EEEEK- A Mouse!

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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 EEEEK - 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.

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.4qdtec.com/meece.html)
- SRI International's Mouse History (www.sri.com/about/timeline/mouse.html)
- The First Computer Mouse (http://sloan.stanford.edu/MouseSite/Archive/patent/Mouse.html)
- The Mouse Site (http://sloan.stanford.edu/MouseSite/1968Demo.html)
- ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- National Science Education Standards (www.nsta.org/publications/nses.aspx)

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.

EEEEK- A Mouse

For Teachers:
Teacher Resources

◆ **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!

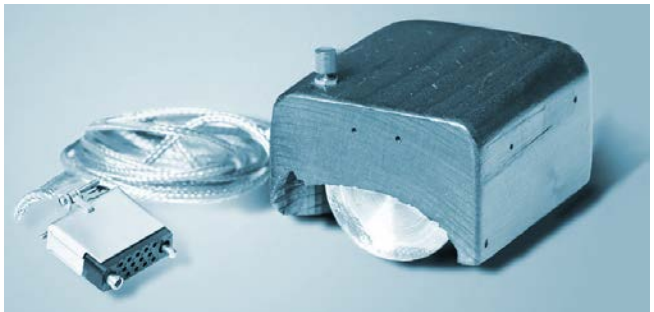
◆ **Procedure**

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.

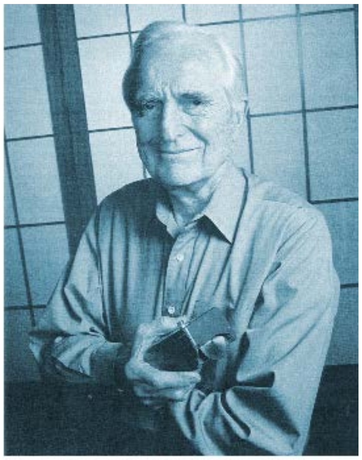
◆ **Time Needed**

One to two 45 minute sessions.

Student Resource: The First Mouse


First computer mouse prototype.
Courtesy of SRI International, Menlo Park, CA

Dr. Douglas C. Engelbart and his team at SRI International created many of the concepts and tools that set the global computer revolution in motion. The first computer mouse was one of many breakthrough innovations originating at SRI. Doug Engelbart conceived of the mouse in the early 1960s while exploring the interactions between humans and computers. Bill English, then the chief engineer at SRI, built the first prototype in 1964. The first computer mouse was based on a carved block of wood with a single red button. Designs with multiple buttons followed soon. A single wheel or a pair of wheels was used to translate the motion of the mouse into cursor movement on the screen. Doug Engelbart was the inventor on the basic patent for what was then called the "X-Y Position Indicator for a Display System." For Doug, the mouse was one part of a much larger technological system whose purpose was to facilitate organizational learning and global online collaboration.


Doug Engelbart developed the mouse in the early 1960s.
Courtesy of SRI International, Menlo Park, CA

When Doug Engelbart was a graduate student in electrical engineering, he began to imagine ways in which all sorts of information could be displayed on the screens of cathode ray tubes, and he dreamed of "flying" through a variety of information spaces. In early 1959, he pursued his visionary ideas further into the formulation of a theoretical framework for the co-evolution of human skills, knowledge, and organizations. At the heart of his vision was the computer as an extension of human communication capabilities and a resource for the augmentation of human intellect.

By 1968, Doug Engelbart had formed and was directing SRI's Augmentation Research Center. With this group of young computer scientists and electrical engineers, he staged a 90-minute public multimedia demonstration at the Fall Joint Computer Conference in San Francisco. It was the world debut of personal computing when a computer mouse controlled a networked computer system to demonstrate hypertext linking, real-time text editing, multiple windows with flexible view control, cathode display tubes, and shared-screen teleconferencing. Video clips of the demonstration are available at http://sloan.stanford.edu/MouseSite/1968Demo.html.

In 2000, Doug Engelbart was awarded the National Medal of Technology -- the United State's highest technology honor -- recognizing innovators who have made lasting contributions to enhancing America's competitiveness and standard of living and whose solid science has resulted in commercially successful products and services.

(Courtesy of SRI International, Menlo Park, CA)

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 curser 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 curser 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. There are "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.

EEEEK- A Mouse

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.

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

For Teachers: Alignment to Curriculum Frameworks (continued)

◆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

◆Next Generation Science Standards – Grades 2-5 (Ages 7-11)

Matter and its Interactions

- 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

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.

◆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 (continued)

◆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.