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Lesson Focus

Lesson focuses on computer and mechanical engineering and explores how computer mice operate and how engineering provided an interface between man and machine.

Lesson Synopsis

The EEEEEK - A Mouse! activity explores the concept of how engineering solved the problem of human/computer interface. Students disassemble a mouse and explore the movement on the X/Y axis that determines mouse positioning. Students explore design enhancements to the mouse over time, and as a team of "engineers" add further enhancements to current mouse design.

Age Levels

8-18.

Objectives

- ◆ Learn about computer/human interface and mouse engineering.
- ◆ Learn about ongoing changes to mouse design in response to software changes and human needs.
- ◆ Learn about teamwork and the engineering problem solving/design process.



Anticipated Learner Outcomes

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

- ◆ computer - human interface
- ◆ impact of engineering and technology on society
- ◆ engineering problem solving
- ◆ teamwork

Lesson Activities

Students learn about how the engineering behind the original development and ongoing design enhancement of the computer mouse have impacted everyday life. Topics examined include problem solving, teamwork, and the engineering design process. Students work in teams to disassemble a mouse, evaluate the design and operation of its component parts, recommend changes to improve functionality through redesign and/or material selection, build a model showing the enhanced mechanics or design, and present to class.

EEEEK - A Mouse!

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Resources/Materials

- ◆ Teacher Resource Documents (attached)
- ◆ Student Resource Sheets (attached)
- ◆ Student Worksheet (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ◆ TryEngineering (www.tryengineering.org)
- ◆ Mice: How do they work? (www.4qdtcc.com/meece.html)
- ◆ SRI International's Mouse History (www.sri.com/work/timeline-innovation/timeline.php?timeline=computing-digital#!&innovation=computer-mouse-interactive-computing)
- ◆ The First Computer Mouse (<https://web.stanford.edu/dept/SUL/library/extra4/sloan/MouseSite/Archive/patent/Mouse.html>)
- ◆ The Mouse Site (<https://web.stanford.edu/dept/SUL/library/extra4/sloan/MouseSite/1968Demo.html>)

Recommended Reading

- ◆ How Computers Work by Ron White and Timothy Edward Downs (ISBN: 0789736136)
- ◆ How Computers Work: Processor and Main Memory by Roger Young (ISBN: 1403325820)

Optional Writing Activities

- ◆ Write an essay or a paragraph describing how engineering has changed another product over time. Choose from the following products: television, toaster, light bulb, automobile transmission.

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For Teachers: Teacher Resource

◆ Lesson Goal

Explore how the computer mouse was developed and has evolved in design over time to bridge the human/computer interface. Students learn about engineering design, how mechanical engineering incorporates locations using X-Y coordinates, and how the mouse was developed taking the abilities and motion of the human hand into consideration. Student teams disassemble a mouse, evaluate the design and materials used, and develop or improve a specific mouse feature using words, drawings, and the construction of a simple model.

◆ Lesson Objectives

- ◆ Students learn about computer/human interface and mouse engineering.
- ◆ Students learn about ongoing changes to mouse design in response to software changes and human needs.
- ◆ Students learn about teamwork and the engineering problem solving/design process.

◆ Materials

- Student Resource Sheets
- Student Worksheets
- One set of materials for each group of students:
 - One roller ball mouse (many less than \$8)
 - Eyeglass Repair Kit or mini screwdriver (must be very small gauge)
 - Model construction materials: water based glue, scissors, tape, ruler, paper, toothpicks, straws, spools



◆ Material Option

Use an old roller ball mouse from your classroom or school computers in this lesson and replace with the new one!

◆ Procedure

1. Show students the various Student Reference Sheets. These may be read in class or provided as reading material for the prior night's homework. They may also be directed to bring in an old unusable mouse from home.
2. Divide students into groups of 3-4 students; provide one set of materials per group.
3. Ask students to complete the student worksheet. As part of the process, the students work in teams as "engineers" to design a new enhancement to the mouse. They plan, draw, and construct a model showing the new enhancement.
4. Each student group presents their vision and model for their new or improved feature of a computer mouse to the class.

◆ Time Needed

One to two 45 minute sessions.

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Student Resource: **Mouse Operation and Innovation**

The purpose of the computer mouse is to translate human motion (use of the hand) into messages or signals that the computer can translate into directions for moving the screen cursor or to open an application.

