

Propelling the *Warrior*

As with her armament, the *Warrior's* propulsion made use of a mixture of old established methods and the latest technology of the day.

Sails and masts were the established technology whereas steam engines powering a screw propeller was very much the latest in marine propulsion.

Brunel had pioneered the use of steam engines and screw propellers in the early 1840s and the concept had been well and truly proved with the launch of his ship, the *SS Great Britain*, in 1843.

Steam power allowed the *Warrior* to sail even when there was no wind and this was a crucial advantage when fighting against ships relying on wind power.



HMS Warrior 1860, showing her combination of funnels and masts
Image courtesy of *HMS Warrior 1860*

However, the steam engines of the day were not very efficient and even fully stocked with 850 tons of coal the *Warrior* could only use steam power when it was essential. This is why the *Warrior* also carried some 4600 square metres of sail.

Under sail the *Warrior* could reach 13 knots and under steam 14.3 knots. If the two were used in combination she could reach 17.5 knots.

Using two means of propulsion definitely gave the *Warrior* a great advantage over its rivals but it also called for some ingenuity of design. When the ship was under sail the propeller produced a huge amount of drag if left in the water. To solve this problem the propeller could be disengaged from the engine shaft and lifted clear of the water. The steam engine funnels also got in the way of the sails so, when not needed, they could be cranked back into the deck.

When under steam, great care had to be taken that sparks coming out of the funnels did not catch the sails alight. To stop this, the lower sails on the fore and main masts were kept furled when under steam.

Continued on the next page



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Producing the steam which powered *Warrior's* engine required lots of heat and this in turn was produced by burning coal. This coal had to be manually shovelled into furnaces deep in the bowels of the ship. Conditions in the stokehold where this went on were awful. The temperature was over 40°C, the air was thick with coal dust and the noise was deafening. The stokers that worked there were expected to shovel over a tonne of coal per hour and were paid half as much again as able seamen to compensate for the harsh working conditions.

Warrior had ten boilers, each served by four furnaces. These furnaces had to be kept clean so that they worked with maximum efficiency. This meant that white hot ash had to be regularly raked out of the furnaces, dowsed with water and then winched up on deck to be disposed of over the side.

The engine itself produced 1250 horsepower (about 900 kW). In comparison the Royal Navy's new type 45 destroyers are powered by two Rolls Royce WR-21 gas turbines, each of which produces 25 MW power (about 33500 horse power). However, for its day, these were powerful engines and they were used to turn a 30 metre long wrought iron propeller shaft which weighed over 50 tonnes.

The bronze propeller had two blades, was 7 metres in diameter and weighed over 25 tonnes. *Warrior's* engine could turn this propeller at over 50 revolutions per minute.

The engineering involved in the *Warrior's* engine is quite astounding and even today it is amazing to see. But just try to imagine what it must have been like to work there in the 1860s. Could you imagine doing a job like that?



One of the twin pistons in *Warrior's* horizontal trunk engine



Sailing Away

The *SS Great Britain* and *HMS Warrior* marked the beginnings of a world linked by great steam powered ships. But at the time steam power alone wasn't reliable or fuel efficient enough to be the sole method of propulsion for a large ship. Sails and wind power were still essential.

In this activity you will find out how to build your own model land yacht and investigate how exactly sails work.

This is what you will need to build your land yacht:

- 10 cm or more of 1.5 cm diameter wooden dowel
- 2 wooden kebab skewers
- A sheet of corrugated card board (about A4 size)
- 2 plastic drinking straws (without bendy bits if possible)
- 4 old CDs
- Two round head pins
- Some garden wire
- 1 metre of 5 mm wooden dowel
- An electric drill
- A hot glue gun
- Side cutting pliers
- A junior hacksaw
- A craft knife

Adult assistance may be required when using the drill, craft knife and glue gun.

Now here's what you do:

Step 1

Cut four 2 cm lengths of the 1.5 cm wooden dowel and drill a 2 mm hole into the centre of one end. The hole needs to be about 1 cm deep.

