Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2004 Volume IV: Energy, Engines, and the Environment

Industrial Revolution in America: Exploring the Effects of the Heat Engine on the Growth of Cities

Curriculum Unit 04.04.05
by Judith S. Goodrich

Introduction including rationale

I teach exploratory American History in three distinct classrooms of 8th grade students. One classroom is grouped by math abilities so that the students will be ready for Algebra 2 classes when entering high school next year. The other two classrooms are more heterogeneously grouped and include a number of students who are identified as 'inclusion' students -- now participating in regular education classes as part of their IEP (individualized education plans). The class sizes are large (usually 25 to 27 students) and the classroom itself seems crowded when we sit in groups around the tables. The room is organized so that students work cooperatively most of the time, and 8 computers are always available with Internet connections. When the unit is implemented in my classroom next year, we will be piloting a Toshiba laptop lab in this same classroom -- and every student will have a laptop to use in class everyday. The unit will be designed with this integration of technology in mind.

Every year we begin our study of history by exploring the theories behind the population growth of the North American continent -- including a discussion of the possibility of indigenous cultures. We move through a study of the regions of Native American settlement (including cultures following a nomadic life) and arrive at the Age of Exploration and the onset of Western Europeans arriving in the western hemisphere. An exploratory history course moves quickly -- the rationale is to expose the students to names and places, chronologies and vocabularies, themes and ideas that will provide a background for their high school curriculum. Students in New Haven will study two years of United States history as sophomores and juniors -- 8- 8th grade American history touches on turning points and key events in American History. Increasingly, 8th Grade American History classes also have stressed writing skills and the connection of historical events with present circumstances. Students are expected to defend a critical stance on a given issue using supporting evidence. The New Haven Social Studies curriculum guide states that

> The overarching goal of social studies is to develop thoughtful, responsible, and active citizens who are able to acquire the requisite information to consider multiple perspectives and to make reasoned judgments. The Social Studies K to 12 curriculums provides students with opportunities to critically reflect upon events and issues in order to examine the present, make connections

with the past, and consider the future.1

To help students learn to think critically and understand the complexity of historical developments, I have developed this unit combining an abstract notion of progress with a concrete body of evidence. The unit *Exploring the effects of the heat engine on the Growth of Cities* focuses on how the industrial revolution -- specifically through the introduction of heat engines into the local setting -- affected selected cities around America in the 1919th and early 20th centuries. In the unit, approximately eighty students will explore the impact that mechanical innovation and advancements in technology have had on the shaping of American society. Students will connect the harnessing of energy (water, steam, combustion and electricity) to the notion of progress and its good and ill effects on the environment and on patterns of urban development in American history. Students will answer an essential question about progress, using evidence from their study of a particular city and a particular heat engine application within that city to support their point of view. The essential question will be framed as: *Is the history of the growth of a city a history of progress?* In the unit, the students will focus on one aspect of change in the growth of a city during the Industrial Revolution to lead them to a detailed response. Students will review their 6th grade science curriculum when we discuss the meaning of work, energy, heat, and engines; they will have the opportunity to make their own steam powered engine (a putt-putt boat); students will think about how heat engines fueled by steam, gas, and coal were used to change the urban environment; and finally students will research, digest and react to their gathered information to write essays to demonstrate what they are thinking and what they have learned.

Components of the Unit

The Essential Question

An essential question leads the students to use higher-order thinking skills to seek out knowledge. Students will be required to use the information they gather to analyze, synthesize, and make evaluative judgments. The student is always asked to “go beyond” the information given to develop a response that is personal, thoughtful, and supported by evidence.

Grant Wiggins and Jay McTighe have created a guidebook for designing the essential question and understanding its theory and application in the classroom in *Understanding by Design: Curriculum and Assessment.* When creating an essential question to use to focus a curriculum unit they recommend that the question

> go to the heart of a discipline: They can be found in the most historically important (and controversial) problems and topics in the sciences: What is adequate “proof” in each field of inquiry?
> *have no one obvious “right” answer:* essential “answers” are not self-evidently true. Even if there are “truths” and essential theories in a discipline, the student comes to know that there are other plausible theses and hypotheses to be considered and sorted through along with the “sanctioned” views.2

In this unit I am using the question -- *Is the history of the growth of a city a history of progress?* In 8th grade we typically explore the idea of progress by looking at the expansion of America through Manifest Destiny, the changes of the industrial revolution, the growth of railroads and the impact of immigration on American life. In this new unit, I think that focusing specifically on the machines and engines that changed the physical and social 'personality' of so many cities across America, will capture the attention of my 8th graders in a concrete way. Students will select a city and identify an industry, a mode of transportation, or an innovation that used a heat engine that had a significant impact on the life and development of that locale. Students will be able to investigate a range of issues about the city in order to answer the essential question. The students will look at why the application of a particular heat engine occurred in that location and how it affected the society. The students will look at how efficiently the machines and mechanisms used energy and how their use affected the environment. They will examine the cost of these innovations both in economic and human terms.

