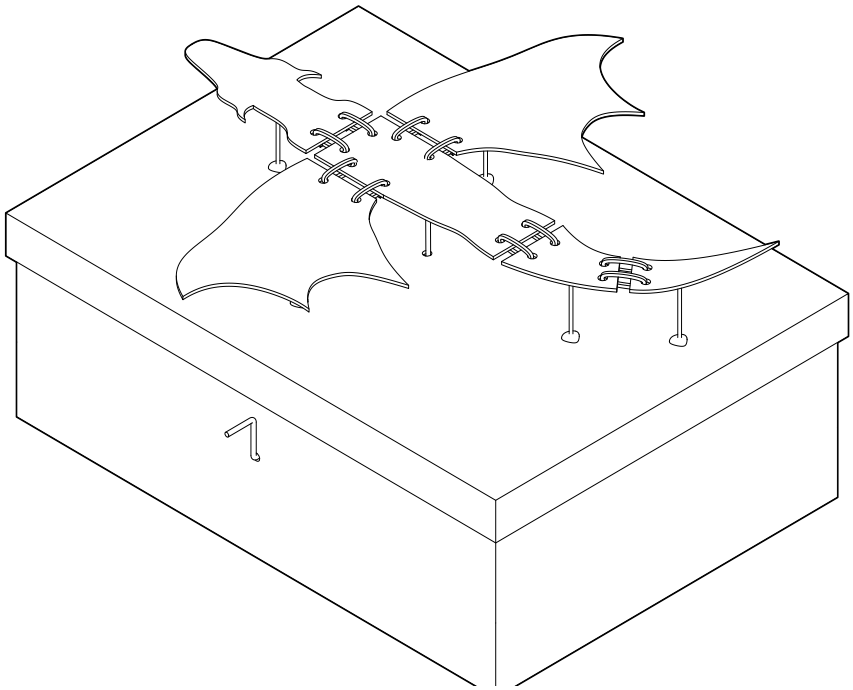


FLYING DRAGON WORKSHEET

GETTING STARTED

5-10m

For this project, we are going to look at the role engineering can play in art and conversely how adding design to engineering principles can help spark the viewers' imagination. Cranks are mechanisms that convert circular motion into linear motion and vice versa. For example, a piston in a petrol or steam engine pushes in a linear direction and it's the crank that allows us to get a circular motion and make the wheels turn.

We are going to use this crank mechanism to power a flying dragon. Mechanical toys like this are often called automatons and were popular to make in the Victorian times. As we spin the crankshaft, the dragon's body will rise and fall, causing the wings, head and tail to move as they hinge on the rods holding the dragon up. By decorating the dragon and the box that it sits on, you will see how good design can bring an idea to life.

VOCABULARY

Crank - A mechanism used to turn linear motion into circular motion and vice versa.

Crankshaft - The rotating shaft that the crank is connected to.

Linear Motion - Movement along a straight line.

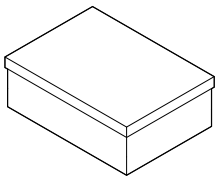
Circular Motion - The movement of an object along the circumference of a circle, or the rotation along a circular path.

Connecting Rod - A bar or wire that connects the piston to the crank, allowing us to turn circular motion into linear motion.

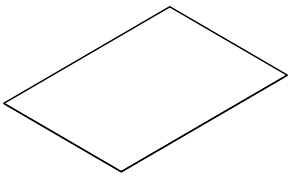
Hinge - A movable joint or mechanism which connects linked objects.

Material Properties - A physical property that does not depend on the amount of material. For example hardness or melting point.

