

The Möbius Strip:

A Hands-On Exploration

Subject: Mathematics

Topic: Geometry

Grade Level: 8-12

Time: 30 min

Post Show Math Activity

Introduction:

In **Show Math** students were introduced to topology and more specifically the concept of a Mobius strip in MC Escher's painting. In class today students will be shown the different properties of a Mobius strip by constructing their own. This activity seeks to engage students in mathematics by allowing them to explore the Mobius strip themselves.

Learning Objectives:

By the end of this activity students should:

- Understand that the Mobius strip is a one sided/edge object
- Explore the properties of the Mobius strip
- Examine the definitions of side, edge, and area

Skills:

Students should develop:

- Observation skills
- Prediction skills
- Spatial Reasoning
- Communication skills

Material & Resources:

- Tape
- Worksheets for the class
- Strips of paper (see template attached, 2 per student)
- Scissors
- Pens/Markers

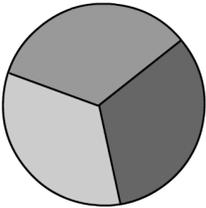
WNCP Curriculum Links:

Apprenticeship and Workplace Mathematics 10	Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies. [C, CN, PS, R]
Foundations of Mathematics 11	Analyze and prove conjectures, using inductive and deductive reasoning, to solve problems. [C, CN, PS, R] Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies.[CN, PS, R, V]

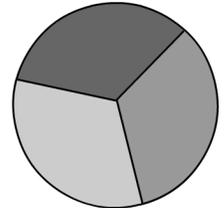
Background:

The Mobius Strip was discovered independently by the German mathematicians August Ferdinand Mobius and Johann Benedict Listing in 1858. It is a surface with only one side and one edge. It can be constructed by taking a strip of paper, and twisting it and connecting the ends.

The Mobius Strip has the mathematical property of being non-orientable. A surface S in the Euclidean space is orientable if a two-dimensional figure cannot be moved around the surface and back to where it started so that it looks like its own mirror image. For example:

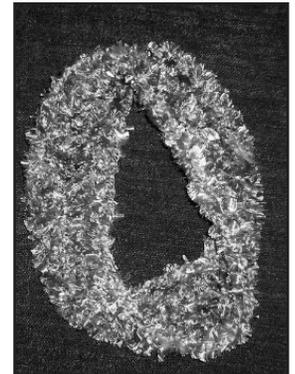


The figure on the left cannot be rotated to look like the figure on the right. Another example of an orientable surface is your hands. You can never rotate your right hand to make it look like your left hand. However, the Mobius Strip is non-orientable; it does not have an orientation.



The Mobius Strip has many practical applications. In 1957, the BF Goodrich Company patented a conveyor belt that it went on to produce as Turnover Conveyor System. Incorporating a half-twist, it had the advantage over conventional belts of a longer life because it could expose all of surface area of the belt to wear and tear. Mobius belts are no longer manufactured because untwisted modern belts can be made more durable by constructing them from several layers of different materials.

Other practical applications of Mobius Strips have included half-twisted, continuous-loop recording tapes (to double the playing time), typewriter ribbons, and computer printer cartridges. In the 1960s Sandia Laboratories used Mobius bands in the design of versatile electronic resistors. Also there have been a number of ideas for children's toys based on the shape, including a railway in which a miniature engine traverses a three-dimensional looped track using magnets to hold on while it travels the some of the upside-down sections.



The Mobius Strip is also found in art and culture. Apart from MC Escher's painting Mobius Strip II, which features ants crawling around the surface of a Mobius strip, the Mobius strip has become a popular design for scarves. The Recycling Symbol of three folded arrows forms a Mobius Strip. As well it can be found in a fountain at the Ramsey Auditorium in Batavia Illinois.

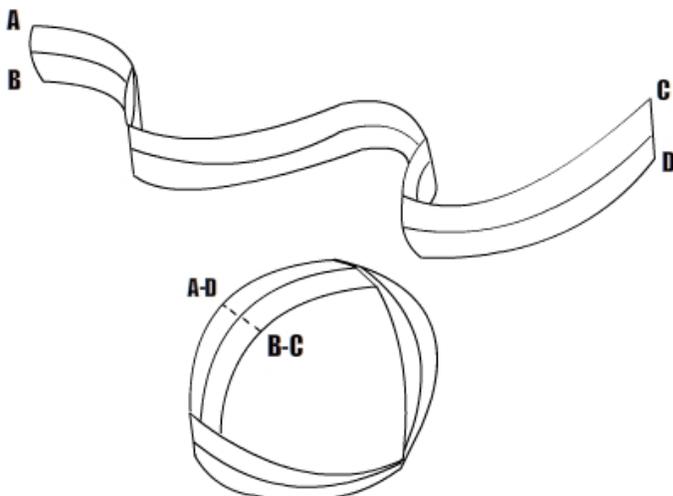
There are also playgrounds modelled after the Mobius strip. The Mobius Strip is often referred to in science fiction such as Arthur C. Clarke's The Wall of Darkness. In fact the popular video game Sonic the Hedgehog takes place on planet Mobius. There are also many references to the Mobius strip in song lyrics.

Resources:

- http://nuclear-imaging.info/site_content/2009/02/03/moebius-moebius-strip-in-art-and-culture/
Shows examples of the Mobius Strip in the real world.
- http://en.wikipedia.org/wiki/M%C3%B6bius_strip
More in depth explanation of the Mobius Strip
- <http://www.youtube.com/watch?v=JNtKcK27x1s&feature=related>.
A video that shows how to make a Mobius Strip

Activity Instructions:

1. Distribute to each student two strips of paper, tape, scissors, marker and worksheets.
2. Have class make a simple ring with paper by connecting one end of the strip to the other with tape (see figure), you can show a demonstration first.
3. Tell the class to fill in question one on their worksheet about the number of edges and sides their simple ring. If necessary review the definition of edge and side.
4. Have the class draw a line around their simple ring and complete question 2 (predicting what will happen when they cut on that line) on their worksheet. If you would like to engage in some group work the class can Think-Pair-Share for their prediction.
5. Now show the class how to make the Mobius strip. Take the second



Think - Pair - Share

- Students will think about the questions themselves
- Pair with a partner that is close by
- Share their answers and write them down on their paper
- Engage in a full class discussion that shares their answers

6. Have the class examine their Mobius Strip and Think-Pair-Share to answer the Question 3 on their worksheet.
7. Have them draw a line on the “outside” of their Mobius Strip. Give them a chance to revise their answer to Question 3.
8. Ask the class to fill out Question 4 (predict what will happen when they cut along the line). Then tell them to cut along the line.
9. Then have class finish the worksheet with Question 5.

Discussion:

Have a discussion about the uses of the Mobius strip in the real world (toys, conveyor belt, art, pop culture). Can they think of any things that a Mobius strip might be good for? Hand out the homework worksheet. If you would like you could also engage in a discussion about the area of a Mobius Strip.

Mobius Strip Template:

