ROPE MAKING

Grade Level: 5-12th grades

Objectives:

1. Youth understand rope structure by twisting fibers into yarn and then twisting yarns into rope.
2. Youth understand the function of a rope making machine and suggest better machine designs.
3. Youth use the Internet to research traditional and modern technologies, history, and science of rope making.
4. Youth work with others to link project to community.

NYS Learning Standards:

Math, Science, and Technology

- Students access, generate, process, and transfer information using technologies.
- Students apply technological knowledge and skills to design, construct, use and evaluate products.
- Students use mathematical analysis, scientific inquiry, and engineering design to pose questions and develop solutions.

National Science Standards:

Content - Grades 5-12

Science as Inquiry
- Ability to do scientific inquiry (5-12)

Science & Technology
- Abilities of technology development (9-12)
- Understanding about science and technology (5-12)

Science in Personal & Social Perspectives
- Science and technology in society (5-8)
- Natural Resources (9-12)

History and Nature of Science
- Science as a human endeavor (5-12)
- History of science (5-8)
- Historical perspective (9-12)

Vocabulary

Elasticity – Ability of a material to stretch and then return to its original shape.

Flexibility – Ability of a material to bend without breaking.

Lay – The amount of twist in the rope as in hard lay, regular lay, and soft lay.

Rope – A cord made by twisting together fibers.

Strength – Durability in terms of breaking, tearing, or puncturing.

Water Resistance – Ability to resist moisture uptake.

History

No one knows when the first rope was made. We do know that sailors, builders, hunters, and farmers have long depended on rope to move and control animals, structures, and machines. Conventional ropes were used in China as early as the 28th century BC and are depicted in Spanish cave paintings dating back 20,000 years. Egyptian ropes from 2,600 BC and ropes carried by early Romans are still intact, and on view at museums. In the US, the ropewalk was one of the earliest industries, established in Boston in 1642. The Plymouth Cordage Company, founded in 1824, was world famous and produced ropes for more than a century before being sold to Columbian Rope (now also closed) in Auburn, NY. The US Navy used steam power to make rope at its Charlestown yard from 1837 to 1971.

Early ropes were made by hand, using cotton, dogbane, sisal, jute, hemp, flax, abaca (manila hemp), coir (coconut husks), leather, or hair. This changed with mechanization and the development of nylon in 1938. Today, most ropes are made in factories from petroleum-based synthetic fibers.

Science

Ropes need to be elastic, flexible, and strong. High-quality ropes should not be damaged by abrasion, heat, water, salt water, sunlight, or microbes. To achieve these properties, rope manufacturers manipulate materials and structure. For example, jute is hard and coarse; hemp is lightweight and strong; and abaca resists salt water. Synthetic fibers, such as nylon, polyester, and polypropylene, are stronger than plant fibers, but they melt at lower temperatures and break down faster in bright sunlight. Aramid fibers (Nomex, Kevlar, and Hyten) are made from long chain, synthetic polyamides and offer exceptional strength and resistance to heat and water.

Rope strength also depends on the degree of twist (lay) and the cord structure. The greater the twist, the stronger the rope. The greater the number of strands, the stronger the rope. Common rope structures are: twisted, braided, plaited, parallel core and fiber, and wire rope. Twisted ropes have good stretch and flexibility; braided ropes are more stable; plaited ropes are easier to grip. Both the parallel core and fiber and the wire rope constructions have an inner core of twisted fibers covered by a braided jacket for high strength and resistance to abrasion.

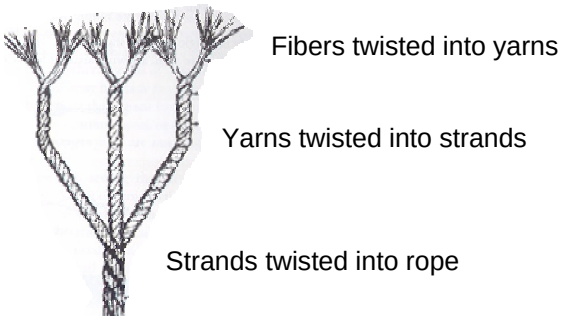
How Big Can Rope Be?

In this activity, any item is called rope if it exhibits the twisting construction described in the Technology section (opposite). Some authors, however, are more specific. *Cordage* is the general term for flexible cords with thread, string, twine, rope, and cable being used to indicate increasing size. For the purist, *rope* is *cordage* one inch or more in circumference.

Technology

Rope technology progressed from hand twisting and braiding —> simple mechanical tools —> compound mechanical tools —> power machinery.

Hand twisting demonstrates the general principle of rope making. Groups of fibers or yarns are twisted in one direction to form larger stands, which are then twisted together in the opposite direction to form a cord. When subjected to tension, the tendency for the individual strands to untwist is opposed by the tendency of the rope as a whole to untwist in the opposite direction.



Both the Egyptians and Southwest Native Americans (1,000AD) are thought to have made short ropes using a simple static device that resulted in one twist of the strand/rope for every twist of the device.

In the 13th century, Europeans introduced the ropewalk, a method for making the long ropes (300 yards or more) required by tall ships. The ropewalk relied on a compound mechanical tool called a *jack* that allowed for multiple twisting of the strands/rope. Early jacks had a large center wheel (flywheel) attached by pulleys to smaller wheels fitted with hooks. For each turn of the flywheel, the smaller wheels would turn 4 to 10 times. By the Renaissance period, pulleys were replaced by gears. Geared machines were scaled down to serve the needs of America's small farmers and ranchers and it is these cast iron rope makers that one finds today in antique shops.

For a while, small machines powered by people and large machines powered by various types of energy co-existed. Today, factories around the world produce uniform, high-quality rope very quickly and economically.