The Best Laid Plans of Mice and Men: The Computer Mouse in the History of Computing

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It could be argued that the history of the computer mouse has already been written. It is true that a number of computer magazine articles and sections of books on computer history, along with online archives and Web encyclopedia entries, have described in some detail how the mouse we know today came into existence. However, these writings by and large have described the design, development, and production of the mouse without really assessing the extent to which it has affected our relationship with computing technology. The history of the mouse raises a number of interesting questions: Why did it take so long to become a mass-produced item? How did people react to the introduction of the mouse? What did the mouse represent, and what does it represent today? How and why did it become the single most accepted interface technology?

There is no denying that the computer mouse is a phenomenally successful product in its own right—a success which can be measured by how "natural" a product it has become as an everyday object. The mouse is so familiar these days that it disappears from our observational and analytical "radars" to become an object people do not stop to consider. Yet despite its success, few people are aware of the mouse's history, of how it was first conceived and then appropriated by the computer industry, or the ways in which it has been used, intentionally and unintentionally, to shape our social and technological worlds.

This article attempts to redress this imbalance through a retelling of the story of the computer mouse: its invention in the early 1960s and its consequent development through work at Xerox and Apple before its "public" release with the Apple Macintosh in 1984; the context of its original application, and its later acceptance by the personal computer industry. It is argued that this wholesale acceptance cannot be totally explained by the "ease of use" provided by the computer mouse. Particularly in the context of the workplace, there were other, less obvious but highly significant, socio-political factors at play. The focus here is on the dichotomy between the intentions of its inventors and designers, and its consumption by others as an artifact, as a symbol, and as an agent of change. In doing so, this article hopefully adds to the debates between technological

Figure 1
Engelbart and English's first mouse, circa 1963. Courtesy the Bootstrap Institute.

determinism and the social construction of technology, and to our understanding of the ways in which technological devices can shape their social and technological environments.

The Computer Mouse as an Artifact

Douglas C. Engelbart first came up with the concept of the device that would become known as the mouse as a student, basing the principle on that of a piece of equipment being used to measure the area of a two-dimensional chart. The idea sat in his notebook for a number of years while he pursued his career. A former WWII naval radar technician, Engelbart earned a Ph.D. in electrical engineering at the University of California, and then applied for a post as a researcher at the Stanford Research Institute in 1957. There, he tried for a number of years to get people interested in supporting research into interactive computer use, but was unsuccessful largely because what he was predicting about computer use at the time seemed like "proposing that everyone would soon have his own private helicopter."[1] Then, while watching operators trying to interact with graphics on computers, he realized that a number of different devices were being used to select objects on screen, and thought it would be interesting to test which device worked the best. He wrote a project proposal and received a grant from NASA in 1963 to experiment with "light pens, tracking balls, and other kinds of gadgets."[2] During one experiment, "the subject would sit there poised and ready and, at some arbitrary time, the computer would put up in an arbitrary place an arbitrary size three by three array of objects, and he had to hit the space bar, access the device, and click on the objects. The computer would keep track of the time it took to respond, and the accuracy and all that information."[3] During these experiments, Engelbart recalled his student days when there was a requirement to try and calculate the area of an irregular shape created by plotted points on a chart. This was achieved through the use of a mechanical device called a planimeter, which used a pantograph-style arrangement of arms attached to wheels in order to measure movement in the x and y planes. Engelbart realized that a smaller, simpler device could achieve the same result by using two fixed wheels at right angles to each other. Measurements could be taken along one axis by rolling one of the wheels across the surface, and dragging the other wheel at right angles to it without it moving. Measurement of the other axis could be achieved by reversing the relative movements of the wheels. This information, he realized, if sent to a computer, could calculate the two-dimensional area. As an added advantage, it also could be used to show the position of a cursor on a computer screen.