YOU WILL NEED

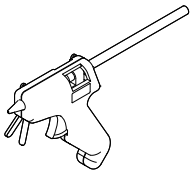


Box
(roughly shoebox size)
1

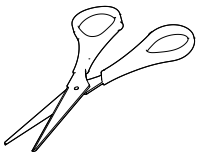


Card
1

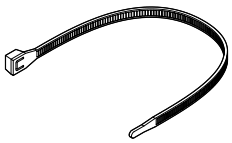
White tac
1



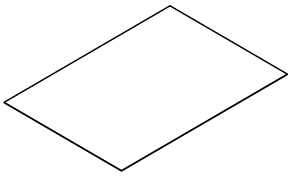
Glue Gun
1



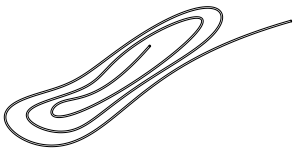
Scissors
1



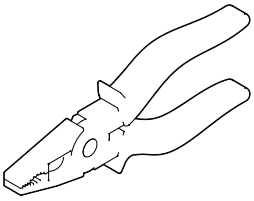
Zip Tie
12



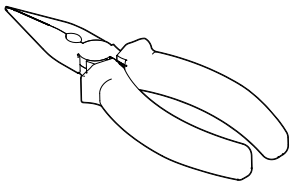
Coloured paper
(Optional)
3



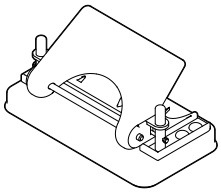
3mm Craft Wire
1



General Pliers
1



Needle nose Pliers
1



Hole Punch
(Optional)
1

WARM-UP ACTIVITIES

A

5-10m

Becoming skilled at any craft takes practice. Spend 10 minutes working with the 3mm wire to understand it's material properties.

Try to make some different shapes or spell out your name. Notice the difference between using your fingers and the different types of pliers.

What advantages do the tools bring?

B

10-15m

Design is often an important consideration when engineering a product. How can you make your dragon look more realistic?

Using whatever craft materials you have to hand, spend some time trying out some ideas for how you might style your dragon. You don't need a complete picture, you could try out simple colours and techniques.

MAIN CHALLENGE

30-40m

Working in teams or individually, you are going to build a moving model of a flying dragon.

Before starting construction, make sure you have all the suggested materials needed to complete this activity.

Don't forget that you can substitute any of these materials by re-purposing items found at home. For example, we have used a shoe box for the base.

Once you have finished, you can complete a quick quiz to test your knowledge. Good luck!

DID YOU KNOW?

The earliest evidence of cranks being used is by Romans in the 3rd century in their saw mills.

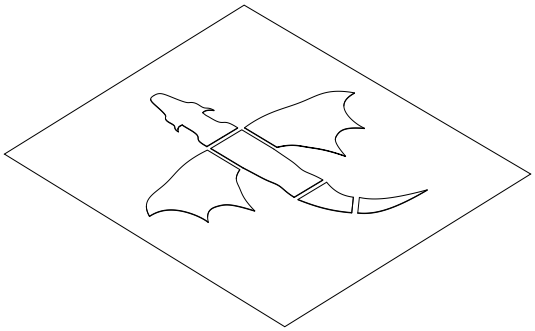
A water wheel (circular motion) would use a crank to power the saw (linear motion), allowing the Romans to cut stone precisely and make some of the impressive monuments that are still standing today!

BUILDING THE FLYING DRAGON

Follow these simple steps to create your flying dragon:

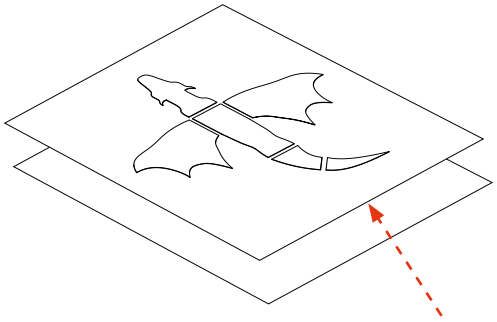
A

First, design your dragon. You can use the design at the bottom of the worksheet as a template, or create your own.



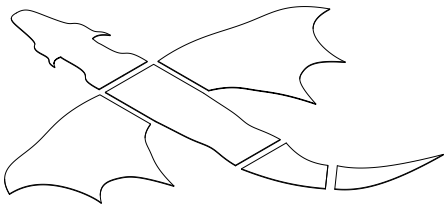
B

Next, stick the design onto card, to make it sturdy, before cutting it out.



C

If you want to customize and personalise your dragon, now is a good time to add designs.

