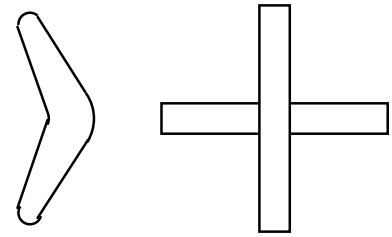
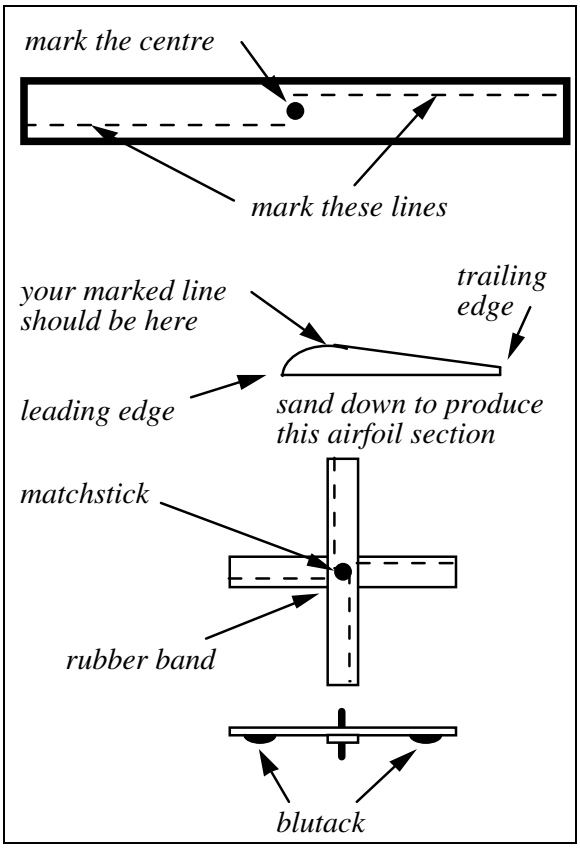
Normal boomerangs derive their shape from the bent bits of wood that are easy to find in outback Australia, but their aerodynamic and gyrodynamic efficiency is poor and you need wide open spaces to fly them. Cross-shaped boomerangs have much better properties and they can be made to fly indoors.

How to make a cross-shaped boomerang



A simple indoor boomerang can be made with balsa wood, a rubber band, some blutack and a matchstick. The only tools that are required are some sandpaper and a sharp knife.

You will need:
- two bits of balsa wood, 200×25×3mm approx;
- some sand paper (not too coarse);
- a match stick;
- some blutack;
- a small rubber band.



STEP 1. Decide if you want a right- or left-handed boomerang. They're easy to throw with either hand. Instructions here are for right-handers. Use the mirror image of all constructions to make a left-hander.

STEP 2. Mark the centre of the two pieces of balsa and draw four lines in pencil near one edge of each piece as shown (about 1/6 the width from one edge). This line must never be touched with sand paper.

STEP 3. Place the balsa near the edge of a table. Wrap the sandpaper around a sanding block (a ruler will do) and sand to create airfoil shapes leaving the bottom absolutely flat. Don't make the trailing edges too 'sharp' as they are easily damaged in flight. When you're done sanding, the pencil lines should still be visible.

STEP 4. Carefully press a matchstick through the centre of the two wings and join them together. Secure with a rubber band as shown.

STEP 5. Add four small blobs of blutack (each about the size of a pea) to the flat side of each wing at about 3/4 the radius from the centre. This should roughly double the weight of the boomerang.

FLIGHT TESTS

1. Radius of Flight From boomerang theory (see the website) the radius of the flight path R is a boomerang constant since the lift coefficient C_L, the moment of inertia J, the boomerang radius a and the air density ρ are all fixed.

$$R = \frac{4J}{\pi C_L \rho a^4}$$

The path radius does not depend on the throw velocity – try it. You can increase the flight by moving the blutack further out along the wings so increasing the moment of inertia J.

2. Flick of the Wrist For good flight the boomerang must have just the right spin and forward velocity. Boomerang theory says that the ratio of these two parameters is what counts. This is the 'flick-of-the-wrist'

$$a\omega = \sqrt{2}V$$

Try throwing with different values of velocity and spin to verify that this is roughly true.