Woods of Wheels and Wagons: Lessons for the new Carriage Museum at Wade House
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Overview and Context for Lessons
The following lessons ideas are being prepared for a new Carriage Museum which is being built at the Wade House, a historic site of the Wisconsin Historical Society in Greenbush, Wisconsin. These lessons or similar ones will be added to the existing repertoire of lessons offered to school groups. The new Carriage Museum is in final planning stages and is due to break ground this fall. The new Carriage Museum will include displays of a variety of restored horse-drawn vehicles along with interpretive information about the vehicles and the types of horses required to pull them. Some hands-on components will be sprinkled throughout the museum.

The Wade House offers program opportunities for visiting school groups. The lessons being developed for the Carriage Museum will be offered as another programmatic option, but focused on and connected to the horse-drawn vehicles. Due to the non-formal museum setting for these lessons, they will be grouped in thematic blocks rather than as individual class sessions to provide flexibility. Each block can be taught independently or together as a series. The focus of Block #1 lessons will be the origin of wood and how to identify trees whose wood is commonly used in carriage building. Block #2 will focus on testing wood properties and why certain woods are selected for particular applications based on their properties. Block #3 will apply the knowledge in a real setting. A lesson in Block #3 will also serve as an assessment in this non-formal setting.

The Wade House will offer the lessons in blocks from 2 hour lessons to half- and full day. For the purposes of this assignment, the lessons will be presented in the order in which I believe they would flow best if taught as a series and in their entirety. In addition, I will use the Standards Model Academic Standards - Science & Social Studies Content and Performance for the State of Wisconsin. It should be noted that the State of Wisconsin provides guidelines as to what students should know at the end of grade 4, end of grade 8 and end of grade 12. Since these lessons are geared toward students in grades 5-7, the academic standards for 8th grade will be used.

Standards Model Academic Standards - Science & Social Studies Content and Performance – Grade 8
Science
C.8.1 Identify questions they can investigate using resources and equipment they have available.
C.8.3 Design and safely conduct investigations that provide reliable quantitative or qualitative data, as appropriate, to answer their questions.
C.8.4 Use inferences to help decide possible results of their investigations, use observations to check their inferences.
D.8.1 Observe, describe, and measure physical and chemical properties of elements and other substances to identify and group them according to properties such as density [and others].
F.8.2 Show how organisms have adapted structures to match their functions, providing means of encouraging individual and group survival within specific environments.
G.8.1 Identify and investigate the skills people need for a career in science or technology and identify the academic courses that a person pursuing such a career would need.
Social Studies
B.8.8 Identify major scientific discoveries and technological innovations and describe their
social and economic effects on society.

**Lesson Goals**
The goals for these lessons will be for students to:

- gain an understanding of from where wood comes;
- learn to identify select trees and the properties of their wood - specifically those species most often used in carriage and wagon parts (including wheels); and
- engage in hands-on experiments testing the properties of select woods.

The assessment will involve a culminating challenge to find the correct wood type for a restoration project.

**Block #1: Stalking Wagons in the Raw**
The lessons in Block #1 are intended to provide students with an overview of trees. Students will understand that people of today and yesterday need/have needed the renewable resources which trees provide. Students will learn about features of trees which distinguish them from others for identification purposes. Students will examine the structure and function of woody plants and their parts. Students will identify several common Wisconsin trees which were used for parts in horse-drawn vehicles and other items from today and in the past.

**Activity #1: We all Need Trees**
To set the stage and to motivate students and get them thinking about the importance of of trees in their lives now as well as in the lives of people in the past, students will participate in a modified activity from Project Learning Tree (PLT) Activity #13 – *We all Need Trees*.

Students will look at and examine selected items from present day which are made from wood or wood products (such as a board, paper, cork, cellulose products like toilet paper, spices and food like maple syrup, wooden chopsticks, brake pad, insulation, Formica). The instructor will briefly talk about which parts of the tree are used for making these products and ask students to name other items they use which come from trees. Students will be asked to think about how many of our needs are met with products that come from trees. The instructor will hold up a large list of items and pictures of various items. Students will decide which items come from tree products.