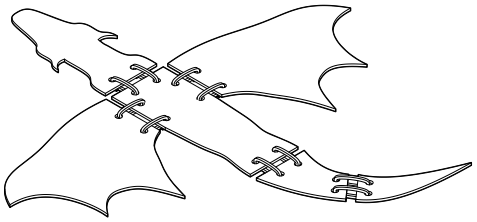


D

Create holes in the separate parts of the dragon and then use zip ties to connect them together.

See the diagram below and at the bottom of this document to see where to place the holes.

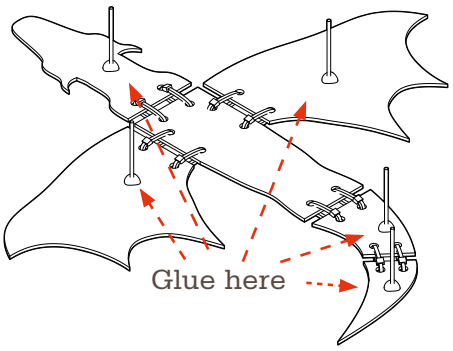
Using a hole punch can be a great way to keep the holes all the same size.



E

Cut sections of craft wire roughly 7cm long, and use the glue gun to attach them to each part of the dragon except for the main body.

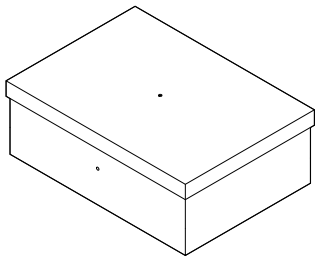
The main body will attach to the connecting rod.



F

Cut a hole in the middle of the top of the box (not the bottom), for the connecting rod.

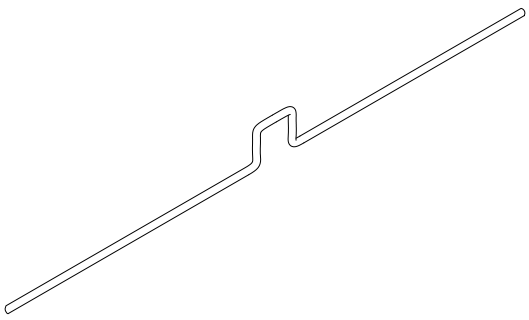
Cut a second hole all the way through the middle of the longest side. The crank will go all the way through the box.



G

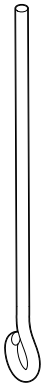
Cut the crank, and bend the metal in the middle. It needs to be long enough to poke through the width and make a handle.

It's fine if you overestimate the length. You'll be able to trim this down later.



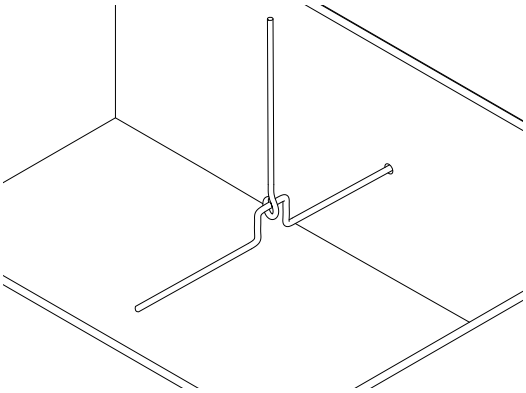
H

Use needle nose pliers to create the connecting rod. To do this, take a length of craft wire roughly 8 cm long, and hold the end with the pliers. You should then be able to twist the pliers to make an eye in the rod.



H

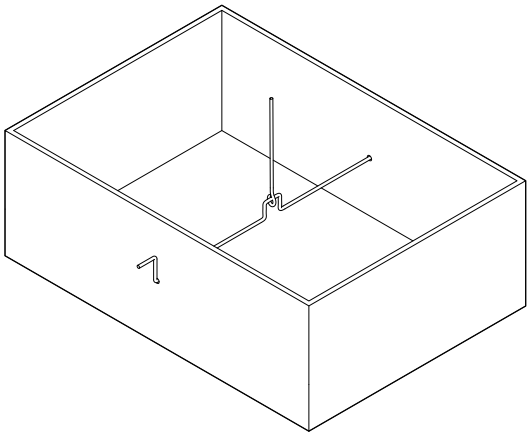
Thread the crank halfway through the box, and then slide the connecting rod onto it.



