



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1979 Volume III: Remarkable City: Industrial New Haven and the Nation, 1800-1900

Discover Eli Whitney

Curriculum Unit 79.03.03
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The following narrative was written to provide teachers with an accessible account of Eli Whitney's life and his place in our history. His spirit of inventiveness and accomplishments have made him the best known New Havener.

The narrative is readable enough, I hope, for sixth and eighth grade students, so that they may use it directly to gain an understanding of Whitney's role in American industrial progress and be proud of his relationship to New Haven. He might become for some of our students a symbol of achievement—a person who used his imagination to its fullest extent.

The learning packet offers an opportunity for the students to learn about other New Haven inventors as well. Using Whitney and inventing as a reference, the students may then consider their possible future careers by exploring what they could offer, the need for education and what some jobs are like. Either the entire packet or selected parts may be used, depending upon the achievement level of the students. The packet may be used in teaching the industrial period in American history or in the study of New Haven as part of a Connecticut curriculum.

The packet can be used independently by the students or according to the suggested schedule. Some of the activities may be assigned as homework and all students should be encouraged to complete at least one of the Quest Activities for extra credit, due at a later date. It would be helpful to make a chart of the activities, options and self-tests to serve as a checklist for student progress and grading.

As an alternative, the teacher may present the packet in a traditional manner. The content narrative may serve as a basis for a series of lectures or as an introduction for the sub-concepts. Lectures, classroom activities, homework and testing can be employed according to the needs of the class.

A class trip to the Inventor's Room at the New Haven Colonial Historical Society or a trip to the Eli Whitney Barn Museum are recommended.

Discover Eli Whitney

“Eli Whitney” There’s a street and a lake with that name. Isn’t there a school around here too?”

“The school is Eli Whitney Technical High School and it is in Hamden, next to New Haven. Students can learn the skills of a trade as well as studying regular high school subjects.”

“He invented something to do with cotton.”

“Tea; a machine that was able to clean the seeds from the cotton. A slave would take an entire day to separate the seeds from a pound of cotton; Whitney’s cotton gin or engine could clean 50 pounds.”

“I guess that put the slaves out of work.”

“Just the opposite. Plantation owners could now make more money growing cotton because it could be cleaned faster, so they planted more cotton to sell. Slaves were still needed to pick it; the more cotton planted, the more slaves needed. Whitney’s invention increased the demand for slaves in the South.”

“So he got a school named after him, but what was he doing in the South?

“The school wasn’t named after him because of the invention of the cotton gin. Whitney did so much more. What he was doing in the South and why a school would be named after him are questions whose answers start in New Haven.”

“Was he born here?”

“No, but he spent many years here; listen, our guide is beginning....”

During the 19th century, New Haven was a vital community that reached beyond its borders across America. Founded as a mercantile center, it grew and prospered. The city served as a crossroads for men of vision. New Haven attracted them, and from here, their investments and achievements spread with the growing nation. Possessing ideas, employing skill and accepting risk, the inventors and entrepreneurs made New Haven a city synonymous with first achievements in the building of industrial America. Eli Whitney ranks high among these early achievers.

The role that Whitney played in early American technology has been debated, however. Whitney’s work in making muskets from a number of interchangeable parts once identified him as the sole originator of the idea. But tests on a collection of Whitney muskets indicate that all their parts were not interchangeable. Historian Robert Woodbury, in his article “The Legend of Eli Whitney and Interchangeable Parts” suggests that the first actual achievement of interchangeability took place at the federal government’s arsenal at Harper’s Ferry, Virginia in 1827. As for the idea, Thomas Jefferson, writing to John Jay in August of 1785, described Honoré Blanc’s musket workshop in France, which made gauged parts by machine. Woodbury states that Jefferson discussed Blanc’s methods with Whitney eight months before Whitney made his first delivery of muskets to the government. Certainly Jefferson, as an inventor, a politician and friend, was an enthusiastic supporter of Whitney’s. As Woodbury contends, the concept of interchangeability and even other methods that Eli Whitney used were not necessarily new.

The concept of interchangeable parts was used by Christopher Polhem in the manufacture of clock gears in

Sweden at the beginning of the 1700s. The gears were made by machines with precision measurement to insure interchangeability; however, this work was probably not known in America. In his book, *The Wealth of Nations*, published in 1776, Adam Smith had discussed the idea of dividing labor—giving a single task to each worker to perform. By the 1790s, Samuel Bethan and Marc Brunel were using division of labor and machinery in mass-producing wooden pulley blocks for the English Navy. Almost every feature of the American system of manufacturing began in Europe earlier, but industrial progress was hindered by maintaining time-honored methods rather than experimentation.

In 1799, as Whitney worked in New Haven, Simeon North was making 500 pistols for the government by using machines and a division of labor just 20 miles away in Middletown. The parts were so well made that little or no filing was needed at time of final assembly. His son, Selah, invented a filing jig—matching concave molds that held the piece that forced the men to follow the contours of the jig in filling the piece to be shaped. Edwin Battison, in his article, “A New Look at the ‘Whitney’ Milling Machine”, argues that the milling machine, which is a power tool used for cutting and grinding metal parts, originated with Simeon North. Interchangeability requires precision machine tools to make exact parts; it appears that the Whitneyville milling machine was made after Whitney’s death when his nephews modernized the factory in 1827. The inventory of Whitney’s estate at time of death does not list a milling machine or any other tools that were not already in use at the two government armories in that period. Still, as the United States was entering the 19th century and its technology was being rooted, Eli Whitney stands as a central figure involved in its growth.