Based on Engelbart's notes, his colleague Bill English created the original prototype of this device—a fairly large, hand-held wooden box with a single button, and wheels attached to internal potentiometers (Figure 1). This prototype then became one of the

1 Interview with Doug Engelbart at the headquarters of Logitech Inc., Fremont, California, April 10, 2006.

2 Ibid. Engelbart's experience with radar in WWII led him to believe that the light pen was the potential device to enable interaction with a computer network. "I knew implicitly, and with surety, that if a computer could punch cards, that it could also electronically display text and draw on a CRT. And if radar attached to a CRT could respond to operators, then people could also interact with a computer that had a CRT. I could see electronically that, if other people were connected to the same computer complex, we could be collaborating." (Logitech Inc., *Douglas C. Engelbart: A Profile of His Work and Vision: Past, Present and Future,* Oct. 2005 [unpublished report]).

3 Ibid.

Figure 2
The Augment System Interface, 1968.
Courtesy of the Bootstrap Institute,

devices in the selection experiments, "and it just happened to win everything." [4] After a few months of leaving all of the various input devices attached to the workstation so that users could choose the device they wanted to work with, it became clear that everyone chose to use the "mouse," and the other devices were abandoned.[5] Engelbart states that: "I didn't give it a name when I was doing all these experiments. I didn't call it a 'mouse.' It was so successful we were sure it would go to the rest of the world, and they'd give it a dignified name. We referred to it as the XY positioning indicator or something." [6] Apparently, the device acquired its nickname early on, when somebody (and no one can remember who) seeing this prototype in action said, "It looks like a one-eared mouse!" [7]

The Augment System

Over time, the history of the computer mouse has become inextricably entwined with the development of the Graphical User Interface or GUI—the control of computer operations through the use of "icons" rather than textual commands. Yet, as described above, the mouse has its own distinct origins and purpose, predating the emergence of the GUI by a decade. The initial application of the mouse (other than in the selection experiments) was as one element of a more complex computer interface system designed for use with a text-based operating system—not an icon-driven one. Doug Engelbart designed this system as part of a large-scale, long-term, visionary project to enable humans to get the most benefit from computing technology. He named this project the "Augmentation of Human Intellect," [8] and as part of this work, Engelbart created the interactive "On-Line System" (NLS) [9] to manipulate computer files and allow on-screen editing of text. This prototype system, which became known as the "Augment" system (Figure 2), used a three-button mouse, a standard "qwerty" keyboard, and a chordset—an input device having five piano-like keys.[10] Engelbart first publicly demonstrated Augment in December 1968 at the Fall Joint Computer Conference, simultaneously in Menlo Park, California and in San Francisco. "In the course of 90 minutes, they displayed a remote network, shared-screen collaboration, video conferencing, hypertext, interactive text editing, and the computer mouse." [11]

The Augment team received a standing ovation. It is difficult today to imagine how significant this demonstration was:

> In technology circles, the demonstration has come to be known as the "Mother of All Demos." Most believe the event set in motion an era of innovation around personal computing and inspired a generation of technology innovators. For Engelbart, the demo represented a paradigm shift: For the first time, the world perceived that the computer could be used as more than simply an administrative tool.[12]

4 Ibid.
5 Logitech Inc., *The Computer Mouse: Adapting Computers to Human Needs: The Evolution of Computer Pointing Devices*, Aug. 1993 (unpublished report).
6 Interview with Doug Engelbart, April 10, 2006.
7 D. Engelbart, quoted in B. Moggridge, *Designing Interactions* (Cambridge, MA: MIT Press, 2006), 15.
8 Engelbart's paper "Augmenting the Human Intellect: A Conceptual Framework" was published in 1962. In this, Engelbart refers to a "pointer" that would allow the knowledge worker to navigate through items on the screen.
9 It was called "NLS" rather than "OLS," because that already was used to indicate an "Off Line System." When the NLS was taken into the commercial world, it was renamed "Augment."
10 In a way similar to a stenographer using a stenotype, a five-key chordset device can recreate any alpha-numerical character by different combinations of the five keys. According to Wikipedia, "Researchers at IBM investigated chord keyboards for both typewriters and computer data entry as early as 1959" (http://en.wikipedia.org/wiki/Chord_keyset, accessed Sept. 20, 2006).
11 Logitech Inc., *Douglas C. Engelbart: A Profile of His Work and Vision: Past, Present and Future.*
12 Ibid.