Students will pursue the subtle effects of technological advancements on the environment, social structure, the meaning of work, and the health and growth of the city. An obvious example of the project could be the development of Lowell, Massachusetts after the textile mills became the main focus of the economy in that area. Another possibility would be to examine the benefits that the steam powered cable cars brought to the growth of San Francisco. In Portland Oregon, steam drove the saws of the lumber mills and in Trenton, New Jersey, steam powered the electric plants of the 1910s.

Understanding aspects of energy use and the efficiency of the machines that use energy (such as engines) can be related to the 8th grade American history curriculum. Wind drove the ships that moved the explorers to the New World; water wheels turned the gears and drives of mills that ground wheat to flour and cut trees to lumber; steam powered the textile looms and moved the locomotives and steamships across America. The combustion engine revolutionized travel and transportation and opened the door for countless new uses for the heat engine in industry. The turbine engine led to wider use of electricity and air travel and flights into space. These developments occurred in real places with real people -- cities grew as innovation in industry and transportation pulled people from the farms.

The students will explore these concrete examples from history to help them formulate an interpretive view. Once they select and examine the elements of an engine system (its structure, its fuel, its efficiency and waste, its 'product' and cost) at work in a city, students will step back from the data to evaluate the benefits and drawbacks of that particular development in the history of the town. They will look briefly at the same city in the 21st century to find connections or notice changes from the city a century ago. Students will conclude their study by thinking for themselves about a definition of progress in American history -- is progress, although inevitable, always a good thing?

In high school, students will need to demonstrate their ability to apply knowledge and learning on a standardized test (CAPT); I think that the ability to research and use facts and data to evaluate a theme is a useful step in developing skills to achieve this goal. I hope that the students will make the connection that innovation in all sorts of technology (not just heat engines) has an impact on the world that they live in, and that thinking about a complex question can generate even more curiosity and more questions about a topic.

Overview of the Unit

The unit *Growth of Cities* spans three or four weeks and complements our textbook's unit titled, "The United States Becomes an Industrial Nation". After five class periods devoted to vocabulary, background, and hands-on exploration of basic concepts related to the meaning of progress, energy and the development of some machines of the Industrial Revolution, the students will work in teams to research and develop a PowerPoint presentation that shows their understanding of the ways that people and cites were affected by industrial (heat engine) changes in the 19th or early 20th century. These teams of two students each will research the history of a designated city at any point within the timeframe of approximately 1800 to 1910. The students will need to discover the personality of the city -- its size, society, and special features (the geography of place) and use this information as a backdrop for the focused investigation of a heat engine at work in that city in the same years. A student team might look at Lowell Massachusetts and textile mills; Titusville, Pennsylvania and oil drilling equipment; Springfield, Massachusetts and the early gas car or the textile mills; Cleveland and iron ore and the steam powered device that removed it from boats; Pittsburgh and its steel mills or Cincinnati and steamboats or railroads. Using the development of the city as a backdrop for investigating heat engines creates a tangible context for the Industrial Revolution in America. Understanding the impact the heat engine had on a way of life makes history more concrete and manageable. Students tend to generalize when talking about history -- the president is interesting, the war was difficult, the factory was big -- I think that forcing a detailed peek into a moment of urban development will help students appreciate historical detail and evidence.

Students will need to constantly reflect and reassess the impact that their selected "heat engine in action" had on the city. The essential question should be at the back of their minds as they work on any facet of the project. For example, they might ask themselves: Is a cable car powered by a steam engine really "better" than a horse and cart for moving around San Francisco? What does the term 'better' mean? Is faster the same as better? Does a steam powered saw mill in Cedar Mills Oregon create dangerous working conditions? What kind of pollution does a heat engines add to the environment? Isn't tying up a pioneer wagon on the Oregon Trail safer than pulling a train into a frenetic railway hub in Chicago?

As a class, we will discuss the notion of progress before students embark on their own research. Students will be aware of the need to define and refine their own notions of progress before drawing any conclusions based on their gathered evidence. Of course, the evidence itself might contribute to a change in their view of progress! Some suggested definitions for "progress" could include gradual improvement or growth or development, development to a more advanced state, development in a positive way, and a progression of development that shows relationships between current conditions and past conditions.3 We will also think about two intriguing statements: progress can't be stopped and what some people regard as progress is not progress at all.

We will discuss these and other classroom generated definitions. We will talk about the areas where students would clearly expect to see progress: improvements in health; better working conditions; better jobs; less poverty; more education for all; cleaner air; cleaner cities; less disease. We'll move into the other side of progress where a negative effect might be present: faster cars -- do these cause more accidents; more machines doing work -- do these contribute to unemployment or pollution; taller skyscrapers -- do they cost more to build at the expense of something else and do they increase population density? Land use -- are groups of people being displaced to accommodate technological changes? We will talk about labor and

working conditions. After these classroom discussions, students should begin to think of evaluating the essential question (on (*Is the history of the growth of a city a history of progress?)* as a complex issue.