In 1798, when the Congress voted \$800,000 for purchase of cannon and small arms, twenty-seven contracts were let out to private arms makers. They were faced with fulfilling their commitments in their own way. The muskets were to be copies of the 1763 French Charleville model, of which the government gave 2 or 3 to each contractor to follow. At best, the government hoped that the gun parts of a factory would be interchangeable with each other, yet not necessarily with those of other contractors. The army was more interested in guns that could be repaired easily after a battle to prepare for the next day’s fighting. Whitney’s goal was to create a system using unskilled labor and machines making the parts to increase production and do it at a *reduced* cost. Interchangeability might have been a by-product of his ideal factory; it was certainly not his single goal. Whitney obtained the largest government contract, 10,000 guns due in two years—indeed a challenge in an age when gun-making was the special craft of the gunsmith.

When he signed the contract, Whitney had no factory, no workers and no experience in gun manufacturing. He did have ambition and an idea. In a letter to Secretary of the Treasury Oliver Wolcott, a fellow Yale graduate and friend, Whitney wrote, “I am persuaded that Machinery moved by water adapted to this Business would greatly diminish the labor and facilitate the manufacture of this Article. Machines for forging, rolling, floating, boring, grinding, polishing, etc. may all be made use of to advantage....” (May 13, 1798). The desire to use laborsaving machines, thereby cutting costs, is clear. Whitney’s ideas for his factory would expand; he would adapt known techniques and add his own experience in thinking how to produce large quantities quickly. After a year of construction and training workers, he again arose to Wolcott “...One of my primary objectives is to form the tools so that the tools themselves shall fashion the work and give to every part its just proportions, which once accomplished, will give exceptional uniformity to the whole” (July 30, 1799). For Whitney, interchangeability was only an aspect of the manufacturing process. He had to build the tools, plan the machines to be powered by water, and co-ordinate materials and workers with his machines. His inventiveness and engineering were things to be learned through practice.

Over these years, Whitney was not alone in his work; others involved in production of arms were working toward standardization of the manufacturing process. Besides the work of North and John Hall’s work at

Harper's Ferry, Roswell Lee, a former employee at the Whitney factory, now superintendent of the government's Springfield, Massachusetts, Armory, began a factory management system. It included inspection and accounting controls which have become important in the American system of manufacturing. Robert Orr, a master armorer also at Springfield, introduced greater standardization of muskets in 1804. Twelve years later, Thomas Blanchard invented a pattern-guided lathe for the shaping of uniform gunstocks based on Whitney's earlier machine. Whitney himself visited the government's armories to learn of their efforts; ideas flowed among armory managers as they all were struggling to meet their contracts. The 'Whitney' milling machine was built from information given to his nephews by James Carrington. He was a former Whitney foreman who had become an official government inspector of contract gun factories; he most likely told them of Hall's machines in Virginia. "Time and again factory masters received valuable assistance from itinerant mechanics," Merritt Roe Smith observes in "John H. Hall, Simeon North and the Milling Machine." "The evolution of the milling machine clearly illustrates this....It did not spring from the mind of any one person. Rather it took form gradually through a remarkable process of cooperation, transfer and convergence." Eli Whitney was not the only force in American technological growth, but one of the many involved in the slow process.

Eli Whitney can be a symbol; he was a man who was involved as an inventor and as an entrepreneur in the whole process of manufacturing. Whitney was not an experienced gunsmith. What he offered was an innovative attitude and an idea by which anything could be mass produced. His contribution was the production of a new way not only of making things, but of making the machines that make things. "Without courage and self confidence, he would never have tried it; without manual dexterity he could not have succeeded," Constance Green writes of Whitney. Thus, Whitney serves as a model of the development of American technology.

"That's all!...the guide's finished?"

"Just moving outside, come on!"

"It seems that some historians don't think that Whitney accomplished as much as people once thought."

"That's true. Earlier biographers wrote more about his background and his personality, accepting his letters as evidence that he alone invented something new. They did not look too closely at the other physical evidence, such as guns or the milling machine; nor did they investigate the other gun makers at the time."

"Just what is interchangeability?"

"It is making each part separate and so nearly alike that it is identical to all others of the same type."

"So it wasn't Whitney's idea; but he put a lot of other ideas together to make his guns. That would make him an...a what is the word?"

"Innovator—a person who attempts to bring about a change in the way of doing things. Yes, Whitney is a good example of that American spirit and his work helped to lay the groundwork for our system of mass production."

"Okay, but why work in New Haven, and I still don't know why he went South and invented the cotton gin and I...."

"The guide is going to start now; maybe he will tell us."

Eli Whitney was a farmer's son, born in Westborough, Massachusetts on December 8, 1765. The farm had a workshop which Eli preferred to the farm work. A natural mechanic, at the age of eight, he took apart his father's broken watch and repaired it. He developed strong farmer's hands, yet they were skillful enough to repair violins for his neighbors. By the age of 18, he had learned to be a general handy-man as farm living necessitated, but he realized that the farm in Westborough was too small a world for him. The mechanical work with his hands made his mind search for more in life than farming.

Whitney prepared himself for college by teaching school for seven dollars a month and attending Leicester Academy over the next five years. With his father's financial help, Whitney entered Yale as a freshman at age 23 in 1789. He studied law, but enjoyed mathematics and science courses more. To earn more money, he made nails, ladies' hairpins and walking sticks. His mechanical ability became known when he repaired an orrery for Yale's President, Ezra Stiles. An orrery or planetarium is a clock-like device which was used to teach the movements and positions of the planets. Stiles' orrery had been damaged in transit from London and was to be returned to the manufacturer for repair. Whitney spent a week making special tools and then had it working perfectly. While in New Haven, the six foot Whitney made numerous friends among his teachers and the community. The city's activity was focused on its harbor, exporting various farm products in exchange for sugar and molasses from the Caribbean islands. Yet there were a growing number of workshops that attracted Whitney, including a soap factory, Abel Buell's mint, an optics shop and Amos Doolittle's copper-engraving shop. For relaxation, he walked the area visiting them, observing the workmen and talking with the owners.