Figure 3
Doug Engelbart using a Chordset and mouse interface. Photo by the author.

It was felt that Engelbart had shown the future of human/computer interaction. Personally, he still uses this system today (Figure 3), and complains about its lack of adoption by the computer industry. Despite his best-laid plans, the success of the mouse is tarnished for Engelbart by the lack of commercial success for the Augment system. If only people would accept the commitment involved in becoming familiar with what he admits is a complicated system to learn, he believes we could achieve much higher levels of efficiency in interacting with computers. Stuart Card, the Xerox Palo Alto Research Center scientist who did a lot of ergonomic testing of computer mice, agrees:

> The Engelbart system is the "verb first" system, because you do the action first, then the selection, and you can do the scoping in the action, so if you want to delete a word, you would say "delete word here" and then whatever you point to it would take it to the scope of the word. In the system that we have now that went into Small Talk and later things, you do the scoping with the mouse, so in the Mac, you double click it and get a word .... There are other ways of doing it, [but] the complexity has got to be somewhere .... In the Engelbartian system, you do your commands [with the chordset] and you do your selection [with the mouse] and then you bring your hands over the keyboard and do what you have to do. This means that that the user looks like this giant bird flapping back and forth, and it takes four hands to operate it! ... In Word today, you would do a command [like] "hold down mouse," that is, of course, very slow and requires visual attention. Nobody has been able to go more than half the speed that you could with an Engelbart interface. When they would do a demo, they were worthless because everybody would stand around and watch them do an edit, and there was this flash and it would all be done. You would never get to see what they actually did, so the only way I could see what they actually did was to video tape it and play it back in slow motion because it was so fast. So if you had a system like Engelbart's which ran at something like the power of my pocket calculator, you could do your editing twice as fast as you do now. [13]

The problem is that teaching people to use a mouse as a pointing device is one thing, but teaching them how to input a large number of shortcut commands using a chordset is quite another.[14] And as icon-driven interfaces became the norm, the need primarily was for a pointing device rather than a chordset.

13 Interview with Stuart Card at Palo Alto Research Center, Palo Alto, California, April 10, 2006.

14 Larry Tesler, cited in M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age* (Orion Business Books, 2000), 203, recalls trying to convince Xerox colleagues that the Engelbart system was too complicated, and that it was not realistic to expect people to train for six months to become literate with it.

Figure 4
The Xerox Star Computer, 1981.
Photo courtesy of Palo Alto Research Center, Inc.

Mouse Development at Xerox PARC

It was during the research work into computing at Xerox's Palo Alto Research Center (PARC) in the early 1970s that the mouse became associated with the Graphical User Interface (GUI). First of all, through an experimental high-end computer system called the "Alto" designed in 1972, and later through the "Star" computer released in 1981 (Figure 4). Bill English, who left the Stanford Research Institute to join Xerox in 1971, was project manager on POLOS—the "PARC On-Line Office System," which was his "attempt to reproduce the Engelbart system on a large network of commercial minicomputers." [15] In continuing his development of the mouse, English worked with Jack Hawley, developing a version which replaced the two wheels of his first mouse prototype with a single steel ball, which actuated two internal encoders in order to measure movement in each plane. It was with a Xerox Alto computer and a software program called "Gypsy" in 1975 that the mouse was first used ..."as it is today, to execute point-and-click operations, Engelbart's system and Bravo [an early Xerox word processing program] both used it simply to position the cursor within a block of text." [16]

