# Computer Mouse

Designers in the computer industry seek not only to "build the better mousetrap" but to build the best mouse. The computer mouse is an accessory to the personal computer that has become an essential part of operation of the computer. The small device fits neatly in the curve of the user's hand and enables the user, through very limited movements of the hand and fingers to "point and click" instructions to the computer. A rolling ball on the underside of the mouse gives directions on where to move to the cursor (pointer) on the monitor or screen, and one to three buttons (depending on design) allow the user to say yes by clicking the buttons on the right instruction for the computer's next operation.

**History**

Dr. Douglas Engelbart, a professor with the Stanford Research Institute in Menlo Park, California, developed the first device that came to be known as the mouse in 1964. At that time, the arrow keys on the keyboard were the only way of moving the cursor around on a computer screen, and the keys were inefficient and awkward. Dr. Engelbart made a small, brick-like mechanism with one button on top and two wheels on the underside. The two wheels detected horizontal and vertical movement, and the unit was somewhat difficult to maneuver. The unit was linked to the computer by a cable so the motion signals could be electrically transmitted to the computer for viewing on the monitor. One of Dr. Engelbart's co-workers thought the device with its long cable tail looked something like a mouse, and the name stuck.

Other scientists, notably those at the National Aeronautics and Space Administration (NASA), had also been seeking methods of moving cursors and pointing to objects on the computer screen. They tried steering wheels, knee switches, and light pens, but, in tests of these devices versus Engelbart's mouse, it was the mouse that roared. NASA's engineers were concerned, however, about the spacewalks the mouse would take from its work surface in the weightlessness of space.

By 1973, the wheels on the mouse's undercarriage had been replaced by a single, free-rolling ball; and two more buttons (for a total of three) had been added to the top. The creature was called both a mouse and a pointing device, and Xerox combined it with its Alto computer, one of the first personal computers. The Alto had a graphical user interface (GUI); that is, the user pointed to icons, or picture symbols, and lists of operations called menus and clicked on them to cause the computer to open a file, print, and perform other functions. This method of operating the computer was later adapted by Macintosh and Windows operating systems.

The development of the personal computer stimulated an explosion of applications for the device that was small enough to be used at a number of work stations. Engineers could develop computer-aided designs at their own desks, and the mouse was perfect for drawing and drafting. The mouse also began to generate offspring, collectively called input/output devices, such as the trackball, which is essentially a mouse lying on its back so the user can roll the ball instead of moving the entire unit over a surface. The military, air traffic controllers, and video game players now had a pet of their own. Mechanical sensors in both types of devices were replaced by optical-electronic sensor systems patented by Mouse Systems; these were more efficient and lower in cost. An optical mouse with no moving parts was developed for use on a special mouse pad with grid lines; light from inside the mouse illuminates the grid, a photodetector counts the number and orientation of the grid lines crossed, and the directional data are translated into cursor movements on screen.

The mouse began to multiply rapidly. Apple Computers introduced the Macintosh in 1984, and its operating system used a mouse. Other operating systems like Commodore's Amiga, Microsoft Windows, Visicorp's Vision, and many more incorporated graphical user interfaces and mice. Improvements were added to make sensors less prone to collecting dust, to make scrolling easier through an added wheel on the top, and to make the mouse cordless by using radio-frequency signals (borrowed from garage door openers) or infrared signals (adapted from television or remote controls).

**Mouse Anatomy**

***Body***

The mouse's "skin" is the outer, hard plastic body that the user guides across a flat surface. It's "tail" is the electrical cable leading out of one end of the mouse and finishing at the connection with the Central Processing Unit (CPU). At the tail end, one to three buttons are the external contacts to small electrical switches. The press of a button closes the switch with a click; electrically, the circuit is closed, and the computer has received a command.

On the underside of the mouse, a plastic hatch fits over a rubberized ball, exposing part of the ball. Inside, the ball is held in place by a support wheel and two shafts. As the ball rolls on a surface, one shaft turns with horizontal motion and the second responds to vertical motion. At one end of each of the two shafts, a spoked wheel also turns. As these spokes rotate, infrared light signals from a light-emitting diode (LED) flicker through the spokes and are intercepted by a light detector. The dark and light are translated by phototransistors into electrical pulses that go to the interface integrated circuit (IC) in the mouse. The pulses tell the IC that the ball has tracked left-right and up-down, and the IC instructs the cursor to move accordingly on the screen.