I

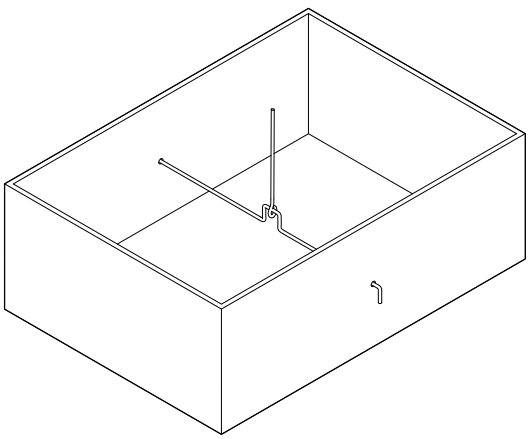
Slide the crank through the rest of the way and bend the wire twice to create a handle shape.

This will also automatically stop the crank from slipping back through the hole.



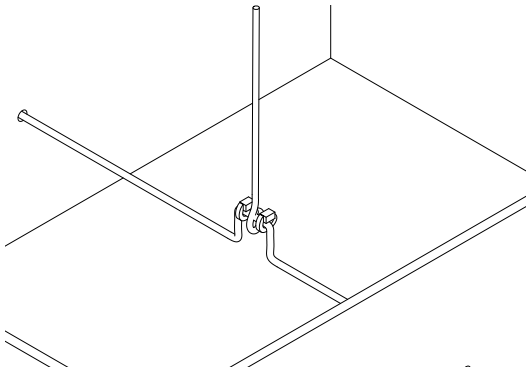
J

Flip the box around and make a single bend in the wire as shown on the back. This helps hold the crank in place from both sides.



K

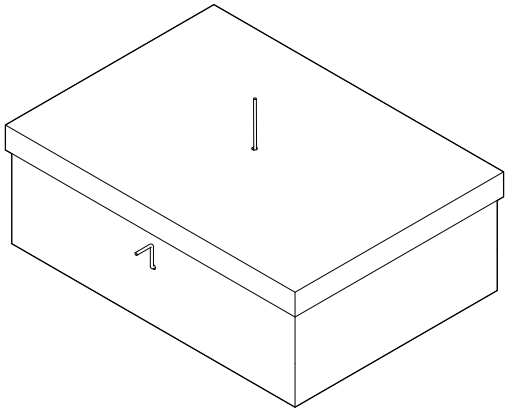
Use zip ties to hold the connecting rod in place on the crank. Without these, the rod can slide out of place and get jammed.



L

Insert the connecting rod through the lid and test the crank motion.

If you need to, adjust the crank to get a smooth spin. The wire should be easy to bend and move until you get a good motion.

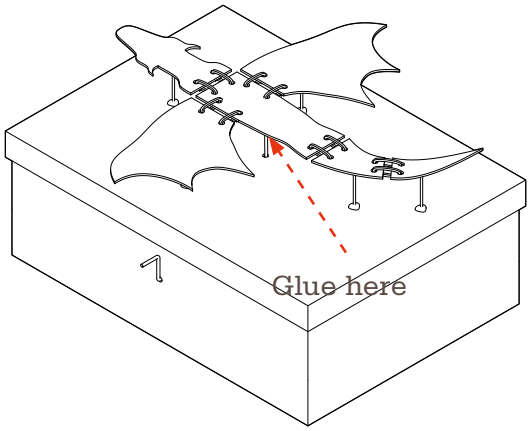


M

Make holes on the lid, in line with the rods on your dragon. Poke the wires through and fix them in place with blue tac.

Finally, use hot glue to glue the connecting rod to the body of the dragon.

The glue should be strong enough to hold the dragon up but flexible enough to hinge.



