

Make a Crumble Robotic Vehicle

Blog

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Follow this step-by-step guide on how to make a Crumble robotic vehicle.

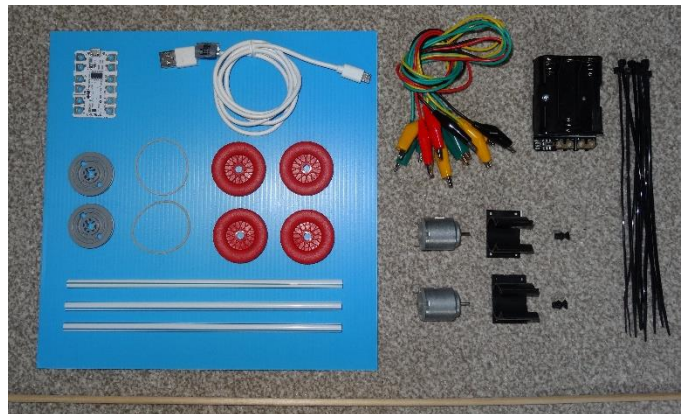
Associated resources:

- Crumble robotic vehicle extension activities blog
- Crumble robotic vehicle lesson plan
- Crumble robotic vehicle PowerPoint
- Crumble vehicles extension activities PowerPoint
- Crumble robotic vehicle worksheet
- Crumble robotic vehicle worksheet – suggested answers
- Crumble vehicle extension activities worksheet
- Crumble vehicle extension activities worksheet – suggested answers

You will need:

Parts from class kit

- 1 sheet corrugated plastic 25cm x 25cm
- 1 Crumble controller
- 1 micro-USB cable
- 6 crocodile leads
- 1 switched battery holder 3 x AA
- 11 cable ties
- 2 plastic pulleys 30mm diameter
- 2 rubber bands 6cm long x 1.5mm wide
- 4 wheels
- 3 drinking straws
- 2 motors
- 2 motor mounts
- 2 motor pulleys
- 1 wooden rod



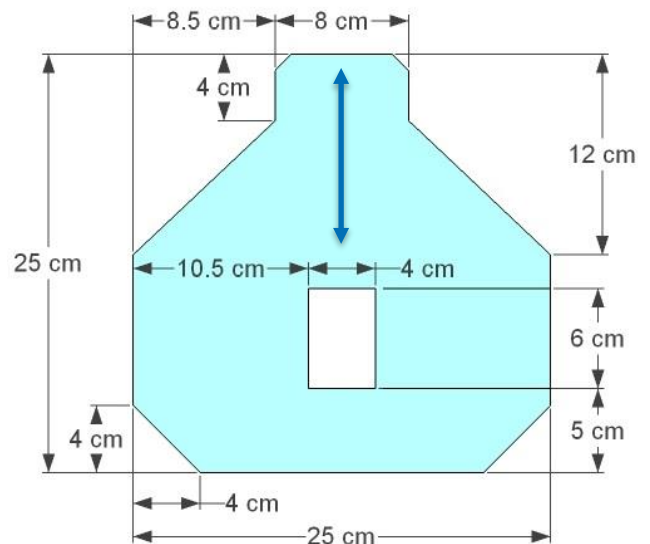
Other parts, tools and consumables

- Computer with internet connection
- Ruler
- Fine marker pen
- Scissors
- Pencil sharpener
- Sandpaper
- Sharp pencil
- Blu Tack
- Double-sided foam sticky tape, 12mm wide x 1mm thick, heavy duty
- 3 new AA zinc cells
- Craft knife
- Straight edge
- Cutting mat
- Secateurs



