

SKILL BUILDING

Learn techniques helpful
in building prototypes.

Introduction
02 Prototyping

Lesson plans
03 Prototyping skills

Resources
11 Skills stations

DID YOU KNOW?

Prototyping is the act of building a rough and ready version of a product. It is needed to help the engineer finalize the appearance or functionality of the intended design swiftly and inexpensively.

James Dyson's first prototype was made from cardboard and stuck onto his existing vacuum cleaner. It wasn't perfect, but it gave him an idea of how his invention might work.

Today, Dyson design engineers still use cardboard to see what their design might look like in 3D. Cheap and pliable, cardboard allows the engineers to model basic functions quickly.



PROTOTYPING SKILLS

Duration: 2 hours 5 minutes

Learning objectives:

1. Develop essential technical skills needed to construct 3D cardboard prototypes.
2. Appreciate the multiple approaches that can achieve similar desired outcomes.

Activity outcomes:

- Completed group rotations through four skill stations
- Assembled cardboard cube and cylinder

Things you will need:

- Pens and paper
- Prototyping supplies and equipment (cardboard, tape, craft knives, staplers, rulers, cutting mats, glue, etc.)
- Skills stations (pages 5 – 9)
- Building instructions: Make a cardboard cylinder (page 10)
- Building instructions: Make a cardboard cube (page 11)

Starter: 50 minutes

Skills station

Learning objective	Activity
1,2	<p>Arrange four stations in your classroom. Label one as 'Sketching and measuring,' and the others as 'Scoring and cutting,' 'Joining materials,' and 'Strengthening and reinforcing.' Print the skills stations worksheet on page 5 – 9 so that each station has a guide for its specific activity.</p> <p>Split the class into four groups, and assign each group to a skills station. Tell students they will have ten minutes at their station to follow the instructions and create something with the supplies on their table. Give every student a sheet of paper and ask them to fold it in half twice, creating four equal sections. Ask students to label each corner with the name of a skills station and write answers to any questions listed in the instructions in the corresponding section.</p>
1,2	<p>After ten minutes, ask each group to move to the next station. Repeat this process until students have circulated through all four stations.</p>

Main: 45 minutes

Constructing 3D figures

Learning objective	Activity
1	<p>Explain that two common shapes in many 3D designs are cylinders and cubes.</p> <p>Ask students to follow the steps listed on the Building Instructions: Make a cardboard cylinder and Building Instructions: Make a cardboard cube, located on pages 10–11, and give them the prototyping supplies so they can create both shapes.</p>

Wrap up: 45 minutes

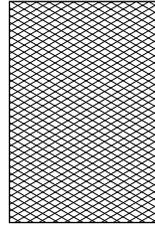
Constructing 3D figures

Learning objective	Activity
1,2	<p>As students finish building their cylinders and cubes, challenge them to make another shape from the list below:</p> <ul style="list-style-type: none"> – Triangular prism – Cuboid – Pentagonal prism – Square-based pyramid – Pentagonal-based pyramid – Hexagonal-based pyramid – Tetrahedron – Octahedron – Dodecahedron – Icosahedron <p>Students may want to research what the more complicated shapes look like before drawing a pattern or trying to construct the prototype.</p> <p>Ask students to start on a piece of paper, Ask students to start on a piece of paper, sketching the pattern they plan to use on the cardboard to make the 3D shape with one continuous piece of cardboard.</p>
1,2	<p>Ask students to share the third shape they made with the class, as well as some of the tips and tricks they learned while creating the shape.</p>

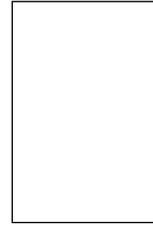
SKETCHING AND MEASURING

Sketching is a great way to communicate your ideas. The drawing does not have to be perfect – it just needs to show how you think a prototype might work.

In this station you will find:



Isometric paper
(page 12)



Plain white
paper



Pencil

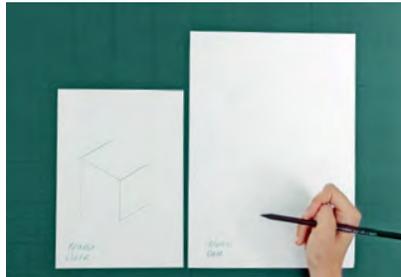


Rulers



Step 1

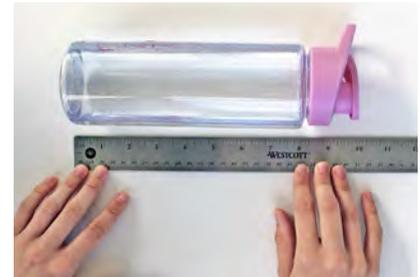
Practice drawing 3D shapes on the plain white paper (like a cube, pyramid, or sphere).



Step 2

Draw the shape again, this time using the isometric paper. Make sure you sign and date your sheet – Dyson engineers do this so they know who an idea belongs to.

Which paper do you prefer?



Step 3

Identify an object in your classroom you want to draw. Use a ruler to measure its dimensions.



Step 4

Using the measurements and your preferred type of paper, sketch a 3D, scaled model of the item.



Step 5

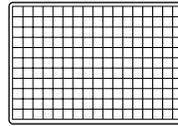
Be sure to include a key to your scale.

Why is taking accurate measurements of the object and the sketch important?

SCORING AND CUTTING

Scoring and cutting cardboard makes it much easier to bend and shape, so you can build prototypes more easily.

