

STEM Fun!

stEM—Paper Engineering!

ST[EM]power

Explore the Wonder of Our World!

4-H Members!

Join Dr. Barb, Ms. Stephanie, and Mr. Andrew online for fun activities exploring **Science Technology Engineering Math!**

In Paper Engineering, we will explore:

- The amazing **Möbius Strip**
- The paper challenge

Collect these materials before watching:

- scissors
- ruler
- markers
- paper (8½"x11" or 8½"x14"—recycled junk mail, newspaper, notebook paper, or any regular-sized paper
- tape

Wonder:

Albert Einstein was 5 years old when his father gave him a magnetic compass. He was amazed that no matter how he shook or turned the compass, the needle always pointed back to north. "A **wonder**," he thought. The invisible force that guided the compass needle was evidence to Albert that there was more to our world than meets the eye. There was "something behind things, something deeply hidden." That led him to his Theories of Relativity.



Dr. Barbara J. Shaw,
Western Region Youth
Development 4-H STEM
K/12 and Scientist

Let's discover
wonder together!



Ms. Stephanie Lamm
CSU Extension
4-H STEM Agent

I'm ready for
~~fun~~...I mean...
serious science!



Mr. Andrew Reed
CSU Extension
4-H Admin. Associate

Get ready for
some awesome
STEMing fun!

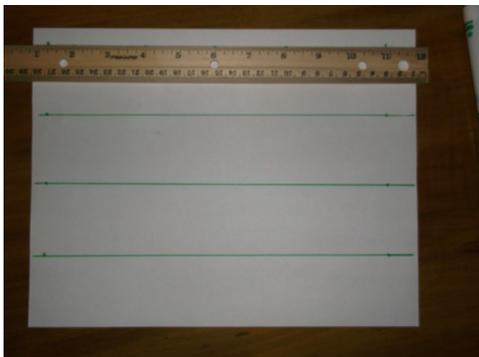


**SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATH**
COLORADO STATE UNIVERSITY
EXTENSION

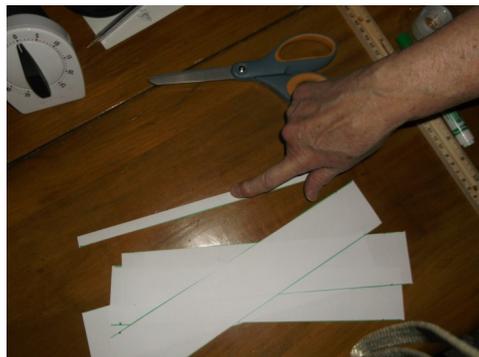
COLORADO STATE UNIVERSITY EXTENSION
PROGRAMS ARE AVAILABLE TO ALL
WITHOUT DISCRIMINATION

Directions:

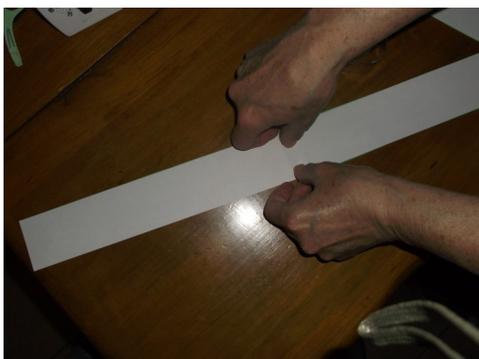
- Measure your paper - With the ruler along the $8\frac{1}{2}$ " edge, place a dot at 2", 4", 6", and 8". You will have $\frac{1}{2}$ " left.
- Turn the paper upside down, and measure and place a dot at 2", 4", 6", and 8". Be sure that it lines up with the other dots. You will have 4 strips, each 2" wide, and 1 strip $\frac{1}{2}$ " wide.



- Cut along each line. You will have four 2" strips and one $\frac{1}{2}$ " strip that you do not need.



- Line up two of your strips to make a long strip. Tape the edge closed on both sides so the edges are sealed. Do the same with your other two strips to make another long strip.