Step 1

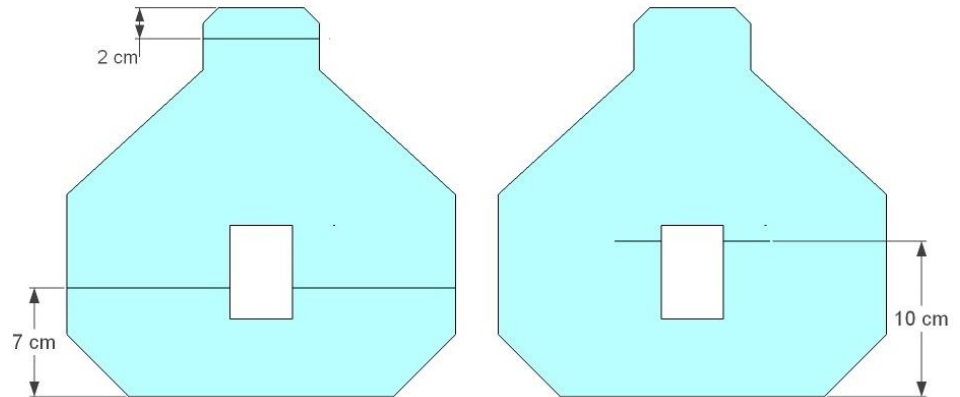
Use the ruler and marker pen to mark out the shape shown here on the corrugated plastic sheet. Make sure the sheet is orientated so that the corrugations run in the direction shown by the blue arrow. This is to help maximise the stiffness where the base is most vulnerable (4 cm from the front). Cut out using the craft knife, straight edge and cutting mat. This is your base.



Before you assemble your vehicle you may wish to use your base as a template to draw round (see the Crumble robotic vehicle lesson plan).

Step 2

Use the ruler and marker pen to mark the lines shown here on the base. These are to help you position the components correctly. The left hand diagram shows the underside and the right hand diagram shows the top.



Step 3

Measure, mark and cut a piece of straw 9.5 cm long. Be careful to cut it cleanly so the ends aren't damaged (this could increase the friction). If the ends become flattened during cutting you can round them out again with the end of the pencil. Stick an 8 cm long strip of double-sided foam tape centrally along the line you marked 2 cm from the front of the underside of the base. Peel off the plastic film and stick the piece of straw to the foam tape as shown. This is the front bearing.



Step 4

Use the secateurs to cut a piece of wooden rod 14 cm long. Sharpen the ends slightly with the pencil sharpener to help the wheels go on. This is the front axle.

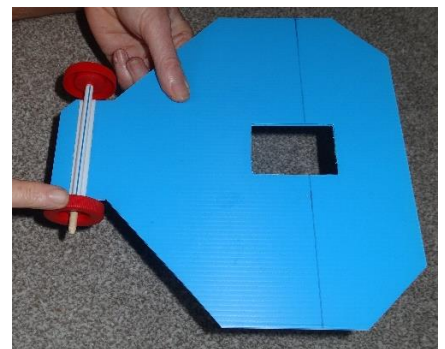


Step 5

Fit one plastic wheel to the end of the axle. Push a second wheel onto the other end to make sure it goes on easily, then take it off again. Slide the axle through the bearing and refit the second wheel. Make sure there is a small gap (about 2 mm) between the wheel and the end of the straw bearing. You can adjust the gap by holding both wheels and twisting them in opposite directions. Hold the base in your hand and spin a wheel with your finger to make sure the axle rotates freely in the bearing.

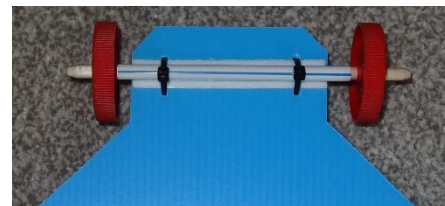


N.B. The wheels should be a tight fit on the axle. However, the wooden rod (axle) can vary slightly in diameter. If the wheels are too tight to fit you can sand the axle down a little. If the wheels are slightly loose, you can glue them onto the axle, but be careful not to glue up the bearing and stop the axle turning.



Step 6

Use the sharp pencil to make holes in the base immediately either side of the foam tape, roughly 4 corrugations in from the edge. Support the base on a lump of Blu Tack just under where you are making the hole, so you don't bend the base or pierce your fingers. Use the pencil to enlarge the hole from both sides until the cable ties fit through. Fit two cable ties as shown but **don't** pull them too tight. The cable ties are to stop the bearing moving around. However, if you pull them too tight, they crush the straw bearing onto the axle and stop it rotating. Snip off the ends of the cable ties with scissors. Hold the base and spin the wheels again to check the axle still rotates freely in the bearing.



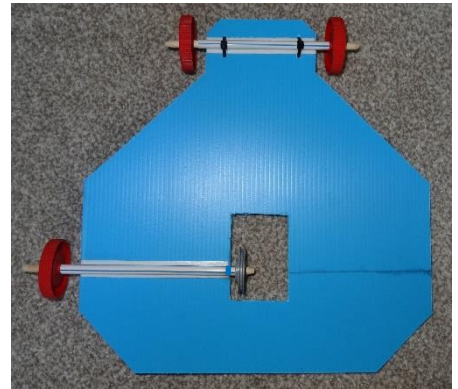
Step 7

Cut a piece of straw 12 cm long cleanly (i.e. so the ends aren't damaged). Cut a 16 cm long piece of wooden rod and sharpen the ends **very slightly**. (N.B. The length of the sharpened part must be less than 0.5 cm.) Mark the rod 0.5 cm from one end and push on a pulley until you can just see the mark. The pulley should fit tightly. Make a mark 0.5 cm from one end of the straw then slide the straw piece onto the rod, marked end first. Fit a wheel onto the other end of the rod leaving a gap of about 2 mm between the wheel and the end of the straw. If the rod is slightly too big or small in diameter refer to the note at the end of step 5.



Step 8

Stick a 10.5 cm long strip of double-sided foam tape centrally along one of the lines 7 cm from the rear of the underside of the base. Remove the plastic film and stick the straw to the foam tape, with the mark on the straw in line with the edge of the slot. Now the pulley should be in the slot and the straw should be overlapping the slot by 0.5 cm. Hold the base and turn the wheel to check the axle turns easily in the bearing.



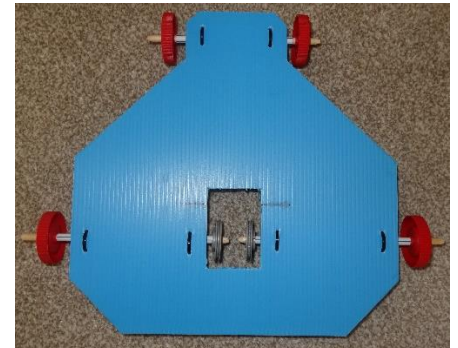
Step 9

Use the sharp pencil to make holes on either side of the straw bearing, supporting the base with Blu Tack as described in step 6. Fit two cable ties as shown but **don't** pull them too tight. Snip off the ends of the cable ties with scissors. Hold the base and spin the wheel again to check the axle still rotates freely.



Step 10

Repeat steps 7, 8 and 9 for the second pulley, wheel, rod and straw bearing. Make sure that there is a gap between the ends of the two rods. Turn the base over – you now have a rolling chassis.



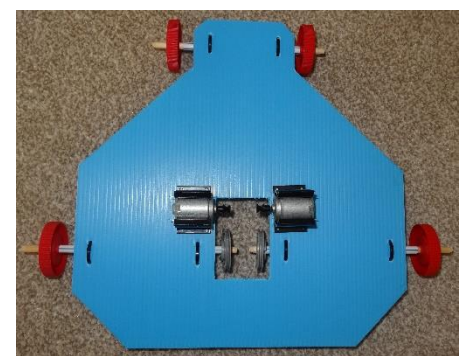
Step 11

Slide the two motors into the motor mounts in the direction shown by the blue arrows. If you push the motors in from above you can snap the motor mounts. Push the motor pulleys onto the motor shafts as shown. Turn each motor in its mount until the motor contacts (at the back) are the same height.



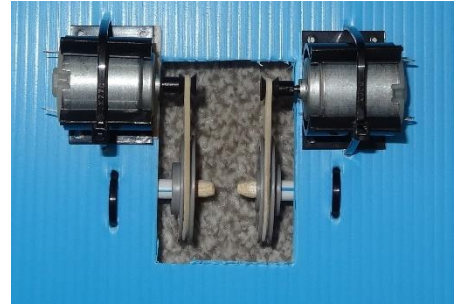
Step 12

Remove the plastic film from the bottom of a motor mount. Stick it to the top of the base so that the motor shaft is directly over the line you marked 10 cm from the rear of the base. The vee of the motor pulley should line up with the vee of the pulley mounted on the axle. Repeat for the second motor mount.



