Forest Resources and Papermaking

Subject Area: Humanities

DESCRIPTION
This session is designed to educate students about forest ecosystems and resources, in addition to the history and process of papermaking. Students will have the chance to observe two different forest ecosystems and make their own paper from recycled newspaper.

OBJECTIVES
• Students will list high points in the history of papermaking.
• Students will list the ways that they use paper in their daily lives.
• Students will learn a simple procedure to make one sheet of paper out of recycled newspaper.
• Students will consider the effect that modern paper consumption has on the environment.
• Students will describe ways to efficiently use paper products.
• Students will define a forest ecosystem and indicate why healthy forests are important to the planet.
• Students will review survival needs of all forest wildlife: food, shelter, water, oxygen and space.
• Students will compare a mono-culture area (Piney Point) with a mixed-culture area (Black Bear trail or Pink Lady Slipper trail), and determine the wildlife diversity at each site.

BACKGROUND INFORMATION
See ‘Chronological History of Papermaking’ and ‘The Commercial Pulp and Papermaking Process’

MATERIALS NEEDED:
This session is conducted in the Craft Porch section of Long House, which is located on the Sequoya Campus. All equipment needed for this class is located in the Craft Porch cabinets. Before class begins, prepare several loads of shredded newspaper. Follow steps 1 through 4 in the section of this lesson plan titled: MAKING PAPER – Method.
PROCEDURES:
1. Ask students to list paper products that they use on a daily basis at home and in school. Be sure to stress how important these products are to their everyday lives. Examples include:
   - Communication- newspaper, notes, signs, magazines, letters
   - Packaging- containers, labels, electronics
   - Personal- tissues, toilet paper, napkins, diapers
   - Money
   - Decorative- wall paper, wrapping paper, origami, matting, photos, etc., art painting
2. Give a brief explanation of how paper is made (You may use this time to share the story of Ts’ai Lun). Discuss with students the health concerns of chemical additives in the papermaking process and the impact of deforestation on the environment.
3. Have students define a forest ecosystem. Lead a discussion on why it is important to protect forest ecosystems.
   - ‘Eco’ means ‘home’
   - The more complex or diverse a forest, the healthier it is
   - Everything in the forest is connected
4. Assign new identities to the students: manager of a papermill, hiker, American black bear, red tailed hawk, gray squirrel, honey bee, fungus, etc. Discuss the habitats and resources that are important to these organisms.
5. Lead students to Piney Point and have them voice observations about the location. Lead students to Black Bear trail or Pink Lady Slipper trail and have them voice observations about the location. Ask students to decide which forest habitat would most benefit their particular organism.
6. Return to classroom. Demonstrate to students how to shred sheets of newspaper for mash.
7. Demonstrate how to make a sheet of paper.

MAKING PAPER
Blender, large tub, mold and deckle, pieces of felt, irons, newspaper, water
1. Shred paper into pieces approximately the size of your pinky nail (2 cups per person).
2. Place shredded paper in blender with 1 cup of water.
3. Blend on a medium setting until the resulting mash is the consistency of cream of wheat (approximately one minute).
4. Pour into pan containing about 3 inches of water.
5. Submerge the mold, screen side up, with deckle on top of it, in the tray of mash. Slide back and forth, and side to side, until the screen is evenly covered.
6. Remove deckle and let the mold drain over the tray.
7. Place a piece of felt over the mold and turn the mold felt side down on a pile of newspapers.
8. Use a sponge to remove excess water from the back of the mold. Be sure to get the corners.
9. Peel felt and wet piece of paper from the mold.
10. Place another piece of felt over the exposed piece of paper, creating a “paper sandwich.”
11. Place felt, wet side up, on a stack of newspapers. Iron on the wet side.
12. After several minutes, the amount of steam should lessen. Have students write their name on a glossy piece of newspaper. Carefully remove partially dried paper and position it on glossy newspaper. Store in a safe place until completely dry.

SUMMARY
Ask students to describe ways in which healthy forests are important to the planet. Forests provide oxygen, diversity, climate controls, etc. Discuss our planet’s rapidly growing population and ways in which students can conserve paper resources at home or in school.
CHRONOLOGICAL HISTORY OF PAPERMAKING

105 A.D.: There are many stories about the origins of paper. One story has it that a man named Ts’ai Lun, who was a servant of the Emperor of China, was washing the emperor’s silk robes in a large pot over a hearty fire in the palace courtyard. He found laundry, like most of us, a hugely boring task, and upon seeing a friend passing by went to chat leaving the laundry unattended. Ts’ai Lun talked a long time and belatedly returned to the laundry pot to find he had reduced the emperor’s fine silk robes to mush. Knowing that he’d lose his head for sure if he didn’t think of something quickly, he raced off to find some help. In his haste, Ts’ai Lun tipped over the pot, spilling the mush all over the stones of the courtyard, where it began drying in the sun. Ts’ai Lun later returned to clean up the mess and he discovered something interesting about the mush. Where he had stepped through the mush and pressed it flat, a thin, smooth sheet had formed. This discovery was brought before the emperor and he was very impressed.