Unfortunately the science curriculum for 8th grade does not easily parallel what we study in American History. Students learn about the Solar System, geology, weather, and review the scientific method. In the 7th grade, students studied the human body and focused on an introduction to biology. Students studied simple machines, energy, work and motion in the 6th grade. Ideally, this unit on progress will be repeating from a different point of view what students may remember from earlier years; but I will assume that we will need to review much of the material on the meaning of energy, work, and heat. We will also review basic thermodynamic laws (and vocabulary) about the conservation of energy and the movement of heat.

Performance Tasks

The students will be writing in a daily 'exit journal' to record whatever new ideas they are mulling over as they conclude each session of research. These remarks will be used the next day to remind students where they left off and to trigger research for the new day. Students will be required to answer the essential question more formally in a final concluding essay but the daily notes should help them keep their ideas and their changes in thinking in mind. Students will be required to use balanced research: they will need to use at least one primary source as well as text-based resources to supplement any information taken from reliable websites. Students will include a bibliography or works cited list in their presentation.

Students will take notes from books and online resources and save their materials in a digital portfolio. "Cutting and pasting" huge paragraphs of information will not be allowed -- the value of using an essential question to guide research is that the use of the material will be unique to the student and not easily imported from a website. For example, copying a paragraph describing James Wattt's steam engine cannot answer the essential question about how life changed in Lowell Massachusetts, although the use of a steam engine in Lowell to industrialize textile mills will be good information when thinking about progress. Research that must answer an essential question avoids the "download online information and call it a report" behavior that many students have developed when using technology as a tool.

Students will present their findings to the class in a PowerPoint presentation or in a Microsoft Publisher newsletter. They will be encouraged to illustrate the heat engine they selected for their city and explain in simple terms how the engine works. Students will follow a rubric to guide them through the requirements of their final presentation so that each student will address the same general topics in answering the essential question. Text-based resources for the topic will be collected from the library media center and made available in the classroom. Students will access some pre-selected websites that explain the workings of simpler forms of the engines or transportation modes they select. Students will be able to use the homepages of their selected cities for historical information and to lead them to more specific topics to research. Students will design their own Internet research guides so that the time spent on the Internet is directed and focused -- in other words, students will be looking for specific information rather than surfing the Internet for inspiration. Students will maintain a works cited list including citations for images and animations..

Integrating technology

> Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other and we need them all. Arthur Clarke (1993, Sri Lanka Speech4)

Integrating technology is an essential part of this unit. The unit's theme about the growth of cities and the impact of the Industrial Revolution is also about technology, or " the application of knowledge to develop tools, materials, techniques, and systems to help people meet and fulfill their needs." The purpose for integrating technology in this unit is to encourage students to use information from the world-wide web judiciously; to use technology tools to help answer important questions and to evaluate and analyze the material they are reading online with a critical eye.

The websites included in the unit are often interactive and can illustrate the workings of a combustion engine or a steam locomotive to students far better than a one-dimensional illustration. Although this unit will be implemented in a classroom where each student has access to his own laptop everyday, it should also be possible to use computers in the library or computer lab and have the students work as teams.

What factors should students consider when analyzing their topics? What will help the students analyze the good and ill effects of progress as it ties into their selected topic? To help them focus, students will use an online causal mapping tool and a visual ranking tool developed by Intel to guide them through the 'thinking' process. These free online tools can be located by searching with the terms Intel and Interactive Thinking Tools or by checking the electronic resource list in the bibliography. Creating causal maps will help students formulate questions for research; creating visual rankings of data will help students organize their thinking about the positive and negative effects of progress on society.

In addition to Intel's Seeing Reason and Visual Mapping Tool, students will be using Microsoft's PowerPoint, Word and Publisher and Inspiration Software's Concept mapping program. A teacher without these resources in her classroom can adapt the format of the performance tasks to be just as effective with note-taking, charts, webs, posters and oral presentations.

Another aspect of technology in the unit will be to demonstrate some actual heat engines to the students. We are limited by safety guidelines in the school to using a tea candle as our source of heat. Students will make simple 'putt-putt' steam engines out of coiled copper tubing, a makeshift boat, and a tea candle and test them in water. We will look at a test-tube Stirling engine that uses heated air to 'work'. (See Figure 1) We also will look at a plastic model engine called the Visible V-8 (an old toy saved in the attic for forty years which is still available from Revell for $60.)

District Standards

The unit will focus on 8th grade Social Studies performance standards that require students to “explain causes and effects of various events” and “gather historical data from multiple primary and secondary sources.” Performance standards in the Social Studies curriculum address historical thinking, historical themes, and the application of history. Students will develop these historical skills by focusing on content drawn from their study of the Industrial Revolution. Students will connect technological advances to changes in American life; students will analyze the use of energy and engines as these factors contribute to the development of cities and the growth of America. Students will reflect on the changes occurring in American life, society and economy over time, and focusing on technological advancements, will respond to the question: *Is the history of the growth of a city a history of progress?*

The critical thinking skills the students will acquire in completing this project -- researching and finding evidence, taking a personal stand, recognizing divergent viewpoints, supporting a point of view-- are directly applicable to the Interdisciplinary Section of the CAPT that they will first encounter as sophomores in high school. The *Writing Across the Disciplines* section of the CAPT requires students to