Students will be asked if they think products from trees are used more today or in the past.

Next, students will be shown items from the past that are made from wood. These include containers for carrying grain, wash tubs, pails, drums, tankard, trap basket, churn, sap pail, mortar and pestle, broom, yoke, carriage seat and box, and wooden children's toys. The instructor will show selected items and will mention how the type of woods used for these items were selected due to the properties of the wood. Many of the first items listed were made from Sycamore wood. White Ash was used for baskets, chairs, tool handles such as pitchfork handles, oars or implements where elasticity (ability to bend) and strength were required. Black Cherry makes attractive and durable cabinets and table tops. Noggins were made from Sassafras, also used as flavoring for drinks. Information about items not familiar to the students will be provided by the instructor.

Again, students will be asked if they think products from trees are used more today or in the past.
Activity #2: Tree Identification Nature Walk
Prior to heading outdoors, the instructor will show students pictures of different species of trees. The presenter should guide students to notice the shape of each tree form (the crown and the way in which branches come off the tree; the trunk and bark) and to note differences in branching between conifers and deciduous trees. Students will examine branches of select tree branches and will compare and contrast their characteristics. Students should note the branching (alternate/opposite). Students will be taken onto the grounds of Wade House for a guided tree identification nature walk. The instructor will show students the features that are used for identification of trees such as the color of bark, shape of tree branches and crown, and leaf margin shapes. (Suggest looking at PLT Activity #68 Name that Tree for additional information and ideas).

While on the walk, the following trees will be interpreted where possible due to the importance of their current and past uses as well as due to their use in lessons in another block: Hickory (Shagbark/Shellbark), Oak (Red & others), Poplar (species to be determined), Ash (White & others), American Elm, Locust, Sycamore, Black Cherry, Sassafras, Sugar Maple, White Pine, Cedar, Basswood and others to be determined. Suggested interpretive information to share with students can be found in Eric Sloane's Reverence for Wood.

Activity #3: Structure of Woody Plants
In this activity, students will examine tree cookie samples (adaptation to PLT Tree Cookies #76 & PLT Tree Factory #63) to learn about the structure of woody plants. While students are examining tree cookies, the instructor will conduct a guided lecture identifying the anatomical wood features including bark, phloem, cambium, xylem, sapwood, heartwood, growth rings, rays, knots, and any abnormal wood features caused from fungus, insects or other causes (such as from drought or fire). Students can count growth rings to determine the age of a tree when it was cut down. While examining the tree rings, the instructor should talk about how there are “stories in the rings” and that one can learn about the tree as well as the climate in history from examining growth rings. If the tree is old enough and it is known when the tree was cut down, have students count back to the time at which Wade House was built or to the age of one of the vehicles. Then have students tell that “tree story” (Tree Stories - Stories in the Rings - adaptation to PLT Tree Cookies #76). For students to understand how the various parts within a tree function, the instructor will have the students participate in the Build A Tree Activity from the National Wildlife's Trees are Terrific.

Addendum: Several more lesson topics could be added to this Block. The history of timbering, logging camps, and how horses and the vehicles they pulled brought out logs from the forest could be added.

Block #2 Properties of Wood
The lessons in Block #2 are centered around:
- real world practical reasons for being able to identify wood;
- how wood species are selected for use in certain applications based on its properties; and
- the properties which can be observed and tested.
Show students same size wood slabs of select species and have them compare and contrast their characteristics. Mention to students that wood pieces can be identified based on their characteristics and properties. Using questioning, guided observations and activities, students will note the following characteristics of select wood slabs that are used for identification purposes. Students will learn about the following wood properties and how these properties are used for identifying the species of wood (activities adapted from Identifying Wood – Accurate Results with Simple Tools & Understanding Wood by R. Bruce Hoadley).