Push a piece of dowel into the centre hole of each of your CDs. These will form your land yacht wheels. The holes you have drilled will be where the axles locate.

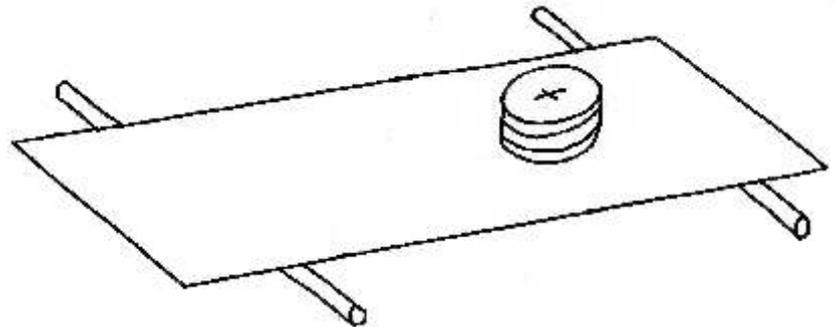
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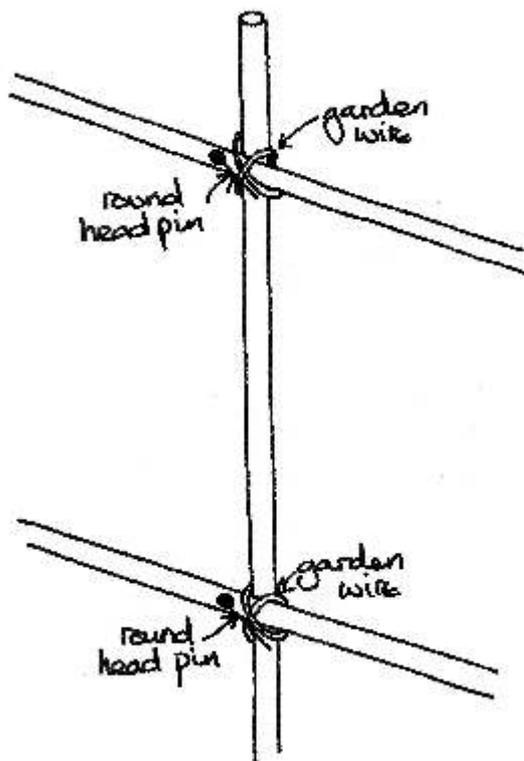
Sailing Away

Step 2

Cut a piece of corrugated card approximately 25 cm by 10 cm. Cut the plastic drinking straws so that they are 15 cm long. Glue the straws to the cardboard as shown in the diagram.



Cut three 5 diameter circles from the leftover card and cut a small cross in the centre of each one with the craft knife. Make sure the cross goes all the way through and that all the crosses line up when the card circles are placed on top of each other. The glue them together and glue them onto the card base two thirds of the way from one end.



Step 3

Cut the 5 mm wooden dowel into one 25 cm length and two 20 cm lengths. The longer length will form the mast. Attach the yards (cross pieces with garden wire as shown. The wire should be tight but still allow the yards to move up and down the mast. The round head pins can be pushed into the mast to stop the yards from moving when necessary.

Continued on next page



Sailing Away

Step 4

Break the sharp end off one of the kebab skewers and push it into the hole in one of the dowel wheel hubs. You may need to secure it with some hot glue. Thread the skewer through the straw glued to the base board, break it off to the correct length and attach the other wheel. Repeat this so that both sets of wheels are attached.

Step 5

Push the bottom of the mast into the cross cut in the stack of card discs. This should hold it fairly firmly but secure it with hot glue just in case. All you need to do now is make a sail. Simply cut a piece of plastic carrier bag or tin foil to fit the space between your yards and secure it with sticky tape.

Your yacht awaits!

Using Your Yacht

If you find yourself becalmed why not use a desk fan to power your yacht?

You could also see what difference different sized sails make to the speed of your yacht, or how about adding a second sail?

Why not get some friends to make them as well and have a regatta?