> Apply knowledge and skills they have gained through their school career to an important contemporary issue. This assessment consists of two Interdisciplinary Writing tests...The tests measure how well students take a clear position on the issue and use accurate information from the articles to support their position. Students are assessed on how well they organize their ideas in a logical and effective manner so that their audience understands and follows their thinking, and express their ideas clearly and fluently using their own words.5

Activities in the Classroom

Preparing for research

Now that the overview of the unit is laid out -- itt’s time to talk about the specifics. How do I take a classroom of students who think that the colonists kept cool with electric fans to a group of students who know how a steam engine works and how it influenced change in American society? The notion of change and development over time is difficult for 8th graders to grasp. Combining the goal to guide students to think critically about the positive and negative aspects of progress with the objective that students understand the concept of energy and how an engine works will be a challenge. Therefore, the unit will begin with a very structured framework before students can move to individual (team) research.

We will begin by developing some basic definitions and creating a useful glossary of important terms and concepts. The students’ understanding of this ‘vocabulary’ should be reflected in their final performance task by their using the words in the reports -- students also will encounter many of the terms in the course of their research and so a glossary will be helpful. More terms can be added as questions arise or as students discover

other essential words or phrases. The teacher resource list contains books and websites (some interactive) that explain many of the basic terms in great detail and in varying degrees of complexity. The class will create a word wall of the terms and their definitions that will be accessible throughout the unit. The key terms to be used in the unit are energy, work, heat and heat engine.

Energy is the ability to do work or the power we use to do things. The kinds of energy include heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy. There is stored or potential energy (chemical) or working energy (mechanical and kinetic) energy. The sources of energy are renewable (solar, wind, hydropower) and non renewable (fossil fuels and uranium). The class will discuss these ideas and come up with practical examples to demonstrate their understanding. We will relate the idea of fuel and energy to their eating of a good breakfast and the energy they have (or don't have) to do work throughout the day. We will talk about the furnaces in their homes and apartments and the kinds of cars their families drive -- what fuels are they using and where do they come from?

Work is the force acting upon an object to cause displacement or movement across(up or down) a distance; it is written in an equation as W = f x d (work equals force times distance). Again we will think of examples of work beginning with the example of someone pushing against a wall and going nowhere. We will talk about why the definition of work was created.

Heat is a form of energy transferred by a difference in temperature; thermodynamics is the study of heat and how it changes into energy. There are laws that describe how this transfer happens and for this unit we will look at the first and second laws of thermodynamics.

Heat engines change heat energy into mechanical energy. Some examples of heat engines are steam engines, steam and gas turbines, spark-ignition and diesel engines, and the Stirling engine. These heat engines can provide power for transportation, can be used to operate machinery, or can produce electricity. I chose heat engines as the focus for the unit because they affected so many areas of urban (and rural) development. The students should be able to find a variety of such engines at work in their chosen cities.

A heat engine6 uses energy from heat to do work, but not all the heat can be used for work because heat engines are not 100% efficient. A heat engine exhausts the heat that isn't used for work -- a more efficient heat engine might find a way to use some of that exhausted heat to provide some other use. For this unit most of the students will be looking at the use of the steam engine. The steam engine, like all heat engines, cannot use all of the heat to do work because no engine is completely efficient. The students should be able to understand that the hotter the steam is and the colder the air into which the steam is 'dumped' is, the more efficient the engine will be. I think the concept of efficiency is important to introduce to the students because it helps drive the quest for more innovation in the world of engines -- a more efficient engine produces more power and 'wastes' less fuel; and a less efficient engine needs to do something with the energy not converted into work, and in many cases this becomes pollution.

Once the class has discussed and been confused by these many ideas and definitions -- we will view some short video clips about energy, engines, fuel and work. We will read Unit 10 -Chapters 1-3 in the textbook *Exploring American History* and talk about the United States becoming an industrial nation after the Civil War. The chapters highlight changes in transportation from the canal system to the use of steamboats and rail systems in the second half of the century. Spinning machines, power looms and mechanical reapers are mentioned, as are changes in industries that rely on iron and steel production. Discussion of turbines, dynamos, oil refineries and the Bessemer process will introduce students to a range of possibilities for their individual topics. As we spend time on the textbook readings we will add other ideas about what to look for

when researching change in the different cities during the Industrial Revolution. We will relate the content of the text to our definitions and frame our reading of the text along the lines of development, progress, and the changing American environment.

The cities that we will use for the research have been pre-selected. (Figure 2) I have checked online for each city to make sure that historical material is available and that a significant heat engine of some sort was used in that city in the 19th and early 20th century. When the students select their cities, they will be choosing from a list of longitude and latitude coordinates -- I want to avoid the studentt's 'vying' for cities and use the opportunity to review some geography skills. Most of the cities developed around the railroad with the establishment of particular lines running different types of steam locomotives. Steam powered electric plants are found in several locations; factories using gas and steam engines seem easiest to find in the steel industry centers of the east. Lumber, grist, and textile mills were powered by steam, and even the cable cars of San Francisco and Omaha! Cities by the great American rivers rely on steamboats -- and almost all of the above heat engines can be found in New York City.