**Color & Cut**– The instructor will show students various slabs of woods of different species and have students compare and contrast the wood slab samples. The students should observe the differences in coloration as well as grain patterns. Students will be given sample slabs of conifer wood species and deciduous wood species to compare and contrast. Students should notice conifer wood tends to be more yellow or reddish as compared to deciduous tree species. The instructor will explain that different wood species have different coloration depending upon from what part of the tree the wood was cut. The instructor will show Black Cherry slabs cut from the sapwood and heartwood. The students should notice the heartwood is more reddish-brown and sapwood more white. The instructor will show several different slabs of Sugar Maple to show the variations of wood and explain how a single species is sometimes segregated into trade names based on its coloration. For example, the sapwood (outer wood) of sugar maple is sold as white maple and if a certain pattern is present it is called bird's-eye maple. Bird's eye and curly maple are not distinct varieties, but Sugar Maple with grain irregularities. The instructor will explain how the way in which cutting of a log influences the appearance of the grain of a board. The instructor will show pictures of different log cuts and show same species of wood cut in this fashion for students to compare and contract (for example, looking at the appearance of quarter-sawn oak).

**Odor** – Students will be given slabs of wood from the White Pine, Cedar, Sassafras and Basswood species. Students will be asked to smell the slabs. They should notice their different odors. The instructor will explain to students that different species sometimes have distinctive aromas. This property can be used for identification in some instances.

**Density and Specific Gravity (Relative Density)** – Using a balance, students will compare the weights of similar sized blocks of wood of different tree species. Students should notice that though the blocks of wood are the same size, there will be differences in their weight. Students should be asked why they think there are differences in the weights. The instructor should explain about density of wood. Students will then take select pieces of wood and float them in a container of water. Students will notice some pieces of wood float while others will not float as well. The instructor will explain how the wood's density influences whether or not it will float. The instructor will briefly mention how after logging pines were floated on rivers due to the pine wood's ability to float. Hardwoods do not float well and were logged primarily by being dragged out of the forest and placed on horse-drawn vehicles and then brought to railroads. In these cases, the properties of woods influences its logging history.

**Hardness** – Students will test the hardness of several species of wood (softwoods and harder woods). Slabs of woods will placed on the floor. Students will measure the height of 5 feet and will be given a screwdriver. Students drop the screwdriver from the 5 foot mark onto the slab of
wood. They will then measure the depth of the resulting divot made in the wood. Students will compare and contract divot depths and make inferences about relatives hardness of wood species. One Internet website suggests using a #2 Robertson screwdriver because the tip of a Robertson screwdriver is standardized making it easy to reproduce test results. If multiple screwdrivers are used, they should be of the same style and of the same weight in order to have a fair test. The instructor should go over the concept of fair tests and controls with the students such as needing to drop the screwdriver from the same height for each test and having the same style and weight for the screwdrivers. It should be mentioned that the hardness of wood varies with the direction of the wood grain. Testing on the surface of a plank, perpendicular to the grain, is said to be of "side hardness." Testing the cut surface of a stump is called a test of "end hardness." The instructor can explain that one use for hardness tests are for testing wood for flooring. One hardness test called the Janka hardness test measures the resistance of a type of wood to withstand denting and wear. On a scale of 1-5, with 1 being soft and 5 being hard, wood species have the following hardness:

- Poplar – hardness of 1
- Cherry – hardness of 2
- Oak – hardness of 4
- Maple – hardness of 5
- Another softer wood is spruce (though could not find number for it)

**Strength** – Using similar sized strips of select wood species or wooden rulers made from different woods, students will examine how different wood bends. Wood strips, wooden rulers or wooden paint stirs can be clamped horizontally in a vice and weights can be slowly placed one at a time on the end to observe how the wood bends. Students will compare and contrast how the wood pieces bend and how much weight can be held at the end of the clamped piece of wood.

**Identification of Wood** – The instructor will explain to students that wood can be identified by its unique cellular structure. The instructor will introduce the terms pore hole and ring-porous and will explain what they mean and how these relate to identifying wood. Students will use hand lenses to look closely at a slab of wood from a conifer and deciduous hardwood to look at cell structure. Students will then use a microscope to look at prepared slides of a thin cell layer of cells of each to observe the cell structure. The instructor will provide students with drawings of the cell structure of the select pieces of wood to help students know what to look for.