600: Papermaking travels to Korea. About 15 years later, it reaches Japan.

770: Earliest instance of text printing upon paper in the Empress Shotoku of Japan’s million dharai (prayers) book.

8th century: Moslems invade China and take the knowledge of papermaking to Egypt and Morocco.

circa 1450 – Johannes Gutenberg invented the moveable type printing press. It revolutionized the way in which information was spread.

1690 – The first paper mill is established in the United States in Philadelphia, Pennsylvania.

1719 – Rene Antoine Ferchault de Reaumur (1683 – 1757), a French naturalist, wrote of his observations of the American paper wasp’s ability to make paper from pulp. It wouldn’t be until the latter part of the 18th century that his observations would be used to make paper out of wood pulp instead plant fibers (linen) or cotton.

1790: Chlorine is identified as an element and is later used commercially to break down lignin in wood pulp.

1799: Nicholas-Louis Robert, a Frenchman, invented the first papermaking machine. He never collected any money for his invention.

1801: Matthais Koops used wood pulp in his paper mill. He went bankrupt in 2 years.

1807: The Fourdrinier brothers (Henry and Sealy) perfected the papermaking machine. A flaw in their patent allows others to copy their machine. However, the machine that they invented is not only still being used, but still called a Fourdrinier.

1851: The first chemical process used in preparation of wood for papermaking.

1857: Benjamin C. Tilghman developed “sulfite process,” an acid method for preparing wood fiber.

1914: It is estimated that 14,000 different paper products were manufactured.
THE COMMERCIAL PULP AND PAPERMAKING PROCESS

• Delivered to the mill by truck or train.
• Sorted by species and stored in piles. Only 50% of the tree is useable for papermaking. The bark, leaves, and upper limbs are not used.
• All bark is removed because it is lower in fiber and more work to process.
• Logs are cut into 1/2 – 3/4 inch square and 1/8 inch thick pieces. Pieces that are too large are run through the machine again. Pieces that are too small are combined with the bark and burned in the furnaces. The chips are stored in bins above the digester until needed.
• 40 feet high, 12 feet in diameter, and has a capacity of 10 tons of dry chips. A solution is added to the chip called white liquor (sodium hydroxide and sodium sulfide). The mixture is pressurized to increase the temperature. The mixture is cooked until the cementing material (lignin) between the wood fibers dissolves. It takes @ 2 1/2 to 5 hours at 330° to 360° F. and pressures up to 100 pounds per square inch.
• The resulting mash is sent to be washed, in order to separate the pulp from the cooking solution.
• The liquid separated from the pulp is processed to recover all the useful chemicals. Evaporation removes the excess water from the solution. The resulting thick dark liquid can be burned in the furnaces like crude oil to help fuel the papermaking process. During the burning, the sodium salts melt and run off and are recycled back into the digester.
• Meanwhile, the wood pulp is being passed over screens to remove any bits of wood that managed to remain uncooked. These uncooked portions are usually knots that are denser than the rest of the tree.
• There are 4 steps in this process: 1. Chlorine gas is passed through the pulp in order to remove any bits of lignin that escaped the cooking process (lignin bonds with chlorine). 2. Sodium hydroxide is added to the pulp/chlorine mixture in order to separate out the chlorine and lignin. 3. The mixture is washed. 4. The pulp is treated with a hypochlorite solution to make it white. Some systems use chlorine dioxide to get paper even whiter. It has been discovered that the bleaching process is releasing harmful toxins into the environment. The toxins come from chlorine mixing with the lignin. The resulting chemical compound is a dioxin. Dioxin is a term used for 75 compounds that have the same basic structure. Some dioxins that we might recognize are Agent Orange and PCP. The dioxin resulting from the bleaching process is called TCDD (tetrachlorodibenzo-p-dioxin). TCDD and other toxins are carcinogens that scientists believe mimic estrogen. These chemical compounds effect many systems in the body, e.g. the liver and reproductive organs. All bleached products are contaminated by dioxins. Dioxins are fat-soluble, which means they stay in your system (bioaccumulation) and that can lead to the toxin traveling the food chain. Colored
paper is created with plastic-based dyes that are non-biodegradable. Pulp mills regularly release contaminated water and dust into the surrounding environment.

- The bleached pulp is brushed, rubbed and cut to allow better bonding.
- Wood pulp is dumped into the “head box.” From there, it travels down onto a bronze screen moving at high speeds. Water falls through the screen and suction is also supplied to remove as much of the water as possible (@ 80%). The pulp then moves on to a series of presses where more water is squeezed out, and the pulp is finally dried into paper by a series of steam heaters. Sometimes during the last step, chemicals are added to change the texture or absorbency of the paper. These machines are called the sizer and the coater. The very last step is called calendaring, which entails rolling and checking for quality in the paper.

BIBLIOGRAPHY
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