Once the students have identified their latitude and longitude locations as actual cities, they can begin their research. The students are set free to begin to answer the essential question *Is the history of the growth of a city a history of progress?* Before students can move to the Internet or to resources in the classroom, they must compile a list of questions to guide them in their research. In essence I am following the "Big Six" school of research that outlines a Six Step approach7. Bob Berkowitz, the man behind the Big Six ideas, has developed a very useful website that is fine-tuned especially for specific grade level students.8 The process of research is outlined at this site -- beginning with the idea that the student must think about what he is looking for before beginning the quest. We will follow this process in the unit and students will need to write out some initial questions before moving out to the World Wide Web -- or to the encyclopedia, or to the library text, to find information.

Any significant source of information must be documented by the students: proper citation formats will be visible around the room on charts -- for images, websites, books, encyclopedia articles -- so that the student can record references correctly. Again, the idea in this exercise is to instill the recognition that organized information, like many other things, belongs to the people who have done the work. Students need to learn to give credit where credit is due.

I hope to spend some time discussing pollution and the heat engines that directly touch the lives of the students i.e. the internal combustion engine as used in automobiles. Almost every student can relate to a trip to the gas station and the rising costs of filling a tank. They know from experience that an SUV will use more gasoline than a small compact car. The students also know about and many have experienced lead poisoning -- which seems a perfect example of a serious pollution problem created by heat engines that was regulated by public policy when lead was removed from gasoline. Students need to realize that individuals and their governments can act to decrease the negative effects of the heat engines so important to our thriving societies.

Many of these current issues can become the focus of homework after we have discussed concepts and terms in class. The homework for the unit will bring the students back to the 21st century and will direct them to think about the effects of heat engines (especially gas combustion engines) on the environment. Students will read excerpts and look at charts and graphs from current news articles and magazines about relevant topics including gas prices, oil reserves, alternative heat sources, and global warming. We will talk about the homework assignments, both before and after the assignment is completed. These charts and graphs can be

found in many of the resources in the bibliography and can be reproduced for classroom use. As the topics of fuel cells, hybrid cars, high oil prices and nonrenewable fuel supplies become increasingly mentioned on the news and in major newspapers, teachers and students can keep an eye out for current material to use in class. A possible homework assignment could also be to have students keep a running record with summaries of news articles and radio and television reports on the topic of pollution, the environment and fossil fuel issues that they encounter over the course of the unit.

Classroom lessons

In the lessons that follow, it should be apparent that I am integrating some science in the social studies classroom, because I believe the demonstrations of how things work -- how energy makes things happen -- should help the students see that they CAN understand how things work in the physical world. It is possible for an 8 8th grader (and his teacher for that matter) to understand how technology has been 'invented' and improved upon by people willing to experiment, to think, and to apply common sense. The world is knowable…or at least parts of it. When the students move to the historical research on their topics, I want them to wonder how the machines, or engines, or moving parts actually work and understand that science and history and other curriculum areas overlap.

I think the students will enjoy seeing some actual engines in operation. The test tube Stirling engine was made from a kit ordered online9 and it shows how the exchange of hot and cool air can cause repeated movement. I also hope the students will grasp how this very simple heat engine can work -- leading perhaps to a better understanding of more complicated engines that they encounter during their research, such as the steam powered looms, trains, pumps, and steamboats. I will show a homemade crank-wheel boat that uses a wound up rubber band to power itself through the water. The boat also demonstrates other types of energy -- mechanical, kinetic and potential (human muscle power). We will keep talking about work (work equaling force times distance) as the engines are demonstrated. The putt putt boats which the students will create in small groups will lead the class into a discussion of steam power and will serve as a reference point over the course of the unit when we need to revisit and clarify terms about heat or types of energy, steam power, or work.k.

Activity One: Webquest on Energy

Grades: Grades 7-9

Guiding Question: What more can we discover about energy to help us review and enrich what we have discussed in class?

Performance Task: Students will complete a graphic organizer that requires them to rewrite definitions of basic terms and find examples.

Social Studies Performance standard: Demonstrate understanding through written, verbal, visual, and/or technological formats

Objectives:

Students will review vocabulary terms: energy, types of energy and work
Students will identify renewable and nonrenewable sources of energy

Students will identify an individual who was a pioneer in the field of energy

Materials: Computers, webquest guide-graphic organizer

Schedule: One block length class period

Procedure: This webquest will be scheduled after the class has spent time together working on definitions and terms. I will identify the websites I want the students to use and will list them in a folder titled *Energy* in the favorites menu. Students will receive a graphic organizer (this worksheet is also available digitally) that will direct them to look for specific information that can be found at the websites. Students will move through the questions to complete the worksheet. The worksheet will include open-ended questions so that students who finish before the end of the class period will be able to work on a task in more detail.

