Introduction to Engineering

Materials used in boat construction

Boats can be made of a vast range of materials. The Vikings used the most common material available to them that would float: wood! Therefore, they made boats from local timber. On the other hand, modern boats or ships are made from multiple materials that suit the purpose of the vessel. Examples of modern materials are given below.

A boat, like a racing speed boat, needs to be constructed of materials that are light, but also strong and flexible. This type of vessel will usually use plastic or carbon composite materials for the structure, which are specially designed to meet these needs when travelling through the water at high speeds. Although these are excellent materials for this type of boat, they can be expensive and hard to maintain.

Bigger boats and vessels, such as large military aircraft carrier vessels or cruise liners, travel at much slower speeds compared to a speed boat. These boats need to be strong but not flexible. Therefore, they are typically made of metal or heavier materials as they are durable and cheap to maintain.

Wood is still used in making boats, but this has mostly been phased out. It is a difficult material to work with and does not offer the same durability or performance as the materials above. Wooden boats are mainly small personal ones that do not require much maintenance or travel shorter distances at a slower pace.

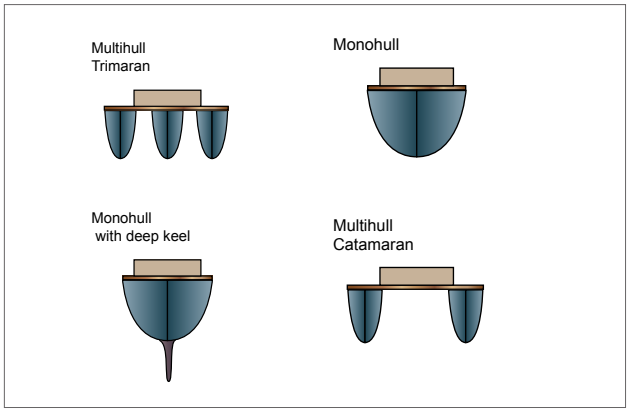
The shape of a boat

The most common shapes of boats are shown below. The hull (the bottom of the ship) is

typically V- or U-shaped. However, the depth and width of the hull varies across ships and depends on how fast or slow it needs to travel. The deeper a ship's hull goes into the water, the more stable it will be as it displaces more water, but this makes it harder to steer.

A ship with a narrow V-shaped hull will displace less water and so can travel faster. However, it is not as stable because it's centre of gravity is higher than larger ships which tend to be weighed down by heavier engines. The overall design of the vessel needs to be a compromise between stability and manoeuvrability - that is why there are so many different types!

To allow the boat to move through the water, the front of the ship needs to displace the water that it is travelling through. To be more efficient and to allow more water to move, the front of the ship is shaped like a knife or a sharp point as this enables the ship to "slice" through the water.



Source: https://en.m.wikipedia.org/wiki/File:Monohull.svg

Learn about: How to use a material's properties for a flotation device

Boat Design Challenge

The Problem: The Mississippi Cookie Company transports their cookies from their factory in Minneapolis, MN to their distribution center in New Orleans, LA. Since the route is over 1,400 miles on the Mississippi River, it is important to ship as many cookies as possible each trip. Their largest barge was damaged in a recent storm, and they need to replace it with another water-craft that will support the weight of thousands of boxes of cookies.

The Challenge: A representative from the Mississippi Cookie Company has contacted you to design a model of a boat that will support enough weight to transport their cookies from Minneapolis to New Orleans.

The Materials: You must construct your model boat using the following materials: Lollipop sticks, aluminium foil and PVA glue. You may also use any of the following optional materials: plastic straws, corks, paper. Remember that a big part of this challenge is to create a model that will support weight and be economical to build. Decide which materials you want to use wisely! The optional materials are expensive!

The Cost: Your boat must be cost efficient to build. You have a budget of **£1000** to build your boat. Using the cost of materials below, calculate the cost.