These radical computers, with their handbuilt mice, were in no way a financial success, and only a hundred or so Altos were sold. The first graphical interfaces worked so slowly that, when demonstrating them, software engineer Larry Tesler "had to record it on videotape at one-ninth normal speed, so it would appear natural when played back in real time." [17] They also were extremely expensive. The Star computer had a retail price of $16,595, and only made economical sense as part of a system which "required two to ten workstations, plus a high-speed laser printer and Ethernet to link it all together. That raised the per-user cost to at least $30,000, and the price of a whole, integrated system to a quarter of a million dollars or more." [18] However, these computers were highly influential in persuading Microsoft (via a former Xerox employee, Charles Simonyi) to develop a mouse to use with Microsoft Word for the text-based IBM PC; and also in influencing Apple in the development of in their GUI operating system. This work, in turn, led first to the overpriced, slow, and consequently unsuccessful Apple Lisa in 1983; and then to the highly successful Apple Macintosh in 1984 (Figure 5).

15 M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age* (Orion Business Books, 2000), 166.
16 Ibid., 210.
17 Ibid., 209.
18 Ibid., 366.

Figure 5
The Apple Lisa (1983) and Apple Macintosh (1984). Courtesy of Apple.

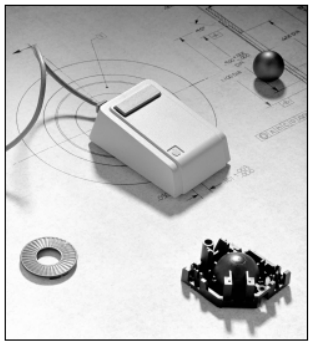


Figure 6
The Apple Lisa Mouse, showing the injection-molded "ribcage," 1983. Photo courtesy of IDEO.

The Move to Production

Before the launch of the Apple Lisa, computer mice were inherently unreliable and incredibly expensive pieces of equipment. Due to their physical and technical complexity, a mouse cost between $350 and $400 to produce. While the Xerox mice were important in terms of the research they embodied, and represented the latest thinking in mouse technology, they in no way were suitable for mass production. The interior steel ball was held in place in a precision-machined metal gimbal assembly that had to be precisely aligned with internal rollers and springs in order to work properly. In use, the mouse collected dirt and debris from the work surface, which affected its performance, and it had to be disassembled to enable it to be cleaned.

The design work that changed that position was carried out by Dean Hovey, Jim Sachs, Jim Yurchenco, and Rickson Sun as part of the Hovey-Kelly design team working on the first mouse for what was to become the Apple Lisa computer.[19] This work, it has been suggested, was probably the most important in the history of the mouse:

> Apple's mouse actually was to its predecessors what the DC-3 was to the Wright Brother's Flyer: not the first of its kind, but the breakthrough in technology and design that made possible a breakthrough in commercialization. Apple moved the mouse from the laboratory to the living room.[20]

Rickson Sun remembers Apple's Steve Jobs approaching them with a Xerox mouse saying: "Hey, what can you do to help me with this? I can't sell these for $350, but for $15 I could sell a ton of these."[21] Steve Jobs wanted a ninety percent reduction in cost and a dramatic improvement in the reliability of the mouse. Starting in many ways from scratch by making a block model from a plastic butter dish and the ball from a roll-on deodorant bottle, the team solved a lot of the engineering problems of reliability and assembly by replacing the load-bearing steel ball of Bill English's Xerox mouse with a "floating" lead ball covered in rubber, and by developing a precision injection-molded "ribcage" which located and held all of the important internal mechanical components in the correct relationship to each other. These improvements turned the production of the mouse from an expensive, skilled-assembly job into a cheap, snap-together process (Figure 6). Jim Yurchenco, who did the mechanical engineering of the Apple mouse, recalls:

> The first ones they made were costing just under $20 to manufacture, so that was a major drop from the $350–$400 it originally cost to make. Now, of course, you can make a mechanical mouse for $2![22]

19 A detailed description of this work can be seen in the form of primary documentation in the online archive from Stanford University, "Making the Macintosh, Technology and Culture in Silicon Valley" (http://library.stanford.edu/mac/, accessed Aug. 1, 2006).

20 A. S. Pang, "The Making of the Mouse" in *American Heritage of Invention and Technology* 17:3 (Winter 2002), 49.

21 Rickson Sun, interview with Dennis Boyle, Jim Yurchenco, and Rickson Sun at the offices of IDEO, Palo Alto, California, April 7, 2006.

