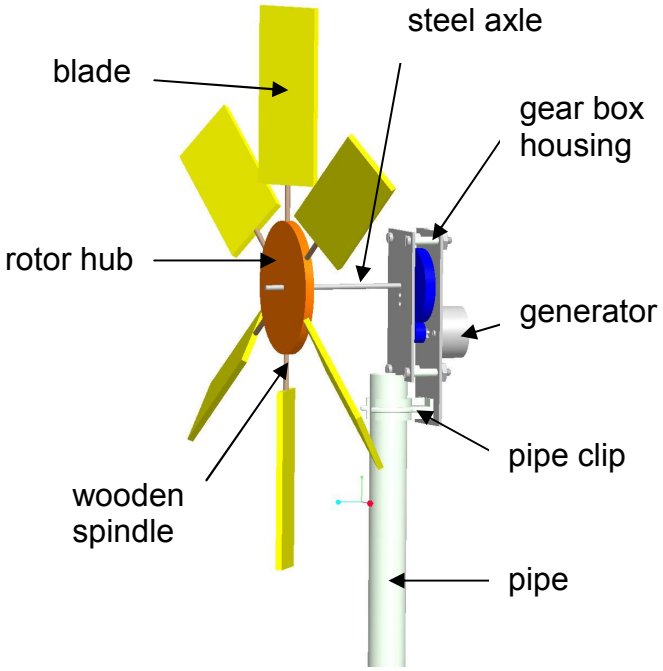
Cambridge University Engineering Department

Wind Turbines

Using the kit provided make a wind turbine to produce as much power as possible.



KIT LIST

- 1 gear box housing
- 1 set of gears
- 1 generator
- rotor hub and steel axle
- turbine blades
  - corriflute OR cardboard
- 6 wooden spindles
- pipe
- pipe clip
- blade angle template

CONSTRUCTION

1. Assemble the gear box housing using the kit provided as shown in the exploded diagram. The smallest gear is connected directly to the generator.

☺ **Top Tip:** You need to choose which gear will be connected to the rotor blades. Think carefully about which gear will make the generator turn as fast as possible.

2. Decide on how many and what size of blades to test. See overleaf for some engineering advice.
3. Assemble the rotor hub and blades. Push the spokes on to the rotor hub. There are a maximum of 6. Cut blades from the corriflute or cardboard and push or stick these onto the spokes.
4. Push the rotor hub onto the axle. Line up the blades using the blade angle template.

☺ **Top Tip:** The turbine will work best if all of the blades are at the same angle. Try different angles to find the one which generates the most power.

5. TEST!

Can you find the best size and shape to get the most power output from your turbine?

Safety note: Do not place your hands or face near the turbine or moving parts of the fan in the testing area. Wait for the turbine to stop after the fan has been turned off before moving it.

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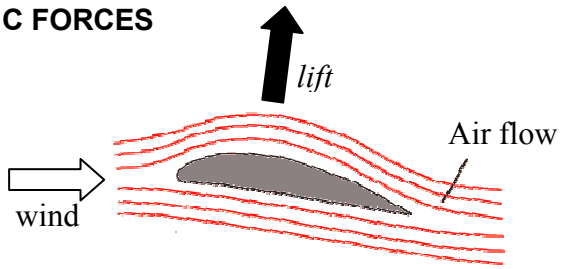
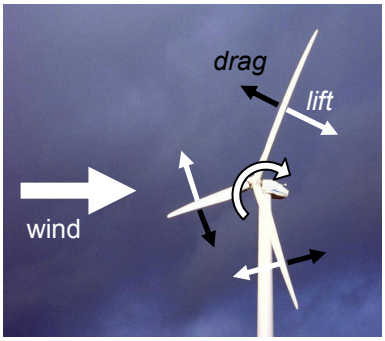
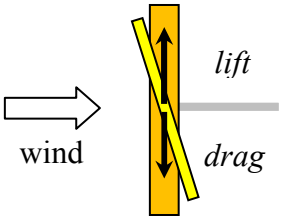
AERODYNAMIC FORCES





The blades of a modern wind turbine turn because of *lift*, the same force that makes it possible for an aeroplane to fly. The blades are shaped to make the air turn as it flows around them, this creates a *lift* force on the blade. The *lift* on each blade makes the rotor turn. Once the blades start moving a *drag* force is created as the blades push through the air. This *drag* forces is in the opposite direction to the *lift*.

The Blade Angle



Blade angle is too small

Small *thrust force, blades turn slowly*.

➢ Low power output

Blade angle is too large

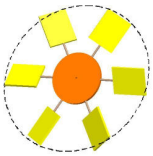
Larger *thurst* force BUT the *drag* force is also much larger.
Blades turn slowly

➢ Low power output.

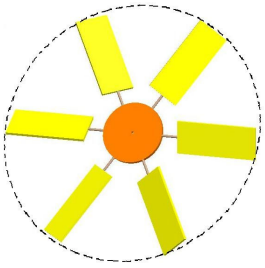
☺ **Top Tip:** Use the blade angle template to help you try out different blade angles. What angle gives maximum output?

Swept Area

Short blades give a small swept area
➢ Small power output

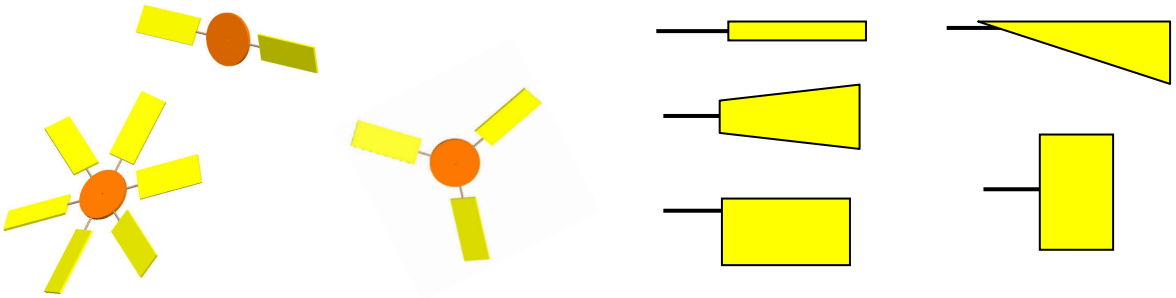


Long blades give a large swept area.
➢ Larger power output



☺ **Top Tip:** Remember that the wind from the fans we are using covers a limited area – if the blades are longer than this, the power will decrease. Larger blades are also heavier which increases *drag*. This means that the wind will have to be stronger to be able to start turning the turbine.

Number and Shape of Blades



☺ **Top Tip:** When engineers choose how many and the size of the blades, they have to think about how much power they get and what the cost of the materials and manufacturing will be. Try different numbers and sizes of blades. Ask an adult for help to cut complicated shapes.