As part of the webquest students will look at an online video clip on energy titled *Adventures in Energy10* This website was developed by the Oil and Natural Gas Industry and the video does a good review on the meaning of energy. The video will introduce a historically oriented lesson on energy, the forms of energy that people and machines use and the strategies of early thinkers whose work made it possible to measure energy and the heat and work that it produces. Students can investigate specific individuals at another website all about the 'pioneers' of energy. Students will be directed to go to another energy site to look at some examples of types of energy at work11.

Assessment: Students will save their completed graphic organizers to their digital portfolios and print out a hard copy. I will review their answers which we will discus as a class in the next class. Students will be quizzed on the meaning of energy, work, and sources of energy and types of work.

Activity two: Let's Look at Some Engines!

Grades: 7-9th Grade

Guiding Question: How do engines do work?

Performance Task: Students will create a simple engine, make predictions, demonstrate it, and reflect on the experience in an essay using appropriate vocabulary.

Social Studies Performance Standards: Students will formulate questions and hypotheses from multiple perspectives.

Objectives:

Students will create a simple heat engine.
Students will analyze a simple engine that they have created by predicting, observing, and reflecting.

Students will use vocabulary correctly and write a response essay
Students will understand the meaning of work

Materials: Copper tubing in 10-inch lengths (8), tea candles (8), plastic, foil, and cardboard materials for making a boat, glue, water table or large container to float the boats.

Schedule: We will use a block period to look at a Stirling engine demonstration and a flywheel rubber band boat demonstration before the students use the rest of the period to make their boats. We will work with the science teacher to use the following science class to test the boats and discuss what the class learned.

Procedure: The class will be divided into groups of three or four students each. Each group will receive copper tubing, the tea candle (no matches), and access to materials to select from for making a boat. Students will have access to a container of water to test whether their boats can float.

Students will make predictions about what will happen when the boats are tested with the candle in the water and will try to explain what happens. Students will be asked to describe how the boat will show the meaning of work.

Assessment: Teacher will observe group interaction; the group will hand in their predictions and explanations; students will write up a short essay describing what they have learned after the boats are demonstrated and the class has discussed results.

Activity three: Homework on Oil Consumption in the US

Grades: 7-9th Grade

Guiding Question: How does the way an American drives affect the consumption of oil?

Performance Task: Students will answer questions based on their reading of a chart and a short news article. Students will write a short response essay.

Content Standard 4.0: Assess the impact of technology on the global economy.

Objectives

Students will analyze charts and graphs
Students will use information from charts and graphs to write an essay
Students will understand the connection between driving habits and fuel consumption.

Materials: Handout of the *New York Time's* Article "Growing more Oil Dependent one Vehicle at a Time" by

Dylan McClain, 2004. Teacher developed worksheet with questions and assignment.

Schedule: One night homework assignment

Procedure: Students will read the article, review the charts and graphs, answer the worksheet questions and write a short essay. The class will review the homework the next day.

Assessment: The essay and worksheet answers will be used as assessment.

District Standards

Content Standard 8.1 Historical Thinking

Formulate historical questions based on primary and secondary sources, including documents, eyewitness accounts, letters and diaries, artifacts, real or simulated historical sites, charts, graphs, diagrams and written texts

Analyze data in order to see persons and events in their historical context, understand causal factors and appreciate change over time

Content Standard 8.3 Historical Themes

Explain how economic factors influenced historical events in the United States and other regions of the world

Content Standard 8.4 Applying History

Describe relationships between historical subject matter and other subjects they study, current issues and personal concerns

Reading List

Teacher resources -- electronic (all accessed on June 28, 2004)

http://www.educationcoffeehouse.com/voc/automotive.htm. Engine animations and a great deal of automotive information.

http://www.oneworld.org/energy/whatis.html Great site answering the question: What is energy?

http://jersey.uoregon.edu/vlab/ University of Oregon Physics department site -- lots of good information on laws of thermodynamics with applets that illustrate the explanations.

http://www.secondlaw.com/two.html#time A wonderfully readable chat about the laws of thermodynamics, definitely way beyond what is needed for the unit but helpful for general understanding.

http://my.unidata.ucar.edu/content/staff/blynds/tmp.html This is a great place to learn about the meaning of heat!

http://www.amscopub.com/free_downloads/review_us_nys_hist/us_nys_hist_ch16.pdf Good background of industrial developments in the 19th century -- actually this seems to be a chapter from a textbook.

http://www.eia.doe.gov/emeu/efficiency/definition.htm Energy efficiency is described.

http://www.h-net.org/~environ/syllabi/flader.htm An amazing bibliography of texts on the history of the American environment listed according to topics and chronology.

http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html I think that this site has the clearest explanation of heat engines and other related terms. It is well organized and has good illustrations.

http://auto.howstuffworks.com/inside-engines-roundup.htm Use this site either as a teacher resource or to use in a whole class discussion -- especially if the interactive engines can be shown to the class.

http://www.klrn.org/learning/ICTT/Lessons/Littlefield.pdf Granted the source here is titled the University of the Incarnate World, but this site presents an entire unit on the Industrial Revolution that has many resources and some very interesting lesson plan ideas and handouts in PDF format.

