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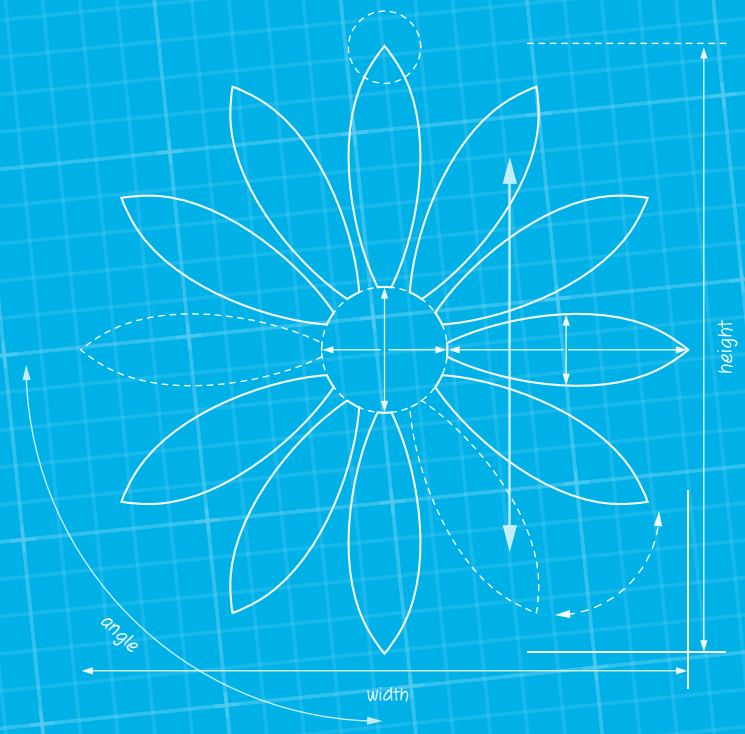
THIS IS ENGINEERING



DEPLOYABLE STRUCTURES

Flowers: natural deployable structures

This resource is designed as an introduction to deployable structures using flowers as an example from the natural world.

FLOWERS: NATURAL DEPLOYABLE STRUCTURES

Deployable structures are amazing.

They pack away into **small spaces**. They can be

- unfolded,
- unrolled,
- fanned-out,
- extended

to occupy **large spaces**.

Time to think # 1

When is a small space ***small***?

We can measure spaces in **one dimension** (such as the width of a room), **two dimensions** (the number of square metres of carpet tiles) or **three dimensions** (the volume of a carton of milk).

THINK... what tools or techniques are used in each case? What units are used?

But a space starts to be described as small when it is only just larger than the things it contains. Getting lots of things into a small space needs careful packing.

THINK... When you pack a lot of different shaped objects into a box, you have to move them and rotate them to get all of them to fit. In deployable structures, that packing is done for you in carefully planned, ingenious ways. Engineers do that careful work.

Some examples of deployable structures

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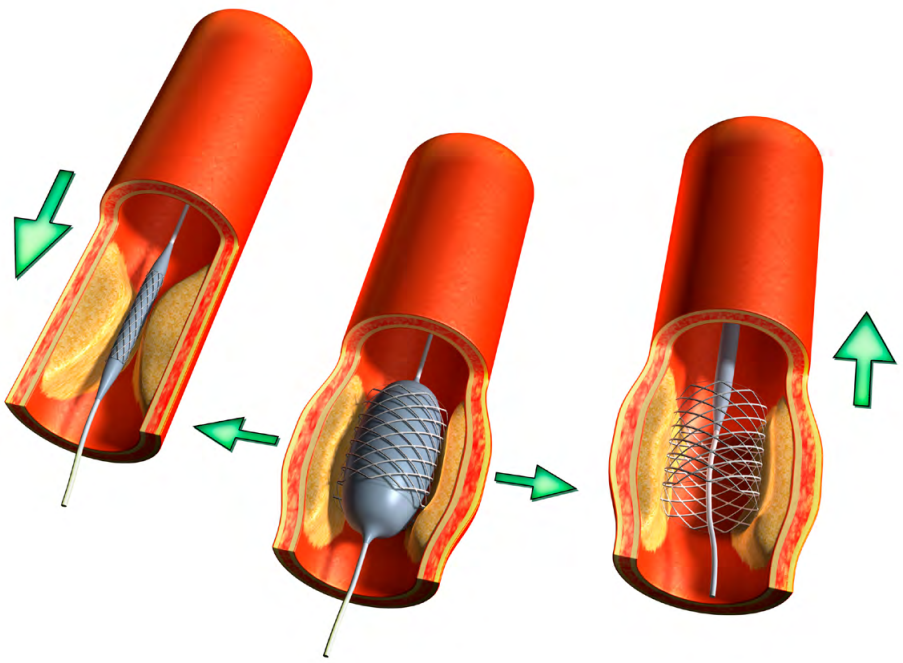
SAVING LIVES WITH DEPLOYABLE STRUCTURES

If someone has a poor supply of blood in the arteries leading to their heart, it could stop working properly which can result in death.