22 Jim Yurchenco, Ibid.

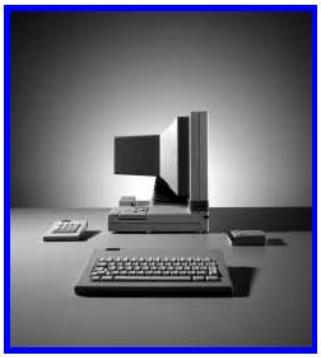


Figure 7
Metaphor Computer, circa 1984. Photo by Rick English, courtesy of IDEO.

Ergonomic Improvements

Looking at the physical development of the computer mouse, it is clear that ergonomics played a limited role in the creation of the earliest mice. The styling of the Alto and Star mice, the early Apple mice designed by Hovey-Kelly, and the first cordless, infrared mouse designed for the Metaphor computer of 1984 (Figure 7), more closely reflected the form and material finish of the computers to which they belonged, rather than being purely informed by user requirements. Logitech's first mouse attempted to break the box-shape norm. Their 1982 "P-4," designed for IBM PCs, was hemispherical in shape, but ergonomically did not work well.[23] Pushing the buttons on the front moved the mouse backwards, and Logitech quickly followed others with rectilinear wedge-shaped forms. Designed forms based on the ergonomics of sanding blocks had been rejected by Apple in favor of more rectilinear forms reflecting the lines of the Lisa and Macintosh computers. Even the first Microsoft mouse, apparently closely based on a lump of clay modeled to fit the hand, was box-like in comparison to the organic forms of today's mice.

A significant move forward in the industrial design and ergonomics of the mouse came through the work of IDEO's Paul Bradley (then of Matrix Design) on the third generation of the Microsoft mouse in 1987. Bradley recalls: "Mike Cooper, the program manager from Microsoft, came to us to basically reinvent the mouse—to design the best mouse in the world and do whatever it took to make that happen.... I think the only real constraint was to do this in a very short time frame—seven months to get it to market."[24] The design project started in a typical fashion, with a number of prototypes made to test with potential users, "looking at exploring the extremes [of] how small can it be, and how large could it be, and which of those is more desirable."[25] "We built about eighty foam models, quickly exploring different possibilities and directions."[26] An extensive series of ergonomic tests were devised by the interaction designer and ex-Xerox employee, Bill Verplank, to assess the prototypes. These included maze tests, point-and-click tests, and handwriting tests, and were analyzed by IDEO's human factors specialist Jane Fulton Suri. Like some of the concepts produced for Apple by Hovey-Kelly, the form finally selected for this mouse (Figure 8) was closely based on a sanding block in order to get the hand-feel right, and also included major changes to the size and shape of the two buttons.[27] These became much larger, and were built into the body of the mouse, stretching right across the front surface, and were gently indented. The left-hand button was larger than the right, since this was the "primary" button, with a small ridge added to its right-hand edge to let users feel the boundary between the buttons. The most important change, however, was a seemingly simple but fundamental one, making the mouse even more accurate to control and comfortable to use. The ball inside the mouse which rubbed against rollers to measure movement had always been placed

23 The first Logitech mouse was based on the hemispherical "Depraz" mouse developed by Professor Jean-Daniel Nicoud at LAMI (*LAboratoire de Micro-Informatique*) in Switzerland, but was technically complicated as well as ergonomically flawed. A more recent example of a circular form in mouse design (and one as ergonomically bad as the Depraz mouse) was the original mouse for the Apple iMac, designed by Jonathan Ive in 1998. *ABC News* commented "The two-tone design looks nice, but Apple has reportedly received dozens of complaints about the discomfort of using it...A quick search of newsgroup postings turned up over 500 posts dealing with the mouse, most complaining about its poor design" (*ABC News*, "The Rodent Revolution" at: www.crews.org/curriculum/ex/compsci/7thgrade/intel/mouse-revol.htm, accessed Sept. 21, 2006).