- Bring the open edges together, and then twist one side one-half turn. Tape the edge closed on both sides so the edges are sealed.



- Examine your **Möbius strip**. What do you notice? There is something very special about it. To find out, you need to use your marker. Do



Power Words

- **Möbius strip:** a surface with only one side and only one edge. It can be made using a strip of paper by taping the two ends together with a half-twist
- **wonder:** a feeling of surprise mingled with admiration, caused by something beautiful, unexpected, unfamiliar, or inexplicable

Möbius strip or Möbius band—they are the same thing.

not pick your marker up from the paper. You will make a continuous line down the center of your strip.

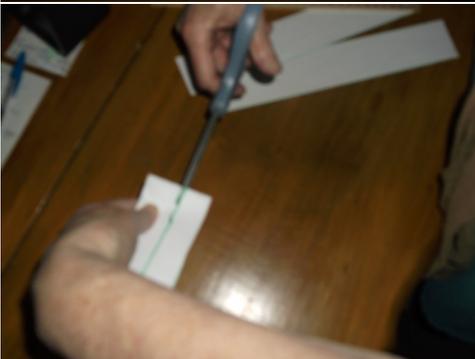
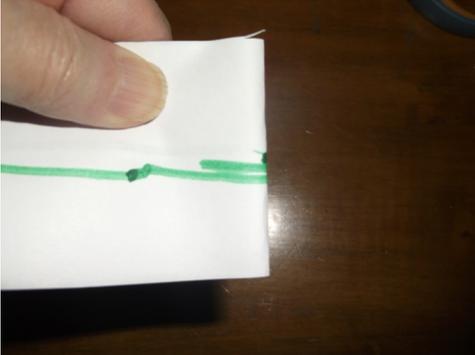
- What happened? Your line met itself, and the entire strip has the line! A **Möbius strip** is a single sided paper! It is 3 dimensional, but only one side!
- Engineers use Möbius strips in designing

Fascinating Facts:

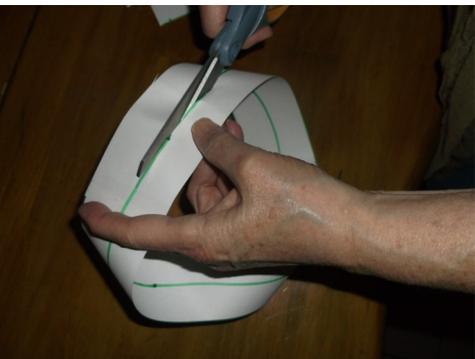
- The Möbius strip is used in several technical applications including:
 - Giant Möbius strips are used as conveyor belts. These belts last twice as long because all the surface of the belt gets equal amounts of wear.
 - Möbius strips have also been used as continuous-loop recording tapes (to double the playing time).

machines like conveyor belts.

- What happens if you cut your Möbius strip down the center? Pinch the center of the strip, and then make a small snip with your scissors.



- Insert your scissors into the snip, and cut your Möbius strip along your center line.



- What happened? Is your paper one or two sided now? Check it out. Place your marker in the center of the strip and drag the paper. When the line meets the beginning, is the line everywhere, or is it only on one side? Right, it is now a two sided paper again. Weird!

- Set that aside, and get your other **Möbius strip**.
- We know that it only has one side. What happens if you cut it into thirds?
- Mark your strip with two dots about $\frac{1}{3}$ and $\frac{2}{3}$.



- Pinch the center of the strip, and then make a small snip with your scissors at one of those marks. Insert your scissors, and cut one-third of the strip.

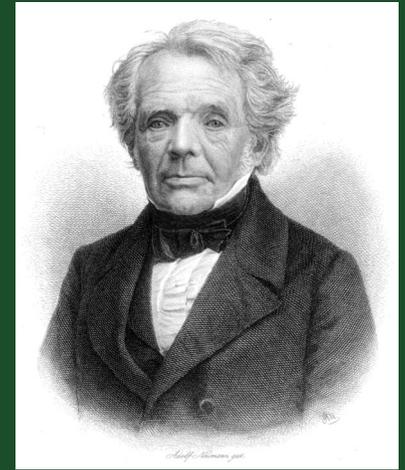


- As you continue to cut the strip, you will meet where you started cutting. Keep on cutting.