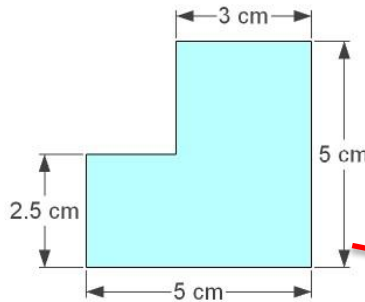
Step 13

Use the sharp pencil to make holes in the base on either side of the two motor mounts (supporting the base with Blu Tack as described in step 6). Fit two cable ties as shown and pull them tight. Snip off the ends of the cable ties with scissors. Fit the two rubber bands over the pairs of pulleys. You can slide the motors backwards and forwards in their mounts a little to line up the vees in the pulleys accurately (so the rubber bands don't fall off during running).



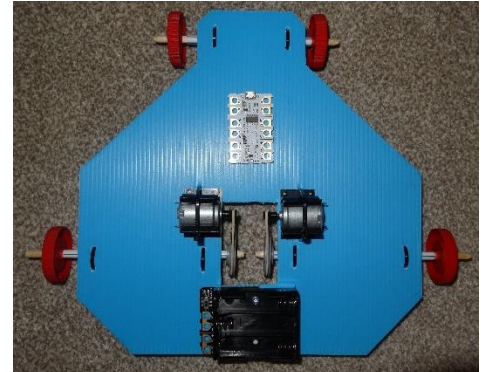
Step 14

Use one of the offcuts of corrugated plastic from the base to make this shape. Foam tape this to the bottom of the battery box, then foam tape to the base as shown.



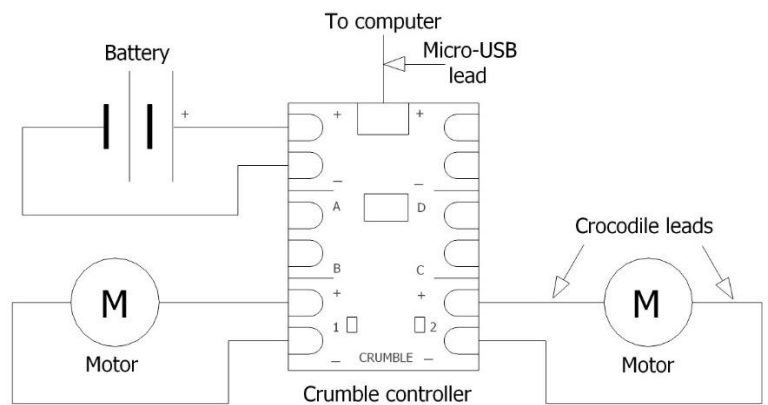
Step 15

Stick a double thickness of foam tape along the middle of the Crumble on the side without the components. Use this to attach it to the base in the position shown. The double thickness is to allow space (height) to attach crocodile clips. (Don't forget to remove the plastic film from the tape!) Make sure the micro-USB connector is facing the front of the vehicle for ease of connection.

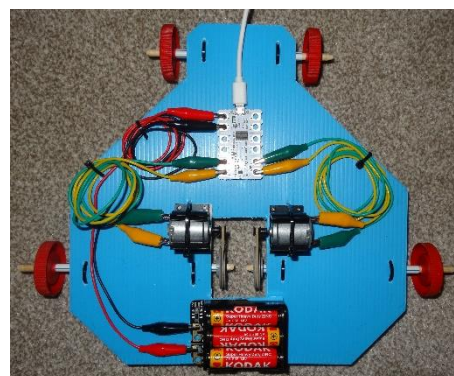


Step 16

Connect up the circuit shown on the right. Fit the cells into the battery holder (the right way round). Wrap the wires up neatly and cable tie them to the base. Position them so that the centre of gravity of the vehicle is just in front of the rear axles. This is because the driven wheels need to grip the floor, whilst the front wheels will need to skid when the vehicle turns. However, if the centre of gravity is too far back then the vehicle will tilt backwards as it accelerates across the floor. Connect the Crumble controller to the computer using the micro-USB lead.



If you do not yet have the Crumble software installed on your computer then see the lesson plan for installation instructions.