Student resources -- electronic (accessed June 28, 2004)

http://www.classroom-energy.org/teachers/energy_tour/pg1.html All about petroleum website -- good activities for teachers and students that introduce or review basic concepts.

http://www.glenbrook.k12.il.us/gbssci/phys/Class/energy/u5l1a.html This website explains the meaning of work and has an online quiz about work that students can try.

http://www.nsta.org/Energy/find/primer/primer1_1.html Good examples for kids to explore to understand about energy and work, all terms are defined by examples.

http://www.oneworld.org/energy/whatis.html Nice definitions of energy and work.

http://www.eia.doe.gov/kids/whatsenergy.html More kid friendly descriptions of basic terms and concepts on energy.

http://www.energyquest.ca.gov/story/index.html An online book of info --very readable for 88th grade.

http://inventors.about.com/od/famousinventors/ A good general resource site linked to many other sites about inventors and the growth of technology.

http://a-day-in-the-life.powys.org.uk/eng/eindex.html A site that compares a 19th century town with its modern match. This could be used as a model of the approach taken by the unit -- looking at how technology can affect a city.

http://www.digitalbookindex.com/_search/search010histsteamboatsa.asp Primary sources on steam engine related narratives -- all digital!

http://www.slatermill.org/index.htm Slater Mill in Massachusetts's home page. Might be a good field trip location. But for the student it is an excellent resource on the working of mills.

http://www.merrycoz.org/bookndx.htm Letters of 19th century children to a magazine on variety of issues. Might be a great source

for effects of progress on society that could help students think of factors to investigate.

http://www.42explore2.com/industrial.htm List of websites on the Industrial Revolution that are very kid friendly and sorted by topics and cities that relate to themes in this unit.

http://www.42explore2.com/industrial2.htm Links to biographical entries on important people of the Industrial Revolution although not all the links work!

http://americanhistory.si.edu/onthemove/themes/story_48_1.html Online short videos about the history of transportation.

http://cgee.hamline.edu/rivers/Resources/Voices/transportation1.htm History of transportation on the Mississippi River-useful for students looking at steamboats.

Text Resources -- Teachers

Dukert, JO, *A Short Energy History of the United States* , Washington, D.C.: Edison Electric, 1980. Offers a unique way of viewing U.S. history.

Gardner, Robert. *This Is the Way It Works: A Collection of Machines* . New York: Doubleday. A variety of machines and technical drawings at a student level.

Hills, Richard. *Power from Steam: A History of the Stationary Steam Engine* . Cambridge University Press, 1993. Good facts and details about the development of steam as a source of power.

Loos, Margaret M.. *Energy And The City Person* /curriculum/units/1981/5/81.05.08.x.html#m This unit includes an interesting survey for students to take to realize how reliant they are on energy in their daily lives.

Miller, G. Tyler, Jr. 1998. *Living in the environment: principles, connections, and solutions.* Belmont, California: Wadsworth Publishing Company. Described as the best college text on environmental science, also used by high school environmental science students. Takes an interdisciplinary approach by combining natural and social sciences.

Sandfort, John. *Heat Engines : Thermodynamics in Theory and Practice* (Science Study Series)Greenwood Press, 1979. I came across mention of this book as something that is easy to read and not full of math -- perhaps even good reading for a 13 year old..

Smil, Vaclav. *Energy in World History* . Boulder: Westview Press. 1994. This book is full of information on the development of all sorts of technology -- the section on steam engines is good -- the illustrations are helpful too. This is the kind of book that would a help a teacher answer all those unpredictable questions a student might ask about how things happen re. the development of energy use.

Stern, Beverly. *Creating Our Energy Future* . YNHTI Curriculum Unit 81.05.10:

Stepan, Thelma. *Energy Alternatives.* YNHTI Curriculum Unit 81.05.09

The Great Search. A Walt Disney production on the history of energy development.

Wiggins, Grant and Jay McTighe. *Understanding by Design: Curriculum and Assessment* . Pennington, New Jersey: The Center on Learning, Assessment, and School Structure, 1997.

Text Resources -- Student

Archer, Dennis W. *Encyclopedia of Urban America: The Cities and Suburbs.* ABC-CLIO: Santa Barbara. 1998

Black, Brian. *Petrolia: The Landscape of America's First Oil Boom* (Creating the North American Landscape) Baltimore: Johns Hopkins University Press. 2000. This interesting book includes background material on Titusville in Pennsylvania where the first oil-drilling machine was operated.

Boeschenstein,Warren. *Historic American Towns along the Atlantic Coast* . Johns Hopkins University Press. 1999

Images of America Series . Arcadia Press. There are over 2000 titles in this series relating to the neighborhoods and cities of America in historical perspective. The books include photographs and pother primary source references to document the history of the selected locale. On a quick search I found entries for Memphis, Hartford, Chicago, Cleveland, New Orleans, Los Angeles, San Francisco, Charleston.

Liberman, Sherri. *A Historical Atlas of the Industrial Age and the Growth of America's Cities.* Rosen Publishing Group. 1st edition, 2004. Written for students in the middle grades.