Upon graduation in 1792, Whitney needed money to repay his father and time to prepare for the bar exam. A tutoring position was found for him in the South, but it never materialized. Instead, he found himself at Mulberry Grove, a plantation near Savannah, Georgia, owned by Catherine Greene, the widow of General Nathanael Greene, and managed by Phineas Miller, a Yale graduate and former tutor of the Greene children. Here Whitney invented the cotton gin that separated seeds from short-staple cotton. The invention solved an economic problem for the south by making the crop worth the effort to grow it for the textile market in New England. Whitney and Miller formed a partnership and in June 1793, Whitney returned to New Haven to take out his patent and to begin manufacturing the gins.

The cotton gin did not bring the partners the expected fortune, however. Whitney's idea soon leaked out and pirated machines were quickly produced in Southern workshops. A patent was obtained but the problems of getting the gins into production allowed competing gin makers to beat him to the planters. His factory was located at the corner of Wooster and Chestnut Streets; here he improvised his own equipment and trained his workers. Whitney intended that the workers would each work on one part of the gin; the parts would be assembled to complete the whole. Often he would lose men because they were not happy working on the separate parts, but as craftsmen were used to involvement with the entire product; others migrated westward to find new opportunities for their skills. Whitney was in a race with time to get the gins on the market. But during the summer of 1794, epidemics of scarlet and yellow fever swept New Haven with 114 dying in the city, forcing Whitney to close the shop; workmen were scarce. A year later, 1795, while Whitney was away from the shop, the men, taking advantage of the easy working atmosphere, went out for a late breakfast. A fire broke out which destroyed all but a new building in the back.

Whitney rebuilt. In his new shop, he had each worker make only one part of the gin—a crank, a spindle, a wheel, etc.—from just a drawing of it. If all the parts were similar, the gins could be assembled faster. Whitney wanted to make all his gins alike according to his single plan. From his experience of watching clock makers, he knew that if the gears were identical you could exchange them and, with the proper machines, the parts could be made faster. Carlton Beals in *Our Yankee Heritage* speaks Whitney's mind: "Put power behind

patterns, and you have precise identical parts to interchange. Any part can be used in any gin. It's the same story as Buell's coins. They fit into any pocket. My coins are metal parts fitting into any gin" (p. 99). But the inventor had no water power for his machines on Wooster Street.

The contested patent fight would last until 1807, involving about 60 lawsuits. Finally Whitney was established as the inventor of the cotton gin and would collect \$90,000 from the suits. However, the time and money spent on the suits meant little profit on the invention. By the late 1790s, Whitney began to search for a new business in which he could use his abilities and make money. One institution that might risk money on his ideas was the U.S. government; and to it he proposed to make a screw press to print stamps. The government had made other arrangements, but it was in need of muskets.

The government at that time was contracting with private arms makers to supply it with muskets. Threat of war with France in 1798 seemed near, and importation of muskets from Europe stopped as those nations prepared for war. The government had established a federal armory at Springfield in 1794, but by 1799 it had only made 7,750 muskets. Thereafter, with improved machinery, only 9 man days instead of 21 would be needed to produce the weapon; and by 1806, 4,000 were made yearly. Another armory was established in Virginia in 1798; this Harper's Ferry Arsenal, which was organized along traditional craft lines, made 1,700 muskets a year. Gun making was a complex craft; the gun was a precision instrument whose making was the work of a single highly skilled craftsman. The gunsmith fashioned each part and assembled the gun, which was a distinctive hand-crafted object. The number of guns produced depended upon the number of craftsmen available. Because of its need for weapons, the government had to let private contractors help meet the demand.

The near bankrupt Whitney saw an opportunity to apply his idea of using identical parts to gun making and to do it with secure government money through a contract. On June 14, 1798, he contracted to produce 10,000 muskets to be delivered within 28 months at the cost of \$134,000.00. Realizing the need for money, even to begin, the businessman in Whitney had in his contract the advancement of \$5,000 upon the signing of the agreement, another \$5,000 upon his preparation to manufacture, and then payment of \$500 for each 1000 guns when delivered. This money, along with \$10,000 put up by ten New Haven backers, including James Hillhouse and Pierpont Edwards, assured Whitney of operating capital. Yet two years passed without the delivery of even one musket.

Instead, Whitney spent the time building and equipping his factory at Mill Rock about two miles outside of New Haven. The summer after he signed the contract, he visited the Springfield armory and noted that the water supply was a distance from the factory. Whitney decided to build outside of New Haven on the west side of Mill River and purchased, in September, Christopher Todd's grist mill. Now he had running water for his "machinery moved by water," and right on a main road! He bought a house from Captain Daniel Talmage into which he moved, and also property that included a barn and a blacksmith shop. Winter snows delayed work and the shipments of materials, but by May of 1799, his main factory building was completed and the waterworks nearly ready. Men still had to be trained on the machine tools that he was designing and building. Whitney provided houses for his workers as an inducement to draw skilled men out of the city. However he couldn't keep them and found the unskilled easier to train. The houses that he built for the workers on Armory Street in 1800 could be termed the earliest model housing project. During the slack periods at the factory, the men farmed the nearby acres.

Work was slow, but Whitney used his experience (gained from his gin shop and his observations at the Springfield operation) and added his own ingredients. He invented the filing jig, which guided the workmen's

file and designed stencils with up to a dozen holes that helped to bore in the exact places. Whitney fixed mechanical stops to his lathe, which prevented the worker from turning the piece too far or not enough. As well as fashioning the dies and molds for various parts, Whitney was busy arranging for the shipment of metal, wood and more tools. He seemed to be making more and more machines rather than guns. Yet under one roof, he constructed a “new method”—employing water driven machinery which made a quantity of parts using unskilled workers who were concerned with only one step of production. His ten year old nephew, Philos Blake, described the factory in a letter to his sister Betsy in September of 1801.

There is a drilling machine and a boring machine to bore barrels and a screw machine and two great large buildings, one other shop and stocking shop to stocking guns in (sic), a blacksmith shop and a trip hammer shop, and five hundred guns done. I have seen a great many ships since I have been here, and I have seen the cannon.

The “one other shop” was the filing shop. Whitney’s factory, once in operation, was to produce large quantities of a crafted item quickly, or so he hoped.

Despite his hard work, resourcefulness and innovations, the original schedule proved unattainable; by January 1801, Whitney needed money and an extension on his contract. Going to Washington, he demonstrated to President Adams and the military that his system of uniform parts worked. With the election of Jefferson as President, further problems with extensions or advancements were solved. Finally in September, the muskets that his nephew wrote about were delivered. Over the next few years, Whitney continued to spend time getting money from the cotton gin suits and making more machines, which slowed production. The last of the agreed 10,000 guns were delivered in January 1809, ten years after the first contract was drawn, at a profit to Whitney of \$2,500.

“Well, Whitney did the job. I guess that his system proved itself.”

“It was the first time that anyone tried to make such a crafted item mainly by power machines using unskilled workers; although others were working along the same idea, Eli Whitney is most remembered.”

“So what happened next?”

“Let’s let our guide finish.”

At the age of 51, Whitney married Henrietta Edwards in 1817. They lived in a house built in 1800 at 275 Orange Street; his only son, Eli Whitney II, was born in 1820. Whitney had money now, for he had secured other contracts during the War of 1812. The management of the Whitneyville factory after 1820 was in the hands of his able nephews. They and his son would make contributions to American life in their own way. In his last years Whitney was troubled by poor health; he died on January 8, 1825. His beginnings in the making of guns left New Haven with a model for future industrial progress in the production of carriages, clocks, springs, rubber products, hardware and more. Eli Whitney III leased the old factory in Whitneyville to Oliver Winchester, who organized the Winchester Repeating Arms Company in 1858, for making .22 calibre rifles. Thus, the factory continued in use toward the 20th century.

Whitney’s world provided a time for innovation in manufacturing systems. His factory would change the precision craft of gun making into routine. The machines would change the role of the worker and the meaning of skill. With a limited American labor supply, his system favored the use of small numbers of unskilled workers. The social and monetary benefits for the skilled craftsmen were reduced by the factory that fostered machine specialization rather than personal craftsmanship. As old crafts became less specialized, the

unskilled were afforded more opportunity of employment and social and physical mobility. Whitney particularly closed the door on time honored skills and opened one for those men willing to learn and adapt. Eli Whitney's vision, successfully applied, would become basic to the American idea of mass production and create a new group of workers.

"Whitney seems to have done a lot!"

"Yes. During the last years, he spent time with his family and improved his machines. He even invented an office desk in which all the drawers were locked by a single key using one lock."

"Inventor and innovator, he showed good business sense getting the government to help him produce and then buy the guns. Maybe he was just smart enough to keep that milling machine a secret after his cotton gin idea got stolen."

"It is hoped that the historical investigation at this factory site will help us understand all the work that he did here."

"I can see why he got things named after him now. Is he buried around here too?"

"In New Haven at the Grove Street Cemetery. That would be a trip back in history as well."

"I'm glad we came to the gun factory; it brings you closer to Whitney."

"Discovering Eli Whitney is discovering our past. At this place where his factory stood, we can see and hear what Whitney did and discover together."

Discover Eli Whitney

Rationale

Discovery often happens when a person uses his imagination to its fullest extent. New Haven, Connecticut can claim a remarkable number of achievements by men of imagination and energy. This series of objectives and their activities will help the student become aware of New Haveners' role in the building of industrial America in the 19th century.

Major Concept:

Inventive New Haveners, among them Eli Whitney, possessed ideas, skills and a determination to achieve success. Their efforts have contributed to making our nation an economic giant and providing our present style of life. Today, the challenge remains for us to achieve success in the future.

Terminal Objective:

Upon completion of the series of sub concepts, you will be aware of inventive New Haveners and their achievements in our history and understand that career exploration is important for self achievement.

Sub concept I. Eli Whitney's imagination made him a pioneer in the development of machine tools and mass production.

Sub concept II. Many New Haveners made contributions to American industrial progress; using

their abilities and ideas of invention, they helped a growing 19th century America.

Sub concept III. Our technological society offers many careers; planning and preparation are important in making successful choices for your future.

INSTRUCTIONS

Each of the following three sections includes: a sub-concept, performance objective, learning activities and an opportunity to test yourself. Read each sub-concept and performance objective carefully. Then complete the learning activities and the options. Some of the work is to be done individually and some will be completed in a group.

Complete the self test before you go on to the next sub-concept. If you have any questions or problems, stop and consult the teacher for help. Self tests will be checked and a record of your progress will be kept by the teacher.

When the three sections are finished, go on to the Post Assessment and complete all questions. From the Quest activities, choose one or more for completion on a date set by the teacher.

SCHEDULE

Day 1: Description of packet, reading of rationale, major concept, terminal objective and sub-concept. Explain concepts as needed. Preview entire packet and read student instructions. Form groups and choose a leader in each.

Day 2: Begin activity 1; assign activity 2 for homework.

Day 3: Complete activity 1; activity 3 for homework.

Day 4: Activities 4 and 5; activity 6 for homework.

Day 5: Activities 7 and 8; choose an option due later.

Day 6: Complete self test I; begin sub-concept II, activity 1—finish as homework.

Day 7: Activities 2 and 3; choose a name for activity 4 to be presented on Day 9. (Library time may be provided)

Day 8: Activities 6 and 7; choose on optional activity, due later.

Day 9: When activity 4 is completed, continue with activity 5.

Day 10: Self test II; begin sub-concept III, activity 1—finish as homework.

Day 11: Activity 2; assign activity 3 for homework.

Day 12: Activities 4 and 5; choose an optional activity due later.

Day 13: Activity 6

Day 14: Self-test III.

Day 15: Presentations of optional activities from subconcepts I, II and III.

Day 16: Post Assessment and Quest activity chosen.

Sub-concept I

Eli Whitney's imagination made him a pioneer in the development of machine tools and mass production.

Performance Objectives:

1. You will write a biographical summary of Eli Whitney describing his life.
2. You will be able to draw a cotton gin showing how it works.
3. You will be able to explain mass production and name examples of things with standardized/uniform parts.
4. You will describe Eli Whitney's work and its effect on America's growth and development.

Activities: (do all activities)

1. Answer the questions on handout I, self correct and save your score. Now, read individually or by taking turns orally in your group, "Discover Eli Whitney".
2. Using your history textbook, find Eli Whitney's name in the index, copy the page numbers and read the sections. (You may take notes.)
3. Using a dictionary, write out the definitions for the following:

cash crop

plantation

textile

machine

precision

factory

inventor

gunsmith

flintlock

musket

armory

arsenal

4. Copy/trace from handout II the drawing of the cotton gin and label the parts. Copy the explanation of how it works from your textbook; use the index to find the proper page number.
5. On a sheet of plain, unlined paper, draw freehand 4 lines that are parallel; turn the paper over and do it again. On another sheet of unlined paper, draw 4 parallel lines using a ruler. Compare your best effort with the one on which you used a tool, the ruler. How does the ruler help in making the parallel or uniform lines?
6. Find a description for the following and copy it.

mass production

interchangeable parts

division of labor

assembly line

List 2 advantages and 2 disadvantages of mass production.

7. Discover and make a list of 3 things in your classroom or in your home whose parts may be exchanged (interchanged); think about why.
8. Make a list of the effects of the cotton gin and those of interchange ability on American history. Share with your group and make a single list. Include the effects on labor, cities, trade, factories and slavery in the North and the South. The group leader will present the list to the class.

Optional Activities for sub-concept I. (choose one)

1. Make something out of wood, metal or paper that demonstrates the idea of interchangeable parts.
2. Define "machine tool," make a list of 3 examples, explain what they do, and draw one.
3. Research gun making in the 1700s. Who made them and how were the guns made? Write a one page report.
4. Read Chapter III in *Our Yankee Heritage* by Carleton Beals or pages 249-257 in *Three Centuries of New Haven* by Rollin G. Osterweis.
5. You have started to work in Eli Whitney's Gun Factory in 1812. Begin an imaginary diary for five days; describe the setting, where you work and live, what you do and how it is done.

Self-test for sub-concept I.

1. You are Eli Whitney and have been called to Washington, D.C. to explain why you want a contract to produce guns for the government. Give your background and experience in the manufacturing of the cotton gin, and then explain what methods you will use to produce the guns. Write two paragraphs and include a drawing of your cotton gin.
2. List the 3 elements of mass production and explain each.
3. Name 4 things in which the parts are made to be interchangeable.
4. Describe in a paragraph at least 2 changes (effects) that Eli Whitney had on American history.

Sub-concept II .

Many New Haveners made contributions to American industrial progress; using their abilities and ideas of invention, they helped a growing 19th century America.

Performance Objectives:

1. You will become aware of the process of developing an innovative idea and the importance of patents.
2. You will be able to identify New Haven "Firsts."
3. You will list reasons why New Haven was an important innovative center.

Activities: (do all activities)

1. Using a dictionary, write the definition for the following: idea, industrial, innovation, patent, mercantile, invention, industry, manufacture, achievement.
2. With your imagination, think of a new product, machine or "thing" and give it a name. Draw a picture and write a short explanation of its use under the picture. On the back, explain why a patent would be important for you to have. Your idea will be posted in the classroom.
3. In your group, list 10 inventions that have made our lives easier. Rank them according to most important, #1, to the least, #10. Add a couple of things that should be invented. The list will be

shared in class.

4. Choose a name from the list that follows. Research what he did first, when, where and describe how it worked or its benefits. Put the information on an index card and prepare to report orally to the class.

John Petrie

Chauncey Jerome

Leverett Candee

Charles Goodyear

Frank J. Sprague

Alexander Twining

Amos Alonzo Stagg

Henry S. Parmelee

Eli Whitney Blake

Thomas Sanford and Anson Beecher

Samuel Morse

Jonathan Mix

Ithiel Town

Eb Jenks

Philos Blake

Abel Buell

Simeon Jocelin

Joseph H. Smith

Edwin Drake

Blake Brothers

James Brewster

Fred M. Carroll

Joseph Parker

George W. Coy

Elisha K. Root

Alvin J. Fellows

Benjamin Silliman

Check the student bibliography for some references.

5. After hearing the reports, you are to choose the 6 people that you think made the most important discoveries. Share your choices with your group, explaining why. Then, as a group, make a list of 3 that are the most important; the list will be shared with the class and compared to other lists.

6. In your textbook, find the meaning of "Industrial Revolution" and list what is needed to become industrialized.

7. Using your list of resources of industrialization, identify all the things that New Haven had and if possible, give examples.

Optional Activities for sub-concept II. (choose one)

1. Make a chart of various (15) inventions that played important roles in the growth of manufacturing. Include the name of the invention, a description, the inventor's name and date. Use your textbook as a source of information.

2. Choose one of the following and, in a one page report, explain their inventive contribution to American progress.

Moses Brown

Samuel Slater

Thomas Jefferson

Francis Lowell

3. Draw an outline map of New Haven and on it, locate 10 manufacturing companies; by the use of a key, give their names, street address and phone number.

4. Visit the library, obtain information on the U.S. government patent laws and describe them in a one page report.

5. Continue your diary for another 5 days; the year is 1876 and it will be your last entry. What changes have taken place? How has New Haven developed or changed?

Self test for sub-concept II.

1. Define *Patent* and state why it is helpful to an inventor.
2. Identify who invented the following:
 - a) vulcanized rubber / _____
 - b) stonecrusher / _____
 - c) corkscrew / _____
 - d) tackling dummy / _____
3. List 3 reasons that helped New Haven become an industrialized area *or* list reasons why you might build a factory in or near the city.

Sub-concept III.

Our technological society offers many careers; planning and preparation are important in making successful choices for your life.

Performance Objectives:

1. You will be able to describe the role of machines in our lives.
2. You will identify the elements in the production of goods and services.
- 3, You will become aware of career exploration.

Activities: (do all activities except where indicated)

1. Read in your textbook the section on the rise of industry in America, pp. (pages assigned according to text used). Describe how machines changed the ways of living in America in a paragraph.

OR

Interview someone that you know who works in a factory/industry. Describe what he/she does, how he/she

does it and what machines/tools that he/she works with;
give the name of the product and how we might use or get
it.

OR

Make a list of 5 items made by machine and 5 that are made by hand; list things that would be found in our houses. Pick one item from each list and describe how its use helps, changes, improves or makes easy your life.

2. In your group, discuss the phrase “machines make more machines”. Decide what it means and be able to cite 2 examples. (consider what machines resulted from the electric motor).

3. Using a dictionary, define the following terms:

technology

craftsmanship

marketing

entrepreneur

consumer

production

manpower

career

4. Make a list of 5 things that would be needed to manufacture and market a product or a service.

In your group, compare your lists and decide on a single list of 5 to be shared with the class.

(clue: think of words that begin with “m”).

5. Copy the following terms:

facts

things

people

ideas

Under each name a job that deals with the term. Then, under the job list all your school subjects that would help in doing the job.

6. Complete handout III.

Optional Activities for sub-concept III. (choose one)

1. List some of the skills, experiences and attitude qualities that helped Eli Whitney to achieve in his career.
2. Your grandson has just found and read your old diary in 1920; add a list of machines that you never knew of in 1876.
3. Write a paragraph describing the job/career that you think you want to have; look in the employment section of the newspaper and include any advertisements for the job.
4. Use a dictionary and define the following terms:
salary
résumé
employer
automation
interview
references
requirement
application
occupation
qualification
5. Obtain from the teacher a list of the U.S. government's career clusters or use the *Dictionary of Occupations* in the library; choose a cluster and a subcategory, copy the category. Circle your job choice and then describe the education, experience, skills and requirements to obtain the job.

Self test for sub-concept III.

1. In a paragraph, explain how a machine that you use is a benefit for you; if the machine did not exist, what would you do instead; list any disadvantages to using the machine.

2. List five elements of production.
3. Name ten careers or jobs that you have observed; if there is one that you would be interested in, circle it.
4. List five things about yourself that you could offer an employer who might hire you.

Note to the student.

In preparation for the Post-Assessment, review the questions found in each of the self-tests, read over your notes on Eli Whitney and check your vocabulary definitions.

Post assessment

- I. Answer again the questions on handout I dealing with Eli Whitney. (Compare the results to your earlier score).
- II. Define or describe each of the following
 1. innovation
 2. patent
 3. technology
 4. cotton gin
 5. interchangeable
- III. Name two New Haven inventors besides Eli Whitney, and their achievements; also describe how the inventions may have changed our lives; give examples.
- IV. Eli Whitney can be described as an *inventor* , an *innovator* and an *entrepreneur* . Write a paragraph explaining why this description is correct.
- V. For your possible future career, how do you think that you can best prepare for it and what do you think it would be like in that career (or why would you choose it)? Answer as completely as possible.

QUEST ACTIVITIES

1. "Discovery and invention happen when a person uses his or her imagination fully". Write an essay on this theme giving examples from your own life or lives that you have studied.
2. Write a report on the South's cotton belt, the cotton industry today and its machines.
3. Read about Henry Ford or Henry Kaiser and write a report on their methods of manufacturing.
4. Build a model of the cotton gin.
5. Visit the Inventor's Room at the New Haven Colonial Historical Society and make a record of the exhibits including names, dates and a brief descriptions.
6. Visit the site of Whitney's Gun Factory, draw a map of the area or take some photographs for exhibit.
7. Research—how did New England benefit from the South's use of the cotton gin in the 19th century? How has the textile industry changed since then?
8. As a gunsmith in 1820, your job is becoming outdated because machines can do your work. Write how you feel, where you will go to work and what you might do. Include a job description of a gunsmith.
9. Visit your school's shops and home economics department and make a list of all the machines found there.
10. Interview someone who is working in your career choice. Make up questions about: requirements, responsibilities, hours, pay scales, working conditions and limitations. Record the answers.
11. Obtain a job application by writing to or visiting an employer. Fill it out.
12. Take a tour of a company or factory; describe the occupations that you observed.
13. Build something that demonstrates interchangeability.
14. Choose one of the following names; write a report relating what he did and trace his company into the 20th century, giving its present address.
John Mahlon Marlin
Hobart B. Ives
Ruel Rowe
William J. Smith
Lewis Osterweis
Samuel Colt
Joseph Sargent
Hobart B. Bigelow
C. Cowles
Oliver Winchester
Lambert H. Hitchcock
15. Choose a book from the student bibliography for reading.

(figure available in print form)

Student Bibliography:

Beals, Carleton. *Our Yankee Heritage : The Making of Greater New Haven* , 2nd. ed. New Haven: Bradley and Scoville, Inc., 1957. Historical fiction format; a reference for Quest Activity 14.

Burlingame, Roger. *Whittling Boy: The Story of Eli Whitney* . New York: Harcourt, Brace and Company, 1941.

Cooper, Carol. "Eli Whitney Armory," *Exploring East Rock* . Ellen Brainard et al eds. New Haven: Advocate Press, Inc. 7-10.

Faude, Wilson H. and John W. Friedland. *Connecticut Firsts* . Chester, Connecticut: The Globe Pequot Press, 1978. A good source for Connecticut inventions and other "firsts" with pictures.

Hays, Wilma Pitchford. *Eli Whitney and the Machine Age* . New York: Watts, 1959.

Latham, Jean Lee. *Eli Whitney—Great Inventor* . Illinois: Garrard Publishing Co., 1963.

Lodewijk, T. ed. *The Way Things Work: An Illustrated Encyclopedia of Technology* . New York: Simon and Schuster, 1973. Explains simple machines found in homes as well as how many other common ones work.

Rolt, L.T.C. *A Short History of Machine Tools* . Cambridge: M.I.T. Press, 1965. Over a hundred illustrations.

Snow, Dorothea J. *Eli Whitney—Boy Mechanic* . Indianapolis: The Bobbs-Merrill Co., Inc., 1962.

Tunis, Edwin. *Colonial Craftsmen and the Beginnings of American Industry* . New York: World Publishing, 1972.

Handout 1 for sub-concept I, activity 1 and Post-assessment.

1. The cotton gin was invented by Eli Whitney in
 - a) Whitneyville
 - b) Georgia
 - c) New Haven
 - d) Westboroug
2. Eli Whitney was born in 1765 and invented the cotton gin in 1793, at the age of
 - a) 28
 - b) 58
 - c) 38
 - d) 32
3. When Whitney attended Yale, New Haven could be described as
 - a) a transportation center
 - b) an industrial area
 - c) a manufacturing center
 - d) a busy port for trading
4. The word "gin" in cotton gin is short for

- a) ginger
 - b) engine
 - c) gingham
 - d) piggin
5. For the South, the cotton gin increased all *except* which of the following
- a) trade with New England
 - b) the amount of cotton planted
 - c) the variety of crops planted
 - d) the use of slaves
6. A gunsmith is a
- a) engineer
 - b) inventor
 - c) pioneer
 - d) craftsman
7. At Harper's Ferry and Springfield the U.S. government had _____ at which guns were made.
- a) arsenals
 - b) arsons
 - c) armoires
 - d) armor
8. Eli Whitney's government contract paid him \$134,000.00 for the 10,000 guns that he produced. What was the cost of each gun?
- a) \$134.00
 - b) \$13.40
 - c) \$1.34
 - d) \$23.40
- Whitney built his factory in which to produce guns near
- a) Wooster St.
 - b) Mill River
 - c) Orange St.
 - d) Mulberry Grove
10. Many workers at Whitney's gun factory were
- a) craftsmen
 - b) artists
 - c) unskilled
 - d) skilled

11. Which of the following is *not* an example of a machine tool?

- a) power drill
- b) corkscrew
- c) lathe
- d) electric polisher

12. A man who supported Whitney in his efforts to produce guns was

- a) Robert Woodbury
- b) Phineas Miller
- c) Simeon North
- d) Thomas Jefferson

13. A word that also means *interchange* is

- a) exchange
- b) intercept
- c) replace
- d) unchange

14. In the following list' choose the title of a book.

- a) "A New Look at the 'Whitney' Milling Machine"
- b) Discover Eli Whitney
- c) *Our Yankee Heritage*
- d) "The Legend of Eli Whitney and Interchangeable Parts"

15. Which of the following words does *not* describe Eli Whitney?

- a) inventor
- b) aviator
- c) innovator
- d) businessman

(figure available in print form)

Handout III for sub-concept III, activity 6.

1. List four different things that you would like to do if you had a lot of money and did not have to attend school.

2. Pick one from your list above that you would be most interested in write it on the line and add 2 other areas that might interest you as a career.

3. From your list, choose one and tell what subjects you are studying now that would help you in that career.

4. List 6 characteristics that are special about you and make you different from others.

5. Of the six above, place a check in front of the ones that you think would be important to an employer.

Teacher Bibliography:

Battison, Edwin. "Eli Whitney and the Milling machine," *Smithsonian Journal of History* . 1, No. 2 (Summer, 1966), 9-34. Analytical study of Whitney's musket; gives credit to Robert Johnson for the milling machine's invention.

Battison, Edwin. "A New Look at the 'Whitney' Milling Machine," *Technology and Culture* 14 (October, 1973), 592-98.

Revised his earlier findings and credits Simeon North with the first milling machine.

Blake, William P. *History of the Town of Hamden, Connecticut* . New Haven: Price, Lee and Co., 1888.

Contains many original sources; good for Whitneyville background.

Blake, William P. "Sketch of Eli Whitney," *Papers of the New Haven Colonial Historical Society* Vol. V (1894), 109-131.

Burlingame, Roger. *Machines That Built America* . New York: Harcourt, Brace and Co., 1953. Very readable; check pp. 34-68 for Whitney.

Chandler, Alfred D. *The Visible Hand: The Managerial Revolution in American Business* . Cambridge: Harvard University Press, 1977. Excellent account of the development of the American business system.

Dawley, Alan. *Class and Community* . Cambridge: Harvard University Press, 1976.

Explains how the factory system shaped classes of people.

Giedon, Siegfried. *Mechanization Takes Command* . New York: Oxford University Press, 1948.

An account of the relationship between workers and machines.

Green, Constance M. *Eli Whitney and the Birth of American Technology* . Boston: Little, Brown and Co., 1956.

Basic biography; positive treatment of Whitney's personality, life and accomplishments.

Hartley, Rachel M. *The History of Hamden, Connecticut: 1786-1950* . Hamden: The Shoe String Press, Inc., 1959.

Hindle, Brooke. *Technology in Early America* . Chapel Hill: University of North Carolina Press, 1960.

Contains a good bibliography.

Jones, Stacy V. *Inventions Necessity Is Not The Mother Of* . New York: Quadrangle, 1973.

An entertaining review of patented inventions, famous and obscure, practical and bizarre. Should be fun to use in class.

Knight, Michael. "Industrial Archaeology: A "Dig" for Eli Whitney," *New York Times* . July 28, 1975.

Explores how archaeology may help in recent historical investigations of Eli Whitney.

Larsen, Egon. *A History of Invention* . New York: Roy Publishers, 1961.

A survey but contains details of work at Whitney's gun factory.

Mirsky, Jeannette and Allen Nevins. *The World of Eli Whitney* . New York: MacMillan, 1952.

Basic biography; tells the story of his invention largely in his own words; good pre-1952 bibliography, some documents.

Mueller, Robert E. *Inventivity: How Man Creates in Art and Science* . New York: The John Day Company, 1963.

Excellent for dealing with ideas, creativity and the concept of invention, with discussion of machines of the future.

North, S.N.D. and Ralph North. *Simeon North: First Official Pistol Maker of the U.S* . Concord, New Hampshire: Rumford Press, 1913.

The descendants claim that Simeon North made the first milling machine and used interchangeable parts.

Olmsted, Denison. "Memoir of the Life of Eli Whitney, Esq.," *American Journal of Science and Arts*. XXI, No. 2 (January, 1832) 201-254.

Early biography of Whitney that used many original interviews.

Osterweis, Rollin G. *Three Centuries of New Haven, 1638-1938* . New Haven: Yale University Press, 1953.

Not much information on Whitney, but provides an excellent background for development of New Haven, its industry and commerce. A reference for students doing Quest Activity 14.

"Preservation of the Eli Whitney Gun Factory Site and Its Potential Development as An Historical Site Museum." Report prepared by Davis, Cochran, Miller, Noyes-Architects for the New Haven Colonial Historical Society, November, 1974. Contains an archeological report on the excavations and a history of the construction of the Gun Factory, 1798 through 1860 and after.

Smith, Merritt Roe. *Harper's Ferry Armory and the New Technology* . Ithaca: Cornell University Press, 1977.

Covers development of technology at Harper's Ferry; claims actual interchange ability happened there.

Smith, Merritt Roe. "John H. Hall, Simeon North and the Milling Machine: The Notion of Innovation among Antebellum Area Makers," *Technology and Culture* . 14 (October, 1973), 573-591.

Covers men working on machine tools, their exchange of ideas and the development of the milling machine.

Thompson, Holland. *The Age of Invention* . New Haven: Yale University Press, 1921.

Two chapters of note: "Eli Whitney" and "Pioneers of the Machine Shop."

Wigginton, Eliot. ed. *Foxfire V* . New York: Anchor Press, 1979.

Excellent articles and pictures on the making of flintlock rifles.

Woodbury, Robert. *The History of the Milling Machine* . Cambridge: M.I.T. Press, 1960.

Chapters 1 and 2 are a good guide to technological development; credits Robert Johnson of Middletown with the first milling machine but states that Whitney's machine was a superior one.

Woodbury, Robert. "The Legend of Eli Whitney and Interchangeable Parts," *Technology and Culture: An Anthology* . Melvin Kransberg and William H. Davenport eds. New York: Schocken Books, 1972, 318-335.

Woodbury reviews the role of Whitney in history; revises his earlier book claiming that Whitney did not originate or achieve actual interchangeability; stated that he did not invent a milling machine and concludes that "Whitney was just perhaps one of several men of genius...."

Other Materials:

"The Birth of a Museum." Tabloid available at the Eli Whitney Museum Contains good pictures for classroom use and an informative article by Merrill K. Lindsay, the Museum's president. Also lists publications by Lindsay that may be useful for reports on guns.

Eli Whitney . B & W film, 18 minutes. EBEC.

The Industrial Revolution: Beginnings in the U.S. . Color file, 25 minutes. EBEC.

American Innovation . Films-Public Affairs, Shell Oil Company, P.O. Box 2463, Houston, Texas, 77001.

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