5-Day Curriculum: Historic Yates Mill County Park

This is a curriculum assembled by a team of students from the Technology, Engineering, and Design Education department at North Carolina State University. Provided are Lesson Plans for 4 days of classroom activity and one visit to the Historic Yates Mill County Park. Each Lesson Plan is 75 minutes, tailored to fit a Middle School on Block Scheduling.

Next Generation Science Standards

MS-PS3-2 Develop a model to describe unobservable mechanisms

MS-PS3-C Relationships between energy and forces

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved

NC Engineering Standards

EG 6-8 H 2 Remember to use optimism in the process of problem solving and design when addressing a problem that is unfamiliar

EG 6-8 H 3.3 Use teamwork to do a hands-on project

EG 6-8 H 5. Apply attention to ethical considerations in engineering design and problem solving

EG 6-8 P 1. Understand systematic problem solving

EG 6-8 S 1. Predict how human action can affect a system in nature and vice versa

Lessons:

Day 1: Fluid Energy Transfer
Day 2: Gears
Day 3: Milling Technology
Day 4: Field Trip
Day 5: Sustainability

North Carolina 6-Point Daily Lesson Plan

Subject:	Topic: Water and Wind as Energy Sources
Teacher:	Date:

Next Generation Science Standards:
MS-PS3-2 Develop a model to describe unobservable mechanisms
MS-PS3-C Relationships between energy and forces

NC Engineering Standards:
EG 6-8H 3.3 Use teamwork to do a hands-on project

Student Outputs: Students will make a pinwheel and test their design to show wind as a power and energy transfer.

Activity	**Description of Activities and Setting**	**Materials and Time**
I. Focus and Review	Problem of the Day activity: Have students sketch/write how water or wind can be used as an energy source.	Pencil & paper (5 minutes)
II. Statement of Objectives	Wind and water are an energy source that can be transferred into other forms of energy and power.	
III. Teacher Input	Ask students to discuss what they know about wind and water as energy sources. Encourage them to share what they wrote from the Problem of the Day exercise. Demonstrate how a pinwheel captures wind energy using a desktop fan. Attach the pinwheel to the shaft of the small DC motor. Attach the output of the motor to either a low-voltage light bulb or a multi-meter. The multimeter can demonstrate both voltage and amperage (current) output. Blow the desktop fan on the pinwheel.	(5 minutes) • Straight pin or thumbtack • Heavier paper e.g. cardstock • Pencil with eraser • Straight pin or thumbtack • Small DC motor • Insulated wire • Light bulb (1.5V) and bulb holder • Desktop fan • Multi-meter (if available)
IV. Guided Practice	In teams of three, the students will design and build a pinwheel. They can choose from any of the templates provided – at least three different templates – or make their own. Encourage the teams to make their designs artistic. Allow teams to test their designs with the DC motor and multi-meter if available. Teams will record the voltage and current.	Links to pinwheel patterns (60 minutes) • http://www.hometrainingtools.com/images/art/PinwheelPattern.pdf • http://0.tqn.com/d/scrapbooking/1/0/_/A/1/starpinwheel.png • http://franticstamper.blogspot.com/2011/07/tip-template-tuesday-6-point-pinwheel.html
V. Independent Practice	Discuss results as a class pointing out that water and wind can be used as an energy source.	(3 minutes)
VI. Closure	Discuss how Yates Mill uses similar technology from water to spin a wheel that eventually grinds grain.	(2 minutes)

North Carolina 6-Point Daily Lesson Plan

Subject:	Topic: Gears
Teacher:	Date:

NGSS:
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved

Student Outputs: Students will create or demonstrate gear chains as a power and energy transfer