However, engineers and doctors have created a type of deployable structure called a stent which a surgeon will put at the site of a weak or partially blocked artery using a long wire. The stent then deploys and presses outwards on the walls of the artery which widens it and increases the blood flow.



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Flowers are natural 'deployable structures' because they pack away in their seed cases and 'deploy' through germination

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Time to think # 2

Why is germination a different kind of 'deployment'?

The seed case contains the basic structures of the **roots** and the **shoot** of the plant along with the nutrients to support early **growth**.

Once the plant first emerges from the seed case it can access nutrients from the soil to **grow further**. At this point it **acquires mass from its surroundings**. This makes **organic systems** unique as deployable structures.

Non-organic deployable structures do not add mass as they deploy.

DENSITY

When a non-organic structure like an umbrella or an expandable heart stent is deployed it gets bigger in volume without adding mass. Something that is big but has little mass has a low **density** and something that is small but has a lot of mass has a high **density**. For example, two bottles the same size but one full of water and one full of air will have different weights because water is denser than air.

You can work out density with the following formula.

Density = mass ÷ volume

So if you had a block of iron that has a volume of 200cm^3 and a mass of 1580g then you could work out the density as 1580 ÷ 200 which is 7.9g/cm^3. Notice the units of density are grams per cm^3.

DID YOU KNOW... Gold is an extremely dense material. Water has a density of 1g/cm^3 while gold has a density of 19g/cm^3. This means a can of coke filled with gold would weigh more than a typical cat.

DID YOU KNOW... The least dense solid is called graphene aerogel and a bottle of this unusual material would weigh less than a bottle of air!

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Time to think # 3

Work out the answers to these questions about density.

- A block of cheddar cheese has a mass of 350g and a volume of 560cm^3. What is the density?
- What is the density of a block of wood that has a length of 140cm, a width of 12cm and a height of 10cm. It has a mass of 11760g.

EXTENSION: A block of iron in a cuboid shape has a density of 8 g/cm^3 and a mass of 25.6kg. The height of the block is 8cm and the width is 10cm. What is the length of the block?

TRANSFORMATIONS AND NETS

Starting as a seed, a flower head develops as a spherical shape with tightly interlocked sepals enclosing the petals. The growing petals force the sepals open first to form a cylinder and then spread out further to form a disk. The sepals and petals grow out of the receptacle which sits at the top of the stem.

Sphere

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Cylinder

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Disk

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Time to think # 4

The 3D sphere in the pictures transformed into a 2D disc. In your maths lessons you might have learnt how to turn a 3D shape into a 2D shape by creating a net.

Draw the net of the following shapes:

a) cube **b)** a triangular prism **c)** a cylinder

The net of a sphere is much harder to draw.

Draw what you think the net of a sphere would look like.

The shapes seen in the 2D nets of spheres and hemispheres can also be seen, sometimes stretched or distorted, in the structure of flower heads.

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Time to think # 5

In maths lessons you might have learnt about symmetry and shape transformations. How do flowers illustrate these ideas?

- Enlargement – flowers grow
- Line symmetry – do all flowers have line symmetry?
- Rotational symmetry

When clustered together, party blowers take on the shapes and characteristics of flowers. They too are deployable structures.

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Individual party blowers look a lot like ferns

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Folded paper medallions also look like flowers

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TIME TO MAKE AND DO

This resource contains a number of ideas that can be easily extended with making activities:

- Pupils can cut out 2D nets of spheres and use the components to make flowers. Using multiple nets, combinations of spheres, hemispheres and 'petals' are particularly effective.
- Pupils can make folded paper medallions very quickly and cheaply. These can be made into flower shapes.
- Party blowers are easily made from folded paper and a drinking straw. A quick internet search will provide step-by-step guidance.
- Instructions on how to make various pop-ups are also available online. A search for Robert Sabuda's site is useful.

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Royal Academy of Engineering
Prince Philip House
3 Carlton House Terrace
London SW1Y 5DG

Tel: +44 (0)20 7766 0600
www.raeng.org.uk
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