**Block #3: Applying Knowledge about Properties of Woods & Wood Identification**

Block #3 focuses on real world applications, today as well in history, for identifying wood. The instructor will use guiding questions to encourage students to come up with a variety of reasons for being able to identify wood and then will discuss real world applications where wood identification has/is used for interpreting prehistoric archeology sites to using different types of woods based on their properties when restoring horse-drawn vehicles to matching wood for an interior home repair or for being sure the species of wood used for a wood floor installation will be hard enough to withstand indentations from high-heeled shoes.

**Activity #1: Woods Found in a Wagon - What Type of Wood is it?**

The instructor will give a brief history as to how the vehicles in the collection at the museum were built, collected and restored using a PowerPoint presentation (to be developed). The
The instructor will show pictures of and provide students with background information about the types of woods and their properties that were most commonly used on vehicles and which woods are used when restoring a vehicle. Students will understand different types of woods are used for different parts of the vehicles. The bodies or boxes and seats on a wagon were typically made out of Oak, Ash and Poplar. Poplar was mostly used for more decorative type bodies and likely was used in some of the more fancy vehicles in the collection because Poplar takes a paint finish well. Poplar was used and is still used today in a variety of woodworking projects such as for making furniture and toys because it is inexpensive, fairly workable, takes nails and screws easily and glues well. According to a website on the Internet, if the proper steps are taken in the finishing process, Poplar can be stained in such a fashion as to simulate finer woods (http://woodworking.about.com/od/typesofwood/p/Poplar.htm). Poplar is the softest of the hardwoods, but still considered a hardwood. A wagon's wheel and tongue were primarily made from hickory due to one of its important properties – its ability to bend after being heated and steamed. Oak is one of the hardest hardwoods and is harder than Hickory, but does not bend or compress as well as Hickory. An Eric Sloane book claims the tensile strength of Hickory is on par with wrought iron. Hubs of a wagon wheel were made from American Elm due to its twisted grain which prevents it from splitting easily.

The instructor will have the students work in teams for an “assessment challenge.” A partially restored child-sized replica wagon with obvious parts of the box missing will be shown to the students. The instructor will give each team a box of pieces of wood from a variety of tree species with the challenge that they have to find the correct type of wood to complete the restoration of the wagon. Students will have to recall what type of wood is typically used for this part of a wagon (Poplar) and then will use the information learned in the prior lessons with additional clues to identify which piece of wood is the Poplar. Students will conduct tests of wood properties to identify the Poplar. After finding the correct wood, students will then be given paint and will paint the poplar along with a couple of other species to observe how it takes the finish.

Activity #2: Assemble & Test a Wagon Wheel for Tightness
The instructor will review which types of wood are used for the various wheel parts and why. Students will learn about the history of the word “spoke”. The instructor will talk about compressibility of the wood and how different woods contract and expand to varying degrees. Students will learn about the purpose behind wheels being dished. For the activity, students will be given parts of a wagon wheel to assemble. Students will then “drop” the wheel onto a surface and will check it for tightness and how well it had been assembled. [This is going to be an actual hands-on exhibit in the museum. This lesson and exhibit idea are still under development].

Addendum: There are other lessons which could be developed for the Carriage Museum which could focus on family life in a world without cars; firefighting with horse-power, and movement of people and goods via horse-drawn vehicles. These ideas were not pursued in this document as they are not connected to the Forestry Ecology class.
References


Hoadley, R. Bruce (1990). *Identifying Wood; Accurate Results with Simple Tools.* Taunton Press, CT.


*How to Make Wood Spoke Wheels.* Retrieved 8/18/2011 from eHow.com [http://www.ehow.com/how_6299895_make-wooden-spoke-wagon-wheels.html#ixzz1Q8MXkZLh](http://www.ehow.com/how_6299895_make-wooden-spoke-wagon-wheels.html#ixzz1Q8MXkZLh)