- What happened? Two circles of paper! Wild! Are both circles one-sided, two sided, or one is one-sided

August Möbius
Möbius was a German mathematician and mathematical astronomer. He lived from 1790 to 1868. He is noted for many contributions to mathematics, and the most famous was the Möbius strip as well as many other geometric concepts.



Adolf Neumann - <http://www.portraitindex.de/documents/obj/33213645>—public domain

- and the other two-sided? Check it out. Place your marker in the center of the small circle and drag the paper. When the line meets the beginning, is the line everywhere, or is it only on one side? Is it one-sided or two-sided?
- Repeat with the larger circle. Is the larger circle one-sided or two-sided?

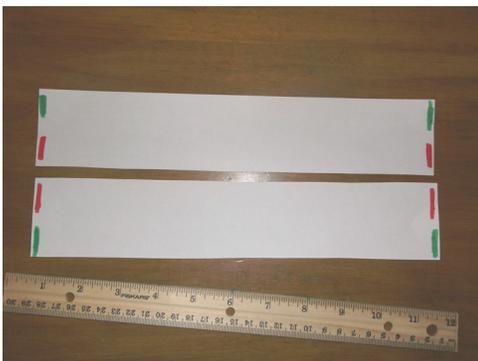


- What happened? Can you figure it out?
The **Wonder** of Engineering!

Wonder:

Let's see if we can figure out what happened.

- Cut another 2 strips of paper. We don't need to make it longer for this thinking part.
- Use two different color markers. In this example, red and green. Mark one side with red on both ends, and the other side with green on both ends. Do the same on the back of the paper, being sure that the green is on the same side of both sides of the paper.

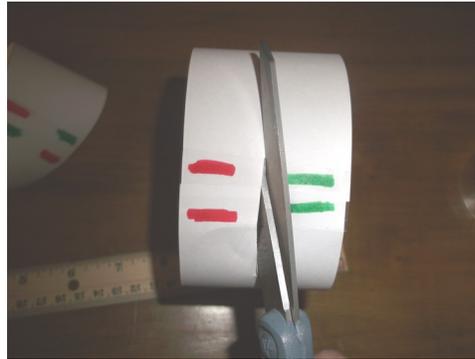


- With one strip of paper, make a loop (without the twist) and tape it together. With the other piece of paper, make the loop with a half twist, to make your Möbius strip.

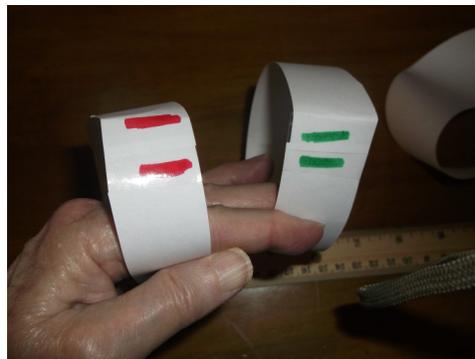


- Notice that the loop ends lines up green to green and red to red. On the Möbius strip, the red lines up with green side, and the green side lines up with the red side.

- Cut the loop down the middle. Pinch and snip, then insert your scissors and cut down the middle.



- When you are done, you have two loops.



- Repeat with the Möbius strip.



- When you are done, notice that the Möbius strip starts

Power Words

- **application:** the action of putting something into operation

red to green, and then the opposite, green to red. That means, it twists back to a two-sided piece of paper!



Fascinating Fact:

- The Möbius strip is used in several technical applications including:
 - The Möbius strips is common in making fabric, computer, printer, and typewriter ribbons. Since the Möbius strip only has one side, the ribbon can be used twice as long using both half-edges evenly.