Step 17

Construct a program to run both motors at 50% of maximum power for 5 seconds:

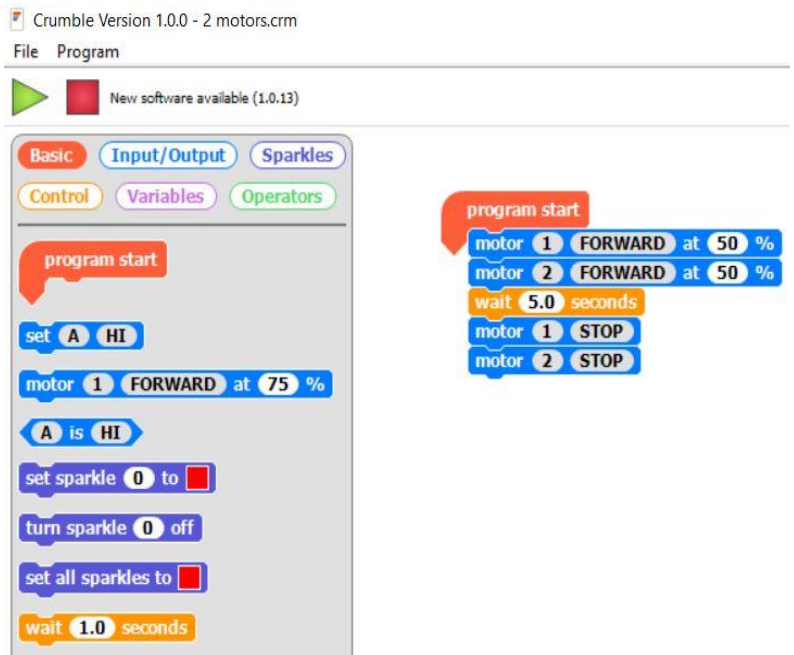
First drag 'program start' from the list on the left and drop it into the blank space on the right.

Drag across 'motor 1 STOP' and attach to 'program start'. Click on 'STOP' and it will change to 'FORWARD at 75%'. Click on 75% and change to 50%.

Drag across another 'motor 1 STOP' command; click on the 1 to change it to motor 2, and change 'STOP' to 'FORWARD at 50%'.

Attach 'wait 1 seconds', then click on the '1' and type in '5'.

Attach 'motor 1 STOP' and 'motor 2 STOP' to finish.



Step 18

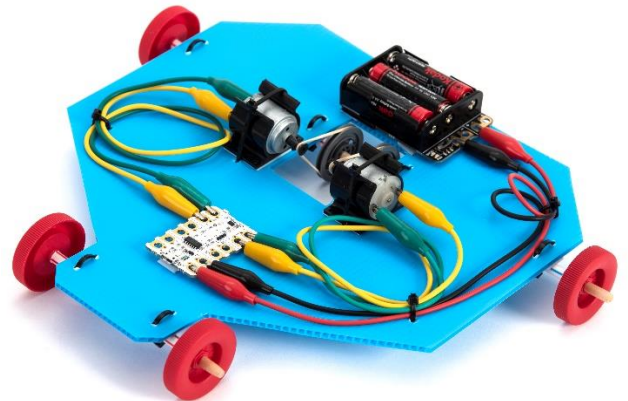
Hold the vehicle in your hand, switch on the battery box then click on the green arrow (top left of the screen) to run your program. This will download the program to the Crumble controller itself. The two motors should run for 5 seconds and then stop. Save your program in the Crumble folder.

Step 19

Run the program again and check whether the wheels turn forwards. If either wheel turns backwards, swap over the crocodile clips attached to the relevant motor terminals, and the motor should turn the other way.

Step 20

Disconnect the micro-USB lead from the Crumble. Place the vehicle on a smooth floor. Switch the battery off and then switch on again. The vehicle should move forwards for 5 seconds and then stop. Switch the battery off when not in use to stop it draining.



Step 21

Program your vehicle to go forwards, backwards, then round in a circle (one motor forwards and the other backwards) – an example is shown here. Always start both motors on 50% power or less – otherwise they draw too much current and the Crumble cannot boot up. (Also if your batteries are a bit flat then you will have problems booting up.) You can experiment with different motor speeds, following a course, three point turns and parallel parking.

Step 22

Don't forget to switch the battery off when not using your vehicle to stop the cells draining. Do not store your vehicle in sunlight (e.g. on the window sill), as this causes the rubber bands to perish. If the rubber bands lose stiffness and become loose then replace them.

