Get it Write

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Lesson Focus

Lesson focuses on how writing instruments have been engineered over time. Students work in teams to design and build a functional "pen" out of everyday materials that can deliver washable liquid watercolor (ink) to a sheet of paper in a controlled manner. They design their pen, build and test their design, evaluate their results, and share observations with the class.

Lesson Synopsis

The "Get it Write" lesson explores how pens have been engineered and re-engineered over time. Students work as a team to develop a working pen out of everyday items. They sketch their plans, identify materials they'll need for construction, build their pen, test it, and present their design to their class.

Age Levels

8-18.

Objectives

- Learn about mechanical engineering.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- mechanical engineering
- viscosity
- engineering design
- teamwork

Lesson Activities

Students explore how writing instruments have changed over time and work in teams to develop their own pen out of everyday items that can deliver a controlled amount of washable liquid watercolor (ink) to paper in order to write the letter "A". They plan their design on paper, built it, test it, reflect on the activity, and share their experiences with the class.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- A Brief History of Writing Instruments (http://inventors.about.com/library/weekly/aa100197.htm)

Recommended Reading

- The Story of Writing by Andrew Robinson (ISBN: 978-0500286609)
- The Incredible Ball Point Pen: A Comprehensive History (ISBN: 978-0764304378)

Optional Writing Activity

- Write an essay or a paragraph about how engineers have developed writing instruments that operate under water or in situations without gravity such as outer space.

Optional Extension Activity

- Have students develop a writing instrument that can switch between two different colors of "ink."

For Teachers:
Teacher Resource

◆ Lesson Goal
Lesson focuses on how writing instruments have been engineered over time. Students work in teams to design and build a functional "pen" out of everyday materials that can deliver washable liquid watercolor (ink) to a sheet of paper in a controlled manner in order to clearly write the letter "A". They design their pen, build and test their design, evaluate their results, and share observations with the class.

◆ Lesson Objectives
- Learn about mechanical engineering.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

◆ Materials
- Student Resource Sheets
- Student Worksheets
- Student Team Materials: straws, paper, string, tape, wire, paper clips, feather/quills, glue, foil, plastic wrap, leaves, wooden sticks, water, washable liquid watercolor or diluted washable paint, flour or corn starch (can be used as a thickener), sponge, or other items.

◆ Procedure
1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students how the pen they might be using works. Ask them to identify several different types of pens, and consider why pens have changed over the years.
3. Teams of 3-4 students will consider their challenge, and design their pen on paper.
4. Teams request the materials they want to use, and can share or trade materials with other teams, as needed.
5. Teams then build their "pen," test it, and demonstrate it for the class.
6. Teams consider the designs of other student teams, and complete a reflection sheet.

◆ Time Needed
One to two 45 minute sessions.

◆ Notes
Students may need to thicken the washable watercolor liquid with flour or corn starch to slow the flow of liquid.

Student Resource: History of Writing Instruments

◆ Writing through the Ages

Humans have developed and refined many different types of writing instruments over history, from simple scratches on stone walls, to elaborate paintings on caves, to ball point pens, permanent markers, and even pens that can operate without gravity in outer space and also under water.

◆ Early Pens

The use of pens goes back very far in history! Many ancient people used bird feathers, bamboo sticks, reeds, and grasses to deliver colored liquids to surfaces such as birch bark and papyrus. Reed pens continued to be used until the Middle Ages but soon the use of quills became more popular. It is believed that quill pens were used to write some of the Dead Sea Scrolls, which date to about 100 BC. Quill pens were used to write and sign the Constitution of the United States in 1787. And, many people today still use quill pens for decorative writing.

◆ Reservoir Pens

But, pens that included a reservoir for holding ink have been identified back into the 10th century. It is said that in 953, Ma'ād al-Mu'izz, of Egypt requested a pen that would not stain his clothes or fingers. He was apparently provided with a design that held ink in a reservoir which provided ink to a metal nib. In 1636 a German inventor named Daniel Schwenter worked on a pen with two quills -- one to hold the ink, and another to deliver ink to paper. A cork was used to seal the ink in the quill. Advances were made with the use of metal "nibs" that helped direct ink. A metal pen point was patented in 1803 but never really developed. In 1809, Bartholomew Folsch was granted an English patent for a pen that included an ink reservoir. A Parisian student named Romanian Petrache Poenaru was granted a patent by the French Government in May 1827 for the Fountain Pen. In 1867 M. Klein and Henry W. Wynne were granted a U.S. patent (#68445) for an ink chamber and delivery system that was all housed in the handle of a "fountain" pen.

◆ Newer Designs

The design and functionality of pens continually is "re-engineered." There are rollerball pens, felt tip pens, marker pens, erasable pens, and pens that work underwater and in zero gravity. Still, the older designs, such as fountain pens, are now considered a status symbol.

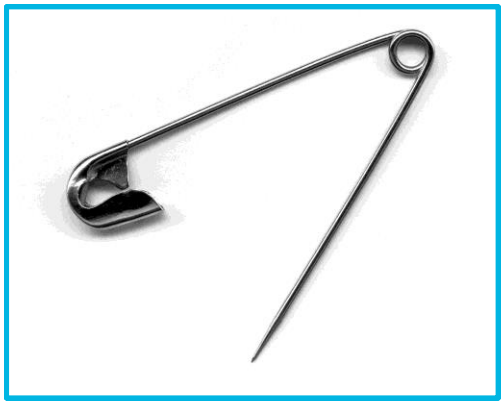
IEEE

Student Resource:
All About Patents

◆ What is a Patent?