Activity	**Description of Activities and Setting**	**Materials and Time**
I. Focus and Review	Problem of the Day activity: Have students sketch/write about where they have seen gears outside of class.	Pencil & Paper (5 minutes)
II. Statement of Objectives	Basics of gears and how they are used in energy and power transfer	
III. Guided Practice	Show students the NASA YouTube Video: How Gears Work Show students the different gear types: Spur, Worm, Bevel, Rack and Pinion, and Belt and Pulley. Ask students to see if they can name something that shows each type of gear.	Computer and Projector (25 minutes) http://www.youtube.com/watch?v=RSZvzVIyjYk http://www.fi.edu/time/Journey/Time/Escapements/geartypes.html
IV. Teacher Input	Ask students to discuss what gears they saw in their homes yesterday. Using Legos, students can build and demonstrate the different types of gears (if available). If Legos are unavailable, a bike can demonstrate gear chains, or the back of a wall clock can suffice as well.	Computer & Projector (5 minutes) ▪ Lego Kit (if available) ▪ Bike (if available) ▪ Wall clock (25 minutes) Lego Gears available at: https://education.lego.com/en-us/lego-education-product-database/machines-and-mechanisms/9686-simple-and-powered-machines-set
V. Independent Practice	Complete the questions from Gear Ratio Exercises Website	Computer & Projector http://www.dynamicscience.com.au/tester/solutions/hydraulicus/gearsratioexe.htm (8 minutes)
VI. Closure	Discuss the production process of Historic Yates Mill County Park for cornmeal and flour and how the waterwheel and gears play an essential role.	Computer & Projector (7 minutes) http://www.yatesmill.org/

North Carolina 6-Point Daily Lesson Plan

Subject:	Topic: Corn Milling Technology and Engineering
Teacher:	Date:

NGSS:
MS-PS3-5. Construct, use, and present arguments to support the claim that when the motion energy of an object changes, energy is transferred to or from the object
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution

Student Outputs: The student will create drawings/sketches that represent their preconceived ideas and prior knowledge about the milling process.

Activity	**Description of Activities and Setting**	**Materials and Time**
I. Focus and Review	Problem of the Day: Suppose a mill can grind 150 lbs of corn in a day. How many pounds of corn can be ground during corn harvest season- October 1st through November 30th? Daily Writing:	Pencil & Paper (5 minutes)
II. Statement of Objectives	"Tomorrow we will be going to Historic Yates Mill County Park for a field trip. Today we will be exploring some of the technology that we will see there."	
III. Teacher Input	1. Show students cornmeal products (or image) such as corn bread, corn tortillas, corn chips, etc. 2. Show students corn as it appears when harvested (or image) and ask how we get these products from the harvested corn. 3. Show students video on cornmeal production at Yates Mill: http://wake.granicus.com/MediaPlayer.php?publish_id=68	Computer & Projector (5 minutes)
IV. Guided Practice	Ask students to use this information to work in a group to predict how they think the Mill converts corn into cornmeal.	Computer and Projector (25 minutes)
V. Independent Practice	Students will be asked to submit sketches/drawings as well as a written portion that answers the following questions: Can you trace the energy transfer starting at the pond and ending with the bagged/crated cornmeal? What mechanisms do you use to make cornmeal from the corn? What influenced your design decisions?	(25 minutes)
VI. Closure	Tomorrow we will be going on the field trip to Historic Yates Mill County Park. Discuss details of trip including departure times, what to bring, what to expect, etc.	Computer and Projector (15 minutes) http://www.yatesmill.org/

Day 4: Field Trip to Historic Yates Mill County Park

4620 Lake Wheeler Rd, Raleigh, NC 27603
(919) 856-6675

Preparing:

Obtain prior approval from your school/school system. Though you may have standing permission from your administration, there may be other events that require students to be present on that day. Check your school's calendar before you schedule your trip.

Obtain parental permissions. Your school may have a standard form for permissions. Remember to carefully describe why the field trip is important and how it relates to the curriculum. Consider using the permission form as a recruiting tool for chaperones.

Complete medical permission forms. Unless you are traveling with an insured travel company, you may have to create your own medical permission form which includes all information related to student health, insurance, and parental permission for medical treatment in the case of an emergency. For example forms, conduct a web search for "medical permission form" and "travel" or a search on "medical release form."