Kerrod, Robin and Sharon Ann Holgate. *The Way Science Works.* New York: DK Publishing, 2002. This book has a few nice pages on heat and heat engines -- with illustrations.

MacAulay, David. *Mill.* Walter Lorraine Books, 1989. Great illustrations and text about the development of mills and mill towns.

MacAulay, David and Neil Ardly. *The New Way Things Work* . New York: Hought-Mifflin, rev. 1998.

McCague, James. *When Chicago Was Young* . Champaign, IL: Garrard Pub. Co., 1971. Good source for information on early Chicago.

Rosen, Robert. *A Short History of Charleston.* University of South Carolina Press; Reprint edition, 1997.

Sharp, HenryK. *Patapsco Valley: Cradle of the Industrial Revolution in Maryland.* Maryland Historical Society, February2002.

Shirley, Michael. *From Congregation Town to Industrial City: Economic Change and Community Culture in Nineteenth-Century Winston and Salem, North Carolina* . New York University Press January1994.

Stanek, Murial. *Chicago: The City and Its People.* San Diego: Coronado Publishers, Inc.1963, pp.16-34 and 127.

Stein, Conrad. *Chicago* . Chicago: Children's Press, 1997, pp. 24-25.

Video Resources

I have not seen these videos but I selected them based on reviews written about them. The videos are available through Amazon.com or through the *Social Studies School Service* catalog.

Energy for Children Video Series. 5-Volume Set, 23 minutes each. These videos are advertised as K-4 "The Energy for Children video series uses simple examples and hands-on demonstrations to help young learners understand the basics of energy and how it affects us in everyday life. The series explains what energy is, the different kinds of energy, and how we use and conserve it."

Modern Times. I thought that segments of Charlie Chaplin's famous satire would be good to show the students. 1936.

Living during the Industrial Revolution. AGC/United Learning. This video was released in 2003 and compares life before and during the industrial revolution. 19 minutes

The American Industrial Revolution . United Learning, 1997. This video uses primary source photographs and documents to cover the rise of industrial America from 1865 to 1900. 27 minutes.

The Second Revolution . CBS News. This video shows the impact of industrial growth on the development of cities and society. 27 minutes.

What is Energy? Educational Video Network, Inc. 2004. Good introduction to the meaning and types of energy.

Figure 1 Steam engines

(image is available in print form)

Figure 2 Cities

San Francisco AP37° 37’ N 122° 23’ W cable cars working with steam power

Denver AP 39° 45’ N 104° 52’ Wsteam railroad hub for the west

Pittsburgh AP 40° 30’ N80° 13’ W gas engines used at Westinghouse and Carnegie Steel

Lancaster PA 40° 7’ N 76° 18’ W Bethlehem Steel, railroads

Providence RI 41° 44’ N71° 26’ W textile mills

Charleston (SC) 32° 54’ N80° 2’ W Charleston & Hamburg Steam lines

Memphis AP 35° 3’ N 90° 0’ W American Queen, steamboats

Fort Worth AP (S) 32° 50’ N97° 3’ W The tarantula railroad

Salt Lake City 40° 46’ N 111° 58’ W Steam pump for fire department; Great Salt Lake railroad

Norfolk 36° 54’ N76° 12’ W steamboats

Portland 45° 36’ N 122° 36’ W steam powered lumber mills

Cleveland 41° 24’ N81° 51’ W iron ore steam unloaders

Cincinnati 39° 9’ N 84° 31’ W railroads

NYC- 40° 47’ N73° 58’ W Fulton’s steam boat, steam power plants

Trenton 40° 13’ N74° 46’ W Public Service Electric Company of New Jersey

Omaha 41° 18’ N95° 54’ W steam power cable car, railroads

St. Louis 38° 45’ N90° 23’ W Steam power plants

Detroit 42° 25’ N83° 1’ W Ford and General Motors

Lowell 42° 39’ N71° 19’ W textile mills

Springfield, 42° 12’ N72° 32’ W early gas car, textile mills

Chicago, 41° 47’ N87° 45’ W steam powered grist mills

Hartford, 41° 44’ N72° 39’ W steam ships, railroads

New Haven 41° 19’ N73° 55’ W shipyards, factories

New Orleans 29° 59’ N90° 15’ W steam ships

Titusville, PA 41.626N 79.673W steam powered oil-drilling pump

Notes

---

1. *Preface* page 3 New Haven Public Schools Curriculum Frameworks: District Standards

2. Wiggins, *Understanding.*

3. Google definition search for progress

4. Arthur Clark. Quoted in a speech given in Sri Lanka at http://www.lsi.usp.br/~rbianchi/clarke/ACC.Homepage.html

5. CAPT Program Overview , p. 20

6. (http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatengcon.html#c1)

7. http://www.big6.com/showarticle.php?id=415

8. http://www.big6.com/kids/7-12.htm

9. http://www.baileycraft.com You can order a test tube Stirling engine from this site for $18.00

10. http://www.classroom-energy.org/students/energy/index.html# .

11. http://www.mansfieldct.org/schools/mms/staff/hand/heattemp1.htm