In this station you will find:



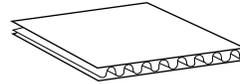
Cutting mats



Rulers



Craft knives



Corrugated
cardboard



Step 1

Use a craft knife to cut a 3 x 3 inch square along the edge of a sheet of cardboard.

How hard do you need to press down on the craft knife? How many times did you need to retrace the cut before the square comes free?



Step 2

Look at the waves of the corrugated cardboard beneath the surface. In between each wave, use your craft knife to cut through the top layer only. This is called scoring.



Step 3

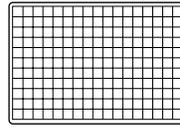
Bend the square at the score mark in both directions.

Which side would look best on the outside of the prototype?

REINFORCING

By using materials to reinforce your prototype, you make it stronger and more able to withstand testing. Try this method of reinforcing.

In this station you will find:



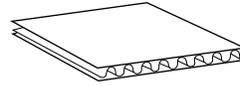
Cutting mats



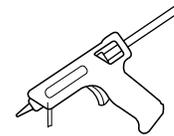
Rulers



Craft knives



Corrugated cardboard



Hot glue



Step 1

With your craft knife, cut five 2 x 2 inch squares of cardboard.



Step 2

Glue each square on top of each other.



Step 3

This method of reinforcing is called stacking.



Step 4

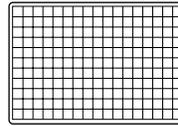
Cut one more 1 inch square of cardboard and try to bend it – then try the same with the stack you glued.

What do you notice?

JOINING METHOD ONE

Joining materials to build your prototype helps to strengthen its structure, while also making it easier to shape.

In this station you will find:



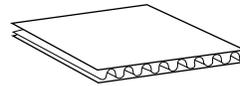
Cutting mats



Rulers



Craft knives



Corrugated
cardboard



Hot glue



Step 1

With your craft knife, cut six 3 x 3 inch squares of cardboard.



Step 2

Take one of the squares and create a thin fold along the edge of one side. Next, take a second square and keep it handy.



Step 3

Use a hot glue gun and glue along the thin fold.



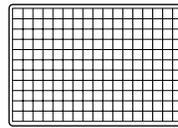
Step 4

Affix the glued fold to the edge of another square and create a 90° angle. This is one way of joining.

JOINING METHOD TWO

Joining materials to build your prototype helps to strengthen its structure, while also making it easier to shape. Try these methods of joining.

In this station you will find:



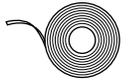
Cutting mats



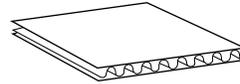
Rulers



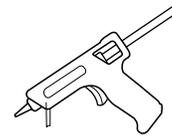
Craft knives



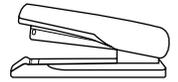
Tape



Corrugated cardboard



Hot glue



Stapler



Step 1

Take two more of the remaining 3 x 3 inch squares.



Step 2

Create a thin fold along the side of one square.



Step 3

Place the fold along the edge of another square and use the stapler to join the two pieces together.



Step 4

Create another 90° angle.



Step 5

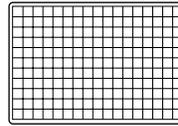
Do the same again but this time try using tape.

Which do you think is stronger?

MAKE A CARDBOARD CYLINDER

Using the skills you've learnt in the skills stations, follow the instructions to make a cardboard cylinder.

You will need:



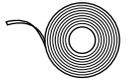
Cutting mats



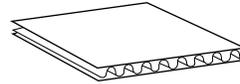
Rulers



Craft knives



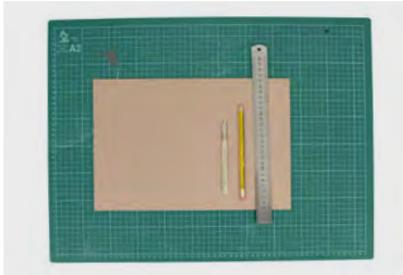
Tape



Corrugated cardboard



Pencil



Step 1

Sketch and cut out any size rectangle or square on your cardboard.



Step 2

Because this cardboard is corrugated, you can use your craft knife to half-cut (score) the cardboard in between the 'waves' of the cardboard. Use a ruler when scoring to keep your cuts straight.



Step 3

When you are done scoring in between all of the 'waves', gently bend the cardboard to achieve a cylindrical shape.



Step 4

Once you are happy with the shape of your cylinder, use tape to secure it.



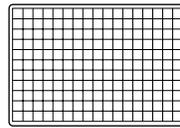
Step 5

Note that the exterior of the cylinder can be the smooth or scored side.

Which do you think looks best?

MAKE A CARDBOARD CUBE

Using the skills you've learnt in the skills stations, follow the instructions to make a cardboard cube.



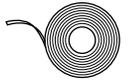
Cutting mats



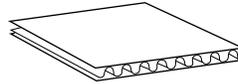
Rulers



Craft knives



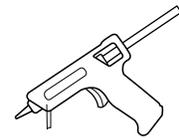
Tape



Corrugated cardboard



Pencil



Hot glue



Step 1

Sketch a 3 x 3 inch box in the middle, at the top of your cardboard.



Step 2

Sketch three identical boxes vertically underneath the first box. Then sketch a box on either side of the second box from the top, making a cross shape.



Step 3

Use a craft knife to cut out your sketch.



Step 4

Carefully score the interior lines of the cross shape you just cut out. This will allow you to bend the cardboard more easily. Gently fold your scored cardboard into a cube shape.



Step 5

Use tape to secure the cube.



Step 6

You can also use hot glue to secure the cube if you prefer not to have the tape visible.