- Lumber (lollipop sticks) = £50 each
- Sheet Metal (aluminium foil) = £25 per 30cm x 30 cm sheet
- Welding materials (PVA glue) = £50 per 250ml bottle
- Reinforcements (plastic straws) = £25 each
- Buoys (corks) = £50 each
- Cable/rope (masking tape) = £10 per inch

Brainstorm, Design and Build!

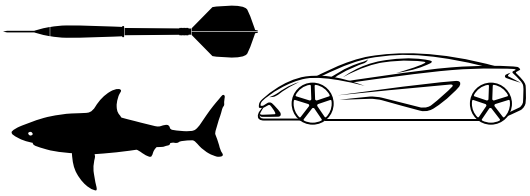
What design do you think would be the best for this challenge? Sketch your boat design and brainstorm some ways that you think might make it strong enough to support the most weight and be the most economical to build. Build your model and test it to see if you will get the job!

https://www.educationworld.com/sites/default/files/build-a-boat.pdf

Learn about: Hydrodynamics in boat bow design

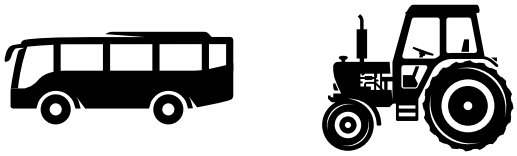
Angles on a Boat

Angles Question 1: Think of things that travel quickly. A dart. A supercar. A shark. What do you notice is common to the front of all of these things?



THEY ALL HAVE POINTED FRONTS

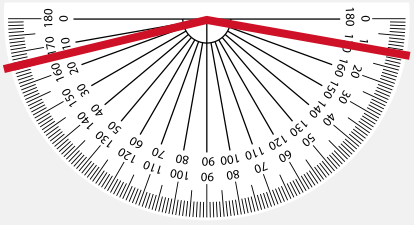
Angles Question 2: Think of things that travel slowly. A bus. A tractor. What do you notice is common to the front of all of these things?



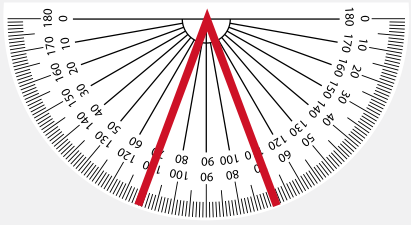
THEY BOTH HAVE FLAT FRONTS

When an object travels, it is met with air or water resistance, which slows down the object. The sharper the front, the lower the resistance. This means that objects with a sharp front, experience less air resistance, and so are able to travel fast. Objects that travel quickly through water can be described as hydrodynamic and objects that travel quickly through air can be described as aerodynamic.

Imagine the front of a boat, also known as the **bow**. It is crucial to design the front of the ship to be hydrodynamic, so that it travels through the water quickly. This means the angle of the bow needs to be sharp.



This image above shows a wide angle for the front of a boat that is **not** hydrodynamic. This means it will encounter a lot of resistance and so travel slowly, but it will allow more space for cargo and/or passengers.



This image above shows a sharp angle for the front of a boat that is hydrodynamic. This means it will encounter less resistance and so can travel faster, but it will struggle to carry lots of cargo and/or passengers.

Aerodynamic: having a shape which reduces the drag from air moving past

Hydrodynamic: having a shape which reduces the drag from water or other liquids moving past

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Learn about: How to practice fine motor skills

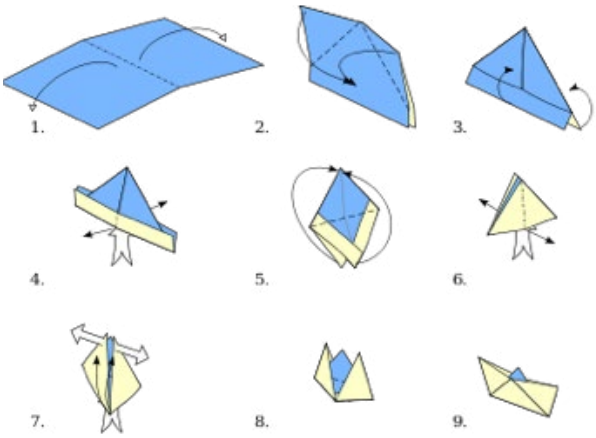
Origami Boat

You will need:

- 1 Rectangular sheet of paper

What to do:

1. Start with your rectangular paper. Lay it down vertically and fold it from left to right so the corners meet up. Unfold the paper, rotate it 90 degrees and fold it in half again.
2. Flip the paper so that the fold opens toward you. Then, fold down the top corners towards the middle of the paper while leaving 1-2 in (2.5-5 cm) of space at the bottom.
3. Grab the flap at the bottom of the paper and fold it up against the bottom of the 2 folded triangles. Turn the paper over and do the same thing to the flap on that side. This will make a paper hat.
   - On 1 side of the paper, grab the corners of the rectangle that are sticking out over the triangle. Wrap these parts of the paper around the edges of the triangle and crease them so that they stay wrapped around the edge of the triangle. Repeat on the other side.
4. Pick up the triangle, rotate it 45 degrees, then use your fingers to open up the bottom of the triangle. Pull the paper apart gently until it pops into a square shape. Make sure the bottom corners of the triangle fold over each other and become the bottom corner of a diamond.
5. Arrange your paper so that the bottom points of the diamond can fold upward. Fold up 1 corner, aligning it with the top corner. Then, flip the paper over and do the same thing to the other side.
6. Just like last time, pick up the triangle, rotate it 45 degrees, then open up the bottom of your new triangle with your fingers. Crease the paper along its edges so that it stays in the square shape.
7. Pull out the triangles on the side of the square. Start at the top of the diamond, and gently pull the two sides apart so that the seam running down the middle of the diamond blooms.
8. Crease the bottom of the folded out sides to make the boat a bit stronger.
9. You have created an origami boat!
10. Fill a small tub with water and place the boat on the water. If it starts to droop a little, keep making small adjustments to keep the sides up and prevent the boat from sinking. You can reinforce the corners with clear tape and tape around the bottom to keep your boat dry.



Source: https://zh.m.wikipedia.org/wiki/File:Origami_boat.svg

https://www.wikihow.com/Make-a-Paper-Boat

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Meet our STEM Ambassador

Laura

1. How do STEM subjects fit into your role at work?

Being an engineer is one of the core careers for STEM. It's super valuable as engineers build societies! Engineers have built everything around you in one way or another, and without them, society would not be what it is now. As an engineer, all the STEM subjects help me to do my job. We use our knowledge of science, engineering, and mathematics to create new technologies every day.

2. Have you found STEM working in unexpected places?

What part of society you contribute to determines how much you exercise these skills? If you're working in Finance, you use mathematics and technology to create all sorts of ways to do your job better. You wouldn't think technology is a big part of Finance, but it is. Using excel, databases or other tools allow Finance workers to do their jobs easier. Another example is journalists. You wouldn't think journalists use much STEM subjects, but they do. Imagine the technology tools they would need to create their stories. Video and audio editing, computer applications, website design, the list goes on.

3. What advice would you give to someone who wanted to study STEM subjects or follow a STEM career path?

My path to engineering was not quite a straight road, but I got there in the end. I took all my GCSE's, which included Maths, Science, English, and Information Technology. I went on to do A-levels in Physics, Maths and Computer Science. From there I did a Bachelor of Engineering at Surrey University in Electronic Engineering and Space Systems. Then I did a Master of Science in Astronautics and Space System Engineering. If you want to be an engineer, you can start as an engineering apprentice and learn and get paid at the same time. The main things to start with is Maths and Science at school. From there, you can do anything as an engineer.

4. Who is your STEM inspiration or role model, and why?

From a young age, I don't think I had a STEM inspiration or role model. I didn't have STEM clubs or anything like that, so I had to find out my own path and what I was passionate about. This is why I am so glad students have industry and organisations promoting STEM so they can learn about what opportunities are out there. Although later in life I found the inspirational stories of astronauts and scientists a true inspiration.