FLYING DRAGON
MECHANICS OF CRANKS

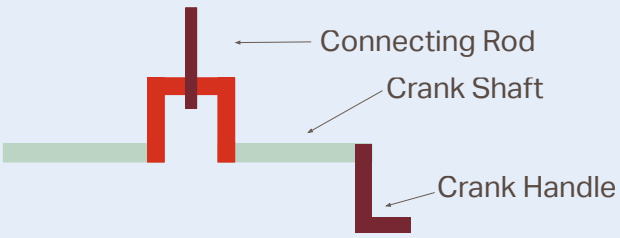
10-15m

KS1/2 PROOF OF CONCEPT

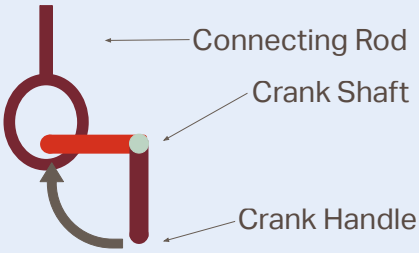
When we look at how to make things move in new ways, engineers tend to look at simple machines, pick the one best suited for the purpose and adapt it as required.

These simple machines include things like slopes, pulleys and gears; for now, we're going to look at what we used to make our dragons fly - crank mechanisms.

Crank mechanisms take a rotational motion and convert it into linear motion. They are built up of three main parts: a crankshaft, connecting rod and a crank handle.



Side view



Front view

The crankshaft is held in place and allows the crank to turn. As it turns the connecting rod is lifted up and down, creating a repetitive up and down motion.

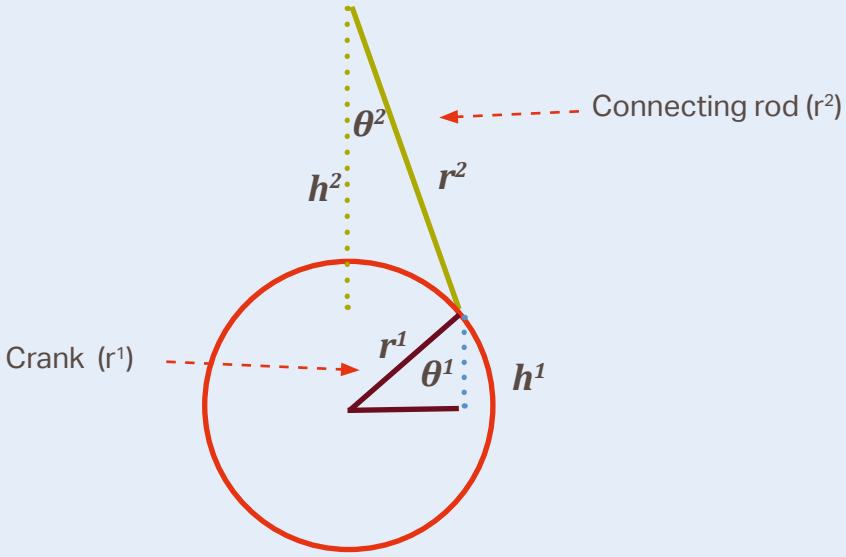
This is the motion that we use in order to make our dragon flap its wings. By changing the length of the crank (the crank throw) or the handle, we change the forces and distances that the connecting rod will place on our dragon.

KS3/4 DEEPER LEARNING

Now that we know the basics of crank mechanisms, we can take a deeper look into the maths we can use to understand more how it works.

To find out the height of the dragon we need to use a mathematical technique called trigonometry. Sine and cosine are mathematical functions which allow us to work out angles and lengths of triangles. When we draw lines from the centre of a circle to it's edge, we are effectively creating a triangle that we can use trigonometry on. On your calculator, you can use the sin button to automatically tell you the height from the angle and radius.

$$h = r\ sin(\theta) \quad or \quad height = radius\ sin(angle)$$



Taking this one step further, we can work out the height of the whole mechanism by calculating the height of the connecting rod as well. Here, we use the notation r^1 and r^2 to help us tell the difference between the crank and the connecting rod.

We will also use cosine on the connecting rod, because we want the length adjacent to the rod, rather than opposite when we were calculating the crank height. The equation now becomes:

$$h = r^1\ sin(\theta^1) + r\ cos(\theta^2)$$

QUIZ

10-15m

How many degrees are there in a full rotation?

What is a crank, and what is it connected to?

Hopefully you've been able to use recycled materials. Why do you think recycling is important?

Name an early historical example of crank usage.

What is a hinge?

QUIZ

What does a connecting rod do?

.....

.....

How do pliers help when working with craft wire?

.....

.....

What are examples of material properties?

.....

.....

What is the purpose of a crank?

.....

.....

How do the zip ties help the crank mechanism work?

.....

.....