Check the weather in advance. Check weather conditions of your destination at least a week in advance and then again one day prior to the trip so that you can prepare yourself and your participants accordingly.

What to bring:

For Students

- Hard surface like a clipboard for note-taking or sketching
- Container (zip-lock bag, grocery bag, etc.) for collecting artifacts
- Recording device like pens, pencils, markers, and paper; handheld devices; laptops; cameras, video cameras or digital cameras; and a tape recorder. For tips on how to best capture the experience through images or video, see The Elements of Digital Storytelling → http://www.inms.umn.edu/elements/
- Students might bring some money for purchasing memorabilia to use in class presentations. You might encourage students to purchase postcards which can better capture sites of interest and allow students to focus their attention to the site itself. Carefully monitor students in museum gift shops and stores since some students may spend too much time shopping rather than exploring!

For Teachers

- Container for class supplies, a first-aid kit, and a container to protect student prescribed medications. For foreign travel, make sure students bring a note from their doctor or pharmacist to accompany prescribed medicines to facilitate passage through customs. For any travel, prescription medicines should be transported in their original container.
- A "Hot File" — a plastic, sealable file or large manila envelope to transport the following important documents:
    - Emergency contact information for your school and school system
    - List of students who must take medication during the trip
    - Checklist of all students and chaperones in attendance
    - Extra cash for emergency situations
    - Contact information of site contact(s), i.e., name, phone number, role, and office location on site.
    - Trip itinerary
- Cell phone for emergency calls and wrong turns
- Student identifiers. To easily spot your students in a crowded space, think about how you will identify them with a quick glance.
- Consider inviting another faculty member along who might take this trip in the future. They can shadow you while also serving as a chaperone!

Subject:	Topic: Sustainability
Teacher:	Date:

Next Generation Science Standards:
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

NC Engineering Standards:
EG 6-8 S 1. Predict how human action can affect a system in nature and vice versa.

Student Outputs: Students will produce a written proposal with sketches for the principal of the school pertaining to sustainability practices in the lunchroom.

Activity	**Description of Activities and Setting**	**Materials and Time**
I. Focus and Review	Problem of the Day activity: Gas costs $3.30 per gallon. Your car uses 13 gallons every 2 weeks. How much do you spend on gas alone every year?	Pencil & paper (5 minutes)
II. Statement of Objectives	Systems can be designed to be sustainable by incorporating alternative energy sources.	
III. Teacher Input	Present a good-sized apple to the class and explain that in this allegorical exercise, the apple represents the earth. Cut the earth into four pieces and discard three of the pieces – representing saltwater oceans, 75% of the earth. Slice the remaining piece of earth in half and discard one piece (one half) – representing land, which is inhospitable to people such as deserts. Slice the remaining 1/8 of the earth into four sections and set aside three of the sections – representing areas too rocky, too steep, or too cold to produce food. Carefully peel the skin off the remaining 1/32 slice of the earth. This represents the surface of the earth, the earth's crust with its topsoil which humanity depends on. The earth's topsoil is only about five feet deep and produces a relatively fixed amount of food. Over farming and erosion take away 24 billion tons of topsoil per year. Each inch of topsoil requires 100 years to form. This should demonstrate to students that despite how large the earth may seem, the amount of land available for people to use is limited and we must use it carefully.	Apple Cutting Knife Cutting Board (15 minutes)
IV. Guided Practice	In groups of 4, have students brainstorm ways they can make their own lunchroom/cafeteria more sustainable in as many different ways as possible. Ideas include: food production techniques: green energy milling, gardening; recycling resources, minimizing trash, composting, etc.	Pencil & Paper (30 minutes)
V. Independent Practice	Individually, write a proposal to the principal including your sustainable suggestions. Attach sketches	Pencil & Paper (20 minutes)
VI. Closure	Discuss how Yates Mill uses similar alternative energy technology from water to spin a wheel that eventually grinds grain.	(5 minutes)