◆ **X - Y Navigation of the Track Ball Mouse**

Inside a standard track ball mouse is a round rubber ball that when moved adjusts the position of either one or two bars which send movement signals that are converted to computer messages telling computer software where to move a cursor on a computer screen. The "bars" usually have a wheel or "optical encoding disks" that usually include 36 holes or slots that allow light to pass. Small, infrared LEDs (light emitting diodes) point to the disk and the pattern or pulses of light that pass through the holes in the disk are converted to "X" and "Y" positions provide computer software with a sense of the distance and direction which the ball has moved. In this way the two dimensional motion of the mouse can be translated into the motion of a pointer within computer software. When you disassemble a track ball mouse in the student activity, you'll be able to see the two bars, and the optical encoding disks, and how the ball movement impacts these other mechanisms when rolled on a surface.

◆ **Click Click Click**

The mouse buttons make a "click" noise when pressed for two reasons....one, the pressing pushes on a "micro switch" that incorporates a very stiff piece of metal that snaps....two, the sound has been proven to improve the human/computer interface, giving the user an audible feedback that their finger has caused an action.

◆ **Engineered Improvements**

Over time, many new engineered improvements have taken the mouse to the next level, or been developed to address specific human needs. For example there are mice with oversized balls on top (instead of underneath) for easier use by very small children or people with physical challenges. There are "roller ball" mice which have additional wheels and switches to activate advance functions in software. There are fingerprint reader mice, which will only operate if the fingerprint of the user is accepted by the mouse as indicating an approved user. And most people now use wireless mice, which allow for greater freedom of movement, and also remote movement. There are "tactile" mice which vibrate when the user reaches a boundary or physical limit in gameware or software. Probably the most widely integrated recent change is the "optical" mouse which completely eliminated the tracking ball and instead projects a LED (light emitting diode) onto the tracking surface which bounces back and is picked up by a CMOS (complimentary metal-oxide semiconductor) sensor. It basically takes thousands of "pictures" each second and as the resulting patterns change it translates the changes into motion and speed patterns. Makes of "optical" mice claim that they will last longer because the bottom is sealed so dust and oils cannot enter the mouse, and there are fewer moving parts to break.

Student Worksheet:
Dissect a Mouse - Component Parts

Step One: As a team, disassemble either a new (inexpensive) or old unusable "track ball" mouse, using the materials provided to you. Be sure that the mouse is not connected to a computer and that no power is flowing through it. You will need to use a very small screwdriver, such as the type commonly found in eyeglass repair kits. Be careful as you pull the plastic cover off the mouse.



Step Two: Observe the mechanical parts that move when you move the roller ball. Also observe the two or three "switches" and see how they can click when the mouse case has been removed.

Questions:

1. How many component parts did you find? List and describe them.
2. What different types of materials (plastics, metals) were used in the construction of your mouse?
3. Based on what you examined, what is the weakest design aspect of the "track ball" mouse? Why? (This might be an attribute that would make it difficult with a physical disability to use, or a perceived limitation of the design, such as the cord is too short)
4. You are the inventors! How would you improve the design to eliminate or strengthen the part or operating feature you found in #3 above? Attach a drawing or sketch of your proposed component part, and answer the questions below:

What new materials will you need (if any)	What materials or parts will you eliminate (if any)	How will this new design address the shortcoming you identified?	How do you think your new design will impact the cost of this mouse? Why?

5. Develop a model of the new working part of the mouse using simple classroom materials (glue, scissors, tape, ruler, paper, toothpicks, straws, spools)
6. As a team, present your model and ideas to the class.

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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 E: Science and Technology

As a result of activities in grades K-4, all students should develop

- ◆ Abilities of technological design
- ◆ Understandings about science and technology

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 F: Science in Personal and Social Perspectives

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

- ◆ Risks and benefits
- ◆ 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

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

CONTENT STANDARD B: Physical Science

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

- ◆ Motions and forces
- ◆ Transfer of energy

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

- ◆ Risks and benefits
- ◆ Science and technology in society

CONTENT STANDARD G: History and Nature of Science

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

- ◆ Nature of science
- ◆ History of science

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For Teachers:

Alignment to Curriculum Frameworks

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

CONTENT STANDARD B: Physical Science

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

- ◆ Motions and forces
- ◆ Interactions of energy and matter

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

- ◆ Nature of scientific knowledge
- ◆ Historical perspectives

◆ Standards for Technological Literacy - All Ages

The Nature of Technology

- ◆ Standard 1: Students will develop an understanding of the characteristics and scope of technology.
- ◆ Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society

- ◆ Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- ◆ 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 8: Students will develop an understanding of the attributes of 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 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.

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