The interface integrated circuit is mounted on the printed circuit board (PCB) that is the skeleton to which all the internal workings of the mouse are attached. The integrated circuit, or computer chip, collects the information from the switches and the signals from the phototransistors and sends a data stream to the computer.

***Brain***

Each mouse design also has its own software called a driver. The driver is an external brain that enables the computer to understand the mouse's signals. The driver tells the computer how to interpret the mouse's IC data stream including speed, direction, and clicked commands. Some mouse drivers allow the user to assign specific actions to the buttons and to adjust the mouse's resolution (the relative distances the mouse and the cursor travel). Mice that are purchased as part of computer packages have the drivers built in or preprogrammed in the computers.

**Raw Materials**

The mouse's outer shell and most of its internal mechanical parts, including the shafts and spoked wheels, are made of acrylonitrile butadiene styrene (ABS) plastic that is injection-molded. The ball is metal that is coated in rubber; it is made by a specialty supplier. The electrical micro-switches (made of plastic and metal) are also off-the-shelf items supplied by subcontractors although mouse designers can specify force requirements for the switches to make them easier or firmer to click. Integrated circuits or chips can be standard items, although each manufacturer may have proprietary chips made for use in its complete line of products. Electrical cables and overmolds (end connectors) are also supplied by outside sources.

The printed circuit board (PCB) on which the electrical and mechanical components are mounted is custom-made to suit the mouse design. It is a flat, resin-coated sheet. Electrical resistors, capacitors, oscillators, integrated circuits (ICs), and other components are made of various types of metal, plastic, and silicon.

**Design**

Design of a new mouse begins with meetings among a product development manager, designer, marketing representative, and consulting ergonomist (a specialist in human motion and the effects various movements have on body parts). A list of human factors guidelines is developed specifying size range of hands, touch sensitivity, amount of work, support of the hand in a neutral position, the user's posture while operating the mouse, finger extension required to reach the buttons, use by both left- and right-handed individuals, no prolonged static electricity, and other comfort and safety requirements; these can differ widely, depending on whether the mouse is to be used in offices or with home computers, for example. A design brief for the proposed mouse is written to describe the purpose of the product and what it achieves; a look is also proposed in keeping with the anticipated market.

The design team returns to the table with foam models; scores of different shapes may be made for a single mouse design. User testing is done on these models; the engineers may do this preliminary testing themselves, or they may employ focus groups as typical users or observe one-on-one testing with sample users. When the selection of models is narrowed down, wooden models that are more refined and are painted are made of the winning designs. Input is gathered again on the feel, shape, and look of the models; the ergonomist also reviews the likely designs and confirms that the human factors guidelines have been achieved.

When the optimal model is chosen, the engineering team begins to design the internal components. A three-dimensional rendering is computer-generated, and the same data are used to machine-cut the shapes of the exterior shell with all its details. The mechanical and electronics engineers fit the printed circuit board (and its electronics) and the encoder mechanism (the ball, shafts, wheels and LED source and detector) inside the structure. The process of fitting the workings to the shell is iterative; changes are made, and the design-and-fit process is repeated until the mouse meets its design objectives and the design team is pleased with the results. Custom chips are designed, produced on a trial basis, and tested; custom electronics will help the design meet performance objectives and give it unique, competitive, and marketable characteristics.

The completed design diagrams are turned over to the project tooler who begins the process of modifying machines to produce the mouse. Tooling diagrams are generated for injection-molding the shell, for example. The size, shape, volume of the cavity, the number of gates through which the plastic will be injected into the mold, and the flow of the plastic through the mold are all diagramed and studied. After the final tooling plan is reviewed, tools are cut using the computer-generated data. Sample plastic shells are made as "try shots" to examine actual flow lines and confirm that voids aren't induced. Changes are made until the process is perfect. Texture is added to the external appearance of the shell by acid etching or by sand blasting.

In the meantime, the engineering team has set up the assembly line for the new mouse design and conducted trial assemblies. When the design details are finalized, tools have been produced, and test results have met the design team's objectives and standards, the mouse is ready for mass production.