

ACHIEVEMENT #4:

Agricultural Mechanization

Teacher's Guide

Introduction

One of the great technical challenges of all time was learning to make and power machinery that would ease the burden for farmers. For centuries, farmers worked the fields with horse or ox-drawn plows, hand tools for planting and reaping, or just their hands. From sun up to sun down, it was backbreaking labor with little time for fun. Kids didn't have much time for fun, either.

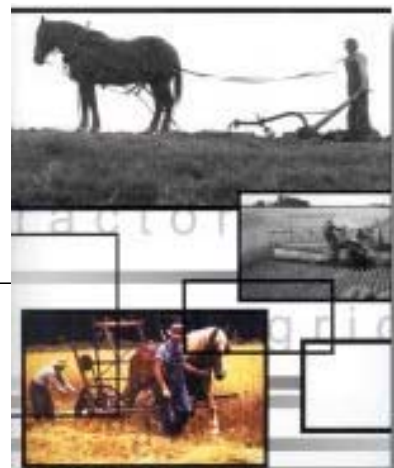
Early tractors were powered by heavy and cumbersome steam engines – an improvement over animal and human power. The invention of the internal combustion engine marked the beginning of modernization of farms. It was a lighter, more powerful engine – and enabled engineers and inventors to develop all sorts of farm machinery. There was no limit to their creative ideas!

Farmers grew more crops with less hard work. In 1900 it took four farmers to feed 10 people. Today, one farmer can produce enough food to feed 130 people. Early in the century, 75% of the American people were farmers. As mechanization of farms increased, people were free from many of the time-consuming household chores required to feed and care for a large family and hired hands. For centuries, farms were handed down from generation to generation. More people were available to work in professions that advanced technology and modernized the world.

Lesson Focus: innovation and invention

Lesson Synopsis:

Students brainstorm an invention to solve a classroom problem, conduct a survey, and create an invention or innovation to solve a problem identified in the survey.



Teacher's Guide (Continued)

Related National Science Education Standards:

Content Standard E (Science and Technology):

As a result of activities in grades 5-8, all students should develop Understandings About Science and Technology. Fundamental concepts and principles that underlie this standard include:

- ◆ Scientists propose explanations for questions about the natural world, and engineers propose solutions relating to human problems, needs, and aspirations.

Related Benchmarks from Benchmarks for Science Literacy:

Section 3C (Issues in Technology):

By the end of 5th grade, students should know that:

- ◆ An invention is likely to lead to other inventions. Once an invention exists, people are likely to think up ways of using it that were never imagined at first.
- ◆ Scientific laws, engineering principles, properties of materials, and construction techniques must be taken into account in designing engineering solutions to problems.

By the end of 8th grade, students should know that:

- ◆ Technology ... is largely responsible for the great revolutions in agriculture, manufacturing, sanitation and medicine, warfare, transportation, information processing, and communications that have radically changed how people live.

Section 8A (Agriculture):

By the end of 8th grade, students should know that:

- ◆ With improved technology, only a small fraction of workers in the United States actually plant and harvest the products that people use.

Section 10J (Harnessing Power):

By the end of 8th grade, students should know that:

- ◆ The steam engine was invented to solve the urgent problem of pumping water out of coal mines. As improved by James Watt, it was soon used to move coal, drive manufacturing machinery, and power locomotives, ships, and even the first automobiles.

Section 12D (Communication Skills):

By the end of the 8th grade, students should be able to:

- ◆ Locate information in reference books, back issues of newspapers and magazines, compact discs, and computer databases.

Teacher's Guide (Continued)

Related National Standards for Technological Literacy:

Standard 1: In order to comprehend the scope of technology, students in grades 6-8 should learn that:

- ◆ Technology is closely linked to creativity, which has resulted in innovation.

Standard 6: In order to be realize the impact of society on technology, students in grades 6-8 should learn that:

- ◆ The use of inventions and innovations has led to changes in society and the creation of new needs and wants.

Standard 10: In order to be able to comprehend other problem-solving approaches, students in grades 6-8 should learn that:

- ◆ Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.

Glossary:

invention The process of turning ideas and imagination into devices and systems. The term invention is also used to refer to the products of the processes of invention and innovation.

innovation The process of modifying an existing product or system to improve it.

prototype A trial working model of a design that is built to test design decisions and identify potential problems.

patent A grant issued by the US Government giving inventors the right to exclude all others from making, using, or selling their inventions within the US, its territories, and possessions

trademark A word, name, symbol, design, combination of word and design, or slogan used by a manufacturer or merchant to identify its goods or services and distinguish them from those manufactured or sold by others.

copyright Copyright protection means that permission must be granted by the copyright holder to allow reproduction, distribution, performance, or display of the author's original work. Copyright covers the expression of ideas but not the idea itself.

Important Concepts:

- ◆ Farm mechanization has dramatically decreased the human labor involved in agriculture, resulting in a shift from rural to urban life and providing people with a wider variety of career choices.
- ◆ Innovation in agricultural mechanization has incorporated engineering achievements such as the gasoline engine to improve the usefulness of farm machinery.

Teacher's Guide (Continued)

Materials for Each Inquiry Team:

- ◆ Copies of the Invention Idea Survey Form
- ◆ Inventor's Log for each student
- ◆ Materials for creating drawings and design prototypes

Safety Precautions: Prior to construction of prototypes, remind students of basic safety rules for the use of construction tools and materials, as appropriate.

Procedure:

Engagement:

If you have not shown the video to the class, you may do so and then proceed with the Exploration activity. If you have already shown the video, you may want to use the activity **“Practicing Inventive Thinking with Your Class”** as an Engagement activity.

“Practicing Inventive Thinking with Your Class” (Activity 3 from The Inventive Thinking Curriculum Project)

Before your students begin to find their own problems and create unique inventions or innovations to solve them, you can assist them by taking them through some of the steps as a group. Solving a "class" problem and creating a "class" invention will help students learn the process and make it easier for them to work on their own invention projects.

Identifying a Problem:

1. Let the class list problems in their own classroom that need solving. Use a "brainstorming" technique. (Perhaps some of your students never have a pencil ready when it is time to do an assignment, because it is either missing or broken.)
2. Select one problem for the class to solve using the following steps:
 - a. Find several problems.
 - b. Select one to work on.
 - c. Analyze the situation.
 - d. Think of many, varied, and unusual ways of solving the problem.
3. List the possible solutions. (Be sure to allow even the silliest possible solution, as creative thinking must have a positive, accepting environment in order to flourish.)

Teacher's Guide (Continued)

Deciding on a Solution:

1. Select one or more possible solutions to work on. (You may want to divide into groups if the class elects to work on several of the ideas.)
2. Improve and refine the idea(s).
3. Share the class or individual solution(s)/invention(s) for solving the class problem.

Exploration:

Have students use the “**Invention Idea Survey Form**” to survey their class, another class, parents, etc. to obtain a list of problems for potential consideration.

Explanation, and Extension:

Have students read the handout and examine the Timeline to infer the importance of both invention and innovation in agricultural mechanization. As an Engineering Challenge, have them work in groups to select a problem and design and construct an invention/innovation to solve the problem.

Evaluation:

Hold an Invention Convention or Invention Fair for students to display and demonstrate their inventions/innovations.

Ideas for Further Exploration:

1. Have students add events to the timeline or research inventors or inventions listed on the timeline.
2. Have students research the events that influenced particular inventors to invent particular products.
3. Have students explore information on patents, trademarks, and copyrights.
4. Encourage students to participate in the Craftsman/NSTA Young Inventors Awards Program. (See <http://www.nsta.org/programs/craftsman.asp> for details.)

References:

- ◆ **The History of Tractors**, an online exhibit at: <http://www.ssbtractor.com/features/index.html>
- ◆ **The Invention Dimension**, website sponsored by MIT, highlights a different American inventor every week with a biographical sketch covering his or her accomplishments and their impact on society. Online at <http://web.mit.edu/invent/>
- ◆ **The Inventive Thinking Curriculum Project**, a 64-page document produced as an outreach program of the United States Patent and Trademark Office, available online at: <http://www.uspto.gov/web/offices/ac/ahrpa/opa/projxl/invthink/invthink.htm>

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Student Handout

Invention Idea Survey Form

One of the best ways to collect ideas for developing an innovation or an invention is to take a survey. Try to interview a variety of people of all different ages and occupations. (The more people you talk to, the more ideas you will get.) The following list of questions may help you:

1. What product does not work as well as you would like it to work?
2. What job(s) would you like to see solved?
3. What problem(s) would you like to see solved or made easier?
4. If you could invent something to make your life easier, what would you invent?
5. What is the most annoying problem you experience

at home? _____

at school? _____

at work? _____

in an airport? _____

on the road? _____

at the grocery store? _____

at the bank? _____

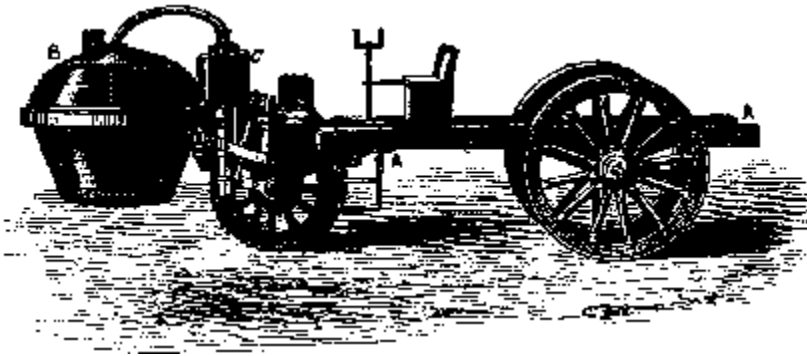
at the shopping mall? _____

Student Handout (continued)

Who Invented the Tractor?

Between 1900 and 1950, the number of tractors in use on US farms rose from about 500 to over 3 million. This rapid shift from manual labor and animal power has tremendously affected our choices about the jobs we choose and where we live. More than any other farm machine, the tractor deserves the greatest credit for this change.

Carefully review the Timeline on the next page. There you will find the dates of many events in the history of the development of the modern farm tractor. You might think it would be easy to determine who actually invented the tractor, but what exactly do we mean by “tractor” – the gasoline-engine farm tractor? In 1769 a Frenchman named Nicholas Cugnot built a three-wheeled road vehicle powered by a “steam traction engine” and to some people’s thinking this was the world’s first “tractor” (**and** the first road vehicle). However, Cugnot’s Steam Carriage (or Steam Tractor) was driven on roads and used to haul cannons, rather than being used in agriculture.



Cugnot’s Steam Tractor (1769)

Invention and Innovation:

Invention refers to the process of turning ideas and imagination into devices and systems, while **innovation** refers to the process of modifying an existing product or system to improve it. (The term invention is also used to refer to the products of the processes of invention and innovation.) Comparing Cugnot’s steam tractor to a modern farm tractor, you can see how new innovations over time led to a product that is radically different from the initial one, although still having recognizable similarities.

Student Handout (continued)

Timeline of Important Events Related to Agricultural Mechanization:

- 1705** Thomas Newcomen develops a steam engine used to pump water from coalmines.
- 1763** James Watt develops important innovations on the Newcomen engine, allowing the Watt steam engine to be used to operate factory machinery.
- 1790** George Washington signs a bill establishing the US Patent and Trademark Office.
- 1831** Cyrus McCormick, at age 22, designs and builds first machine (the horse-drawn reaper) used to harvest (reap) grain, such as oats, barley, and wheat.
- 1849** First portable steam engine for farming use developed.
- 1862** Nikolaus Otto develops the internal combustion engine (gasoline engine).
- 1892** First record of a successful gasoline-engine tractor. Case begins production of the Case farm tractor, powered by a steam traction engine.
- 1893** Rudolf Diesel patents the principle for the diesel engine.
- 1904** Benjamin Holt develops his gasoline-powered tractor.
- 1907** Henry Ford builds his first experimental tractor. Estimates are that only about 600 tractors were in use on US farms at this time.
- 1911** Case's steam-engine production peaks when the company also produces its first gasoline-powered tractor.
- 1916** Ford Motor Company begins production of the Fordson tractor.
- 1925** Benjamin Holt merges with Best Tractor to form Caterpillar Tractor Company.
- 1948** Frank Zybach invents the center-pivot irrigation machine, revolutionizing irrigation technology.
- 1949** John and Mack Rust develop the first mechanical cotton picker.
- 1950** An estimated 3,400,000 tractors in use on US farms.
- 1956** Rollover bars made available on tractors to reduce fatal injuries.

Student Handout (continued)

Engineering Challenge: Invent a Product that Solves a Problem

Selecting a problem and Evaluating Potential Solutions:

Select one of the problems identified in your survey and brainstorm possible solutions in your Inventor's Log. Evaluate the possible solutions by considering the following questions:

1. Is my idea practical?
2. Can it be made easily?
3. Is it as simple as possible?
4. Is it safe?
5. Will it cost too much to make or use?
6. Is my idea really new (an invention) or is it a modification of an existing product (an innovation)?
7. Will it withstand use, or will it break easily?
8. Is my idea similar to something else?
9. Will people really use my invention/innovation? (Survey your classmates or the people in your neighborhood to document the need for and potential usefulness of your idea.)

Producing Your Invention/Innovation:

1. Give your invention/innovation a name.
2. List the materials needed to illustrate your invention/innovation and to make a model of it. (You will need paper, pencil, and crayons or markers to draw your invention. You might use cardboard, paper, clay, wood, plastic, yarn, paper clips, etc. to make a model.)
3. List, in order, the steps for completing your invention/innovation.
4. Think of the possible problems that might occur. How would you solve them?
5. Complete a "prototype" (working model) of your invention/innovation. (In some cases, a non-functioning scale model or design drawings may be substituted for a working model. Check with your teacher before proceeding.)