands with the ends held with rubber bands and 5 glued strands of spaghetti and record your results in a table. Add the water or sand slowly and make sure you don't spill any!
- Plot a graph of your results and predict what the breaking load of 3 and 4 strands of spaghetti will be. How much stronger do you estimate they would be if you had laminated the spars? Calculate the average results from all the class and see if it changes your predictions.
- If time permits, carry out experiments to verify your predictions for 3 and 4 strand spars.

We hope you have fun designing and testing your wing spars! ***See you on an airfield soon!***

Find out more about GLIDING at the links below, all types of AVIATION at airleague.co.uk & CAREERS at **stem.caa.co.uk/careers-in-aviation-and-aerospace**