A patent for an invention is the grant of a property right to the inventor, issued by a country's Patent and Trademark Office. The procedure for granting patents, the requirements placed on the patentee, and the extent of the exclusive rights vary widely between countries according to national laws and international agreements. In the United States, the term of a new patent is 20 years from the date on which the application for the patent was filed or, in special cases, from the date an earlier related application was filed, subject to the payment of maintenance fees. *Utility patents* protect useful processes, machines, articles of manufacture, and compositions of matter. Some examples: fiber optics, computer hardware, medications. *Design patents* guard the unauthorized use of new, original, and ornamental designs for articles of manufacture. The look of a specific athletic shoe or a bicycle helmet are protected by design patents. *Plant patents* are the way we protect invented or discovered asexually reproduced plant varieties. Hybrid tea roses, Silver Queen corn, and Better Boy tomatoes are all types of plant patents.

◆ Famous Patents



Safety Pin: The patent for the "safety pin" was issued on April 10, 1849 to Walter Hunt, of New York. Hunt's pin was made from one piece of wire, which was coiled into a spring at one end and a separate clasp and point at the other end, allowing the point of the wire to be forced by the spring into the clasp.

Dishwasher: A patent for the first practical dish washing machine was issued December 28, 1886 to Josephine Garis Cochran of Shelbyville, Illinois. She was wealthy, entertained often, and wanted a machine that could wash dishes quickly, and without breaking them. When she couldn't find one, she built it herself.

◆ How to Register a Patent

Each country, or sometimes a region has its own patent procedures. For example, in Europe, there is the European Patent Office; in the United States, the U.S. Patent and Trademark Office manages the patent process. Wherever you are, you have to design your product on paper or on a computer and specifically show why your design is different from others. On the left is one of the first drawings of the Coca Cola bottle, and on the right, is a copy of the patent design. You also need to check to see if someone else has already invented what you think you did! Try searching for a trademark at www.uspto.gov/patents.

Student Resource:
All About Viscosity

Viscosity is a measure of the resistance of a fluid. For fluids, viscosity can be thought of as the "thickness" or "internal friction" of the fluid. Thus, water is "thin," and has a lower viscosity, while oil is "thicker," and has a higher viscosity.

Some materials such as corn starch and flour can be added to water to increase its viscosity. By increasing viscosity, water will flow at a slower pace, which means it can possibly be controlled easier.

The word "viscosity" is derived from the Latin "viscum alba," which means white mistletoe. Apparently a highly viscous glue called birdlime was made from mistletoe berries.

Liquids with higher viscosities will not make such a splash when poured at the same velocity. If you dropped a sugar cube into water, it will splash more than if you dropped it into honey.

Another way to consider viscosity is to imagine you had a paper cup with a hole in the bottom. If you pour water into the cup, you can imagine how quickly the liquid would pass through the hole. Now consider how quickly honey might pour through the hole. In this example, honey would move much more slowly through the hole because its viscosity is large compared to other liquids' viscosities.

Viscosity can also be considered as a measure of a fluid's resistance to flow.

Student Worksheet:

◆ Engineering Teamwork and Planning
You are part of a team of engineers given the challenge of developing a writing instrument out of everyday materials that can deliver a controlled flow of ink (well, actually washable liquid water color). You'll consider the challenge as a team, read about how different pen styles have been engineered over the years, and come up with your own design. Hint: you may need to engineer your "ink" as well, to change its viscosity.

◆ Research Phase
Read the materials provided to you by your teacher. Consider how modern and older pen designs operate and think how you would develop your own working pen using the materials that have been provided to you.

◆ Planning and Design Phase
In the space below or on a separate piece of paper, draw a detailed diagram showing the plan for your pen, including the materials you plan to use.

Materials you will need:

Student Worksheet:

◆ **Presentation Phase**
Present your ideas, drawings, and plan for your pen to the class, and listen to the ideas the other teams have come up with.

◆ **Construction and Testing Phase**
Build your pen, and test it. You may need to adjust your design during this phase to reach your goal. You may also trade or use materials that other teams do not need….or ask your teacher for additional supplies. You should be able to write the letter "A" clearly on a piece of paper with your instrument.

◆ **Reflection**
Complete the reflection questions below and then share your experiences with the class:

1. How similar was your original pen design to the actual pen your team built?

2. If you found you needed to make changes during the construction phase, describe what happened that caused your design to adjust during manufacturing.

3. Which pen engineered by another team made was the most effective? What made this pen work the best?

4. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

5. If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

6. Did you change the viscosity of the fluid you used for your "ink?" If so, what did you do, and what impact do you think it had on how your team met the challenge?

7. Do you think your team could get a patent for you pen design? Why? Why not?

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- Properties of objects and materials

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understanding about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- History of science

For Teachers:
Alignment to Curriculum Frameworks

◆**National Science Education Standards Grades 9-12 (ages 14-18)**

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

◆**Next Generation Science Standards Grades 3-5 (Ages 8-11)**

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

◆**Next Generation Science Standards Grades 6-8 (Ages 11-14)**

Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

For Teachers:
Alignment to Curriculum Frameworks

◆Standards for Technological Literacy - All Ages

The Nature of Technology

- Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

- Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.