24 Interview with Paul Bradley at the offices of IDEO, Palo Alto, California, April 7, 2006.

25 Ibid.

26 Paul Bradley, quoted in Bill Moggridge, *Designing Interactions* (Cambridge, MA: MIT Press, 2006), 45.

27 Microsoft mice always had two buttons, while Apple went for the simplicity of one button. The decision to go with one button was a lengthy one since it meant designing the operating system software differently. Eventually, according to Jim Yurchenco, the decision to go with one button was made so that the instruction manual would be easier to write.

Figure 8.
The third-generation Microsoft mouse with development models, 1987. Photo by Rick English, courtesy of IDEO.

at the back of the device due to the amount of space required at the front for switches, etc. The user trials during Paul Bradley's redesign surprised the team when they proved that very small mice moved by the fingers alone performed poorly, despite the team's presumptions that they would be more accurate. However, prototypes of a normal-sized mouse, with the ball under the fingers at the front, proved to be a lot more accurate. There was a cost for this when it came to a production version—the internal circuit board bearing the switches and electronics had to be split into two; one at the front and one at the back of the mouse; in order to create the necessary internal space and allow the ergonomics of the form to take precedence. This allowed the rolling ball to be moved from the back to the front of the mouse, placing it much closer to the fingers rather than the palm of the hand, and improving the accuracy and dexterity of the user, which "gave a better performing mouse." [28]

The ergonomics of this form of mouse have remained basically unchanged to today, despite technological developments adding scroll wheels, extra buttons for navigating the Internet, and even the removal of the ball altogether with the introduction of affordable, optical laser mice.

The Computer Mouse as a Symbol

The Apple Macintosh was launched in January 1984 with a now famous advertisement by Ridley Scott.[29] This was when—twenty-one years after its conception—the computer mouse first entered the public consciousness. But it took the public some time to become accustomed to such an unusual object.

The first manuals for the Macintosh devoted entire sections on how to use the new device, reassuring users that they would soon get used to it, stating: "Using the mouse might feel a little awkward at first, but it will soon be second nature." [30] To convince users of the simplicity of the mouse, some of the first brochures for the Mac used the slogan: "If you can point, you can use a Macintosh." Many "third-party" books were written as instruction manuals for the Apple Macintosh, and these also tried to convince Mac owners of the benefits of using a mouse: "If you're like most people, you're probably muttering one (or more) of the following complaints about mice: 'Mice are stupid; they slow things down'; 'My desk is too small and crowded to make room for a mouse'; and 'You have to take your hand off the keyboard to use the mouse.' A fair warning: Don't be quick to condemn the Mac's mouse before you've tried it—*really* tried it." [31] Another stated: "There has been a lot of negative reaction to the use of a mouse as a pointing device; most of it is unwarranted...The typical user is able to manipulate the mouse for most functions after a very short time...However... users do need some practice at becoming fast with a mouse. Like riding a bicycle, once users have become skilled at mouse movement, it is a skill they do not forget." [32] Microsoft launched a mouse

28 Interview with Paul Bradley at the offices of IDEO, Palo Alto, California, April 7, 2006.

29 The story of the Apple Macintosh advertisement is told in many places. One of the best descriptions appears in Steven Levy's *Insanely Great: The Life and Times of Macintosh, the Computer that Changed Everything* (Penguin Books, 1994), 169–171. The advertisement can be viewed at: www.youtube.com/watch?v=0YecfV3ubP8 (accessed Sept. 28, 2006).

30 Apple Computer Inc., *Macintosh Manual* (1984), 13.

31 G. McComb, *Macintosh User's Guide* (Howard Sams & Co., 1984), 32–33.

32 J. Martin, et al., *A Breakthrough in Making Computers Friendly—The Macintosh Computer* (Prentice Hall Inc., 1985), 10–12.

to use with the IBM PC in 1983, and to help people become familiar with using mice, included "Notepad," a mouse-based text editor, "Piano," an on-screen