Möbius, marvels and movement

Think about your table top, this piece of paper, the surface of a ball. Can you imagine a one-sided surface: no front or back, no inside or outside, just one side? A Möbius strip is one of these strange surfaces. Let's learn about its weird and fascinating properties and see how they are already part of our everyday lives! This activity will need scissors, so please have adult supervision.

Make a Möbius strip

1) First we'll make a cylinder to help us compare it to a Möbius strip: carefully cut off the strip called "cylinder" and glue or tape the ends together to make a band that looks like the picture.
2) To make a Möbius strip, cut off one of the strips called "Möbius". Twist one end of the strip and then stick the ends together, so that it looks like the picture. You're holding a Möbius strip!

Count the sides

A cylinder and a Möbius strip behave differently when we try to colour them in.

1) Pick up the cylinder. Draw a line along the centre of the strip. Do this for both sides of the paper. How many different lines did you draw?
2) Pick up the Möbius strip. Draw a line along the centre of the strip. How many lines do you need in order to draw on both sides of the paper?

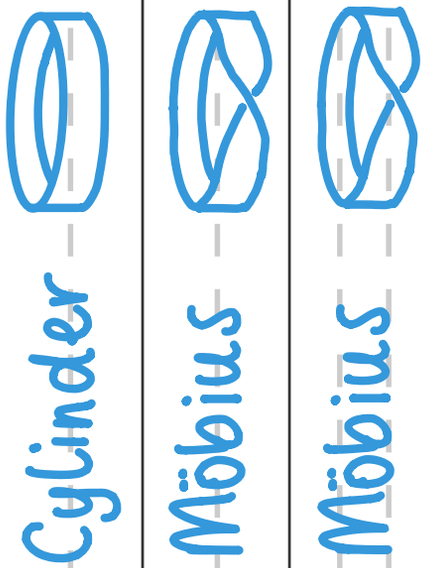
Extension activity 1: Make another Möbius strip from different paper, then decorate it. Can you make a bracelet?

A cylinder is a two-sided shape, so we needed to draw two lines: one for each side. By contrast, the Möbius strip only needed one line to cover both sides of the paper. This is proof that it is a *one-sided shape*!

Cutting tests

A Möbius strip acts very peculiarly when we cut it into thinner strips. Let's have a go!

1) Pick up the cylinder again. Carefully cut down the centre line of the cylinder. How many strips of paper do you get?
2) How many strips of paper do you think you will make if you cut the Möbius strip down its centre line? Cut and find out!
3) Make another Möbius strip using the "Möbius" template that has two dotted lines down its length. Cut along these lines. How many strips do you get? Is this different to what you expected?



Extension activity 2: We got two interlocked strips after Step 3, the little one was another Möbius strip! Does it matter where we draw the two lines that we cut? Make another Möbius strip of your own and draw the centre line, plus a second line either above or below the centre line. Now when you cut along these two lines, how many strips do you get? Are they the same strips as in Step 3?

Extension activity 3: A Möbius strip was made by doing one twist before sticking the ends together. Try making two twists instead. How many sides does this shape have? Try making a cut along the centre line: how many new strips do you get? Try making more strips with different numbers of twists and cuts. How big or small are they? Do you get smaller Möbius strips? Do you find any patterns?

Möbius strips and the human body

You may be surprised to learn that there is a Möbius strip in your own body!

1) Put one arm out with palm facing upwards.
2) Keeping your palm facing up, bring your hand in towards your body, passing under your armpit, until your palm is in the place it started. That was once around a circle centred at your elbow. You're probably now in a slightly uncomfortable position!
3) Keep going in the same direction around the circle, now up and over your shoulder, to return your palm to its starting place.

Notice how we had to go around the circle twice, in order to get back to where we started? The same thing happens with a Möbius strip - we have to go twice around in order to get back to the starting position. This means that a Möbius strip is encoded into the movement of our body!

A Möbius strip is a strange shape with very different properties to the cylinder. It's a one-sided world that got its name from August Möbius in 1858. It has been studied by mathematicians, scientists, engineers and artists alike: Möbius strips turn up in scarves, Escher paintings, the recycling symbol, also one-sided conveyor belts help to even out wear and tear, one-sided strips of paper can have more printed on them without flipping the paper over. As topologists, shapes like Möbius strips are part of the foundation of our research. By using these properties, our research can help build better models of robot arms or understand the shape of the universe.

Inspired by anything in this activity today? Want to share your discoveries or Möbius decorations? Have any questions, or simply want to know more? Get in touch! For the duration of the festival I will be replying to your queries. Contact me at a.linton@soton.ac.uk or @mathsunicorns on Twitter!

Hope you had fun! - Dr Abi Linton