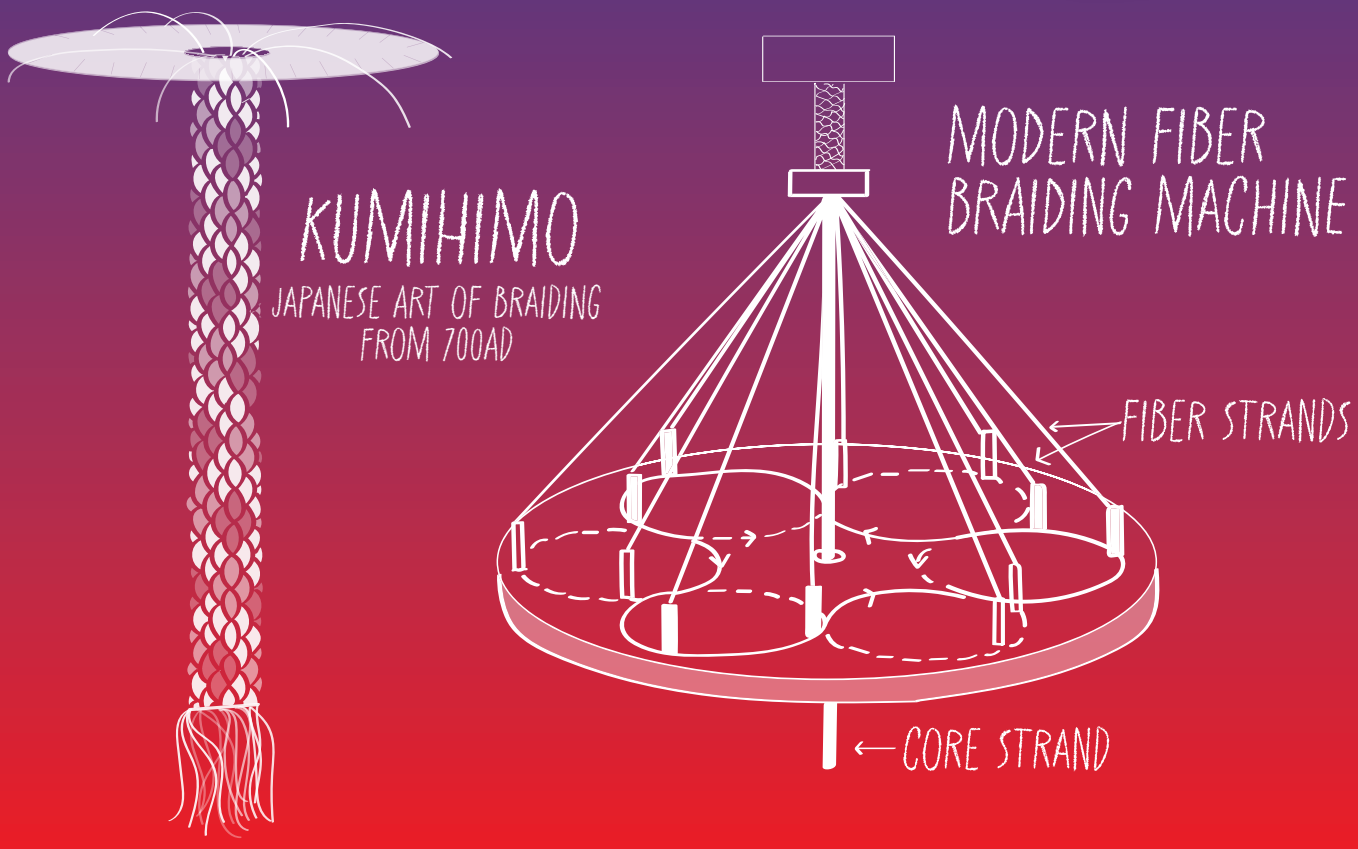
DREAM. BUILD. BECOME.

ACE METAL FOUNDATIONS

By IACMI

Modern Materials, Ancient Technology



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Prior Knowledge

To ensure success, students should be able to follow simple, step-by-step instructions, use basic hand coordination, and communicate observations. Students may have experience braiding hair, twisting string, or tying knots.

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Lesson Overview

In this activity, students will learn how combining simple materials can create something stronger. Students will use string and a simple tool called a kumihimo disk to braid multiple strands together into one cord.

Kumihimo means "gathered threads" in Japanese. It is a traditional Japanese braiding method used to make strong, decorative cords. Long ago, kumihimo cords were used in important ways, including clothing, tools, swords, and samurai armor. Today, people still practice kumihimo as an art form, and the same basic idea — combining fibers into strong braided structures — is also used in modern materials and manufacturing.

We still use this same basic idea today, including when we work with composites like carbon fiber. A composite is made when two or more materials are combined to make something stronger, lighter, or more useful than the materials would be alone. In some composites, thin carbon fibers are braided, woven, or layered together, then combined with another material that holds them in place. The braided structure helps spread out pulling forces, twisting forces, and impacts, so the finished part can be strong without being too heavy.

By braiding the strands, students will see how weak individual pieces can become stronger when combined in a pattern. They will explore how structure affects strength, including tensile strength, or how much pulling force a material can handle before breaking, and how materials can be improved through design.

Students will also explore how ancient fiber technologies are still used in modern materials and manufacturing.

Vocabulary

Fiber: A thin strand of material such as thread, yarn, or plant fiber.

Braiding: A method of crossing strands over one another to create a stronger cord or material.

Structure: The way parts are arranged or combined to form a stronger system.

Tensile Strength: A material's ability to resist pulling forces.

Figure 1: Braided fibers.

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The Foundations of Fiber Strength and Structure

Material science is when we learn about materials—how they feel, how they behave, and how they change when we combine them.

Today, we are going to be material scientists by building a braided cord.

What happens when we combine fibers? A single piece of string can be pulled apart easily. But when multiple strands are combined, something new happens. The strands work together to become:

- Stronger
- More stable
- Less likely to break

This happens because of how the strands are arranged. This arrangement is called a structure. For thousands of years, people have used braiding to make rope, clothing, and tools. Today, engineers still use this same idea to create strong materials used in everyday life.

Engineers combine fibers to create cables, composite materials, medical sutures, climbing ropes, and advanced braided materials used in aerospace and manufacturing.

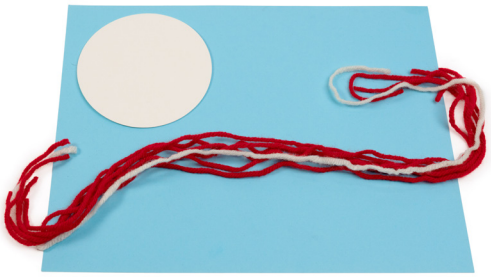
This activity introduces a braiding method that demonstrates how structure can increase strength.

Materials

Materials Supplied in Kit

Per Student

- 4-inch cardboard coaster (kumihimo disk)
- 7 lengths of string (approximately 12 inches each)



Materials Supplied by Teacher

- Scissors
- Ruler
- Pencil
- Optional: key ring or lanyard clip
- Optional: magnifier
- Optional: tape measure or digital calipers)

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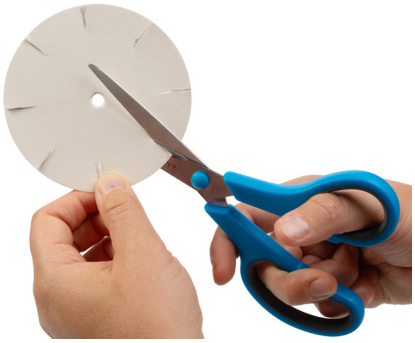
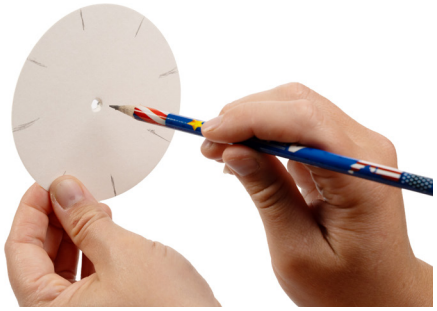
Activity Directions

Step 1: Prepare your disk

- Cut eight evenly spaced slits around the edge of your disk



- Using the tip of a pencil, punch one small hole in the center of the disk



Step 2: Prepare your strings

- Cut seven strings, each the length of your arm from your elbow to your hand

- Take your strings and tie them together in a knot at one end
- Push the knot through the hole in the center so it hangs underneath

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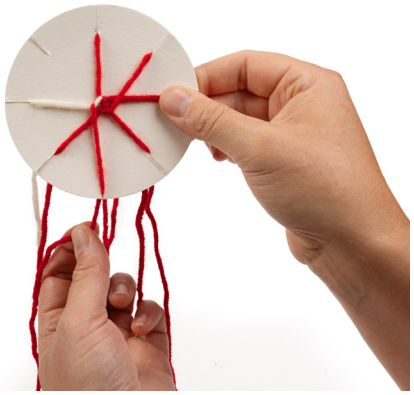
Activity Directions Continued

Step 3: Place the strings

- Put one string in each slit. One slit will be empty.

Step 3



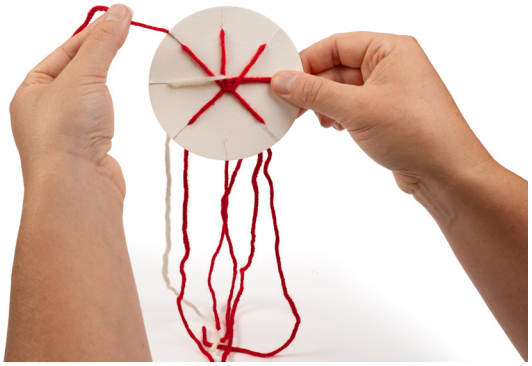
Step 4: Find the empty slit

- Turn the disk so that the empty slit is pointing towards you

Step 5: Move one string

- Starting at the empty slit, count three slits to the left.
- Take the string out of that slit, and move it to the empty slit.

Step 5



Step 6: Turn and repeat

- Turn the disk so that the new empty slit is pointing towards you
- Repeat step 5

Step 7: Keep going

- Repeat steps 4-6 many times. As you work, a braided cord will grow underneath the disk

Step 7

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Discussion Prompts or Reflection

- How does the strength of a single strand compare to the braided cord?
- What happens when multiple strands combine?
- How does the braided structure affect strength?
- Why might engineers combine fibers instead of using a single strand?

Variations and Enrichment

- Students may measure the diameter of a single strand and the braided cord using calipers or a ruler to compare thickness.
- Students may perform a simple pull test by wrapping the cord and a single strand around a pencil or dowel and pulling steadily to compare resistance.
- Teachers may discuss how ancient fiber technologies influenced modern materials used in manufacturing.

Foundation Exploration

- **Materials engineers** study how fibers and materials behave when they are combined into structures such as cables, fabrics, and composites.
- **Manufacturing engineers** design processes that braid or weave fibers into strong industrial materials used in equipment, vehicles, and aerospace systems.
- **Engineers** also design braided materials used in climbing ropes, parachute lines, medical sutures, reinforced composites, and protective textiles.
- **Aerospace engineers** use advanced braided materials to build lightweight parts for airplanes, rockets, and spacecraft.
- **Medical engineers** design materials like sutures and implants that must be strong, flexible, and safe for the human body.
- **Construction workers** and **rigging specialists** use ropes and cables made from braided fibers to lift, secure, and move heavy objects safely.
- **Outdoor and safety equipment designers** create products like harnesses, ropes, and protective gear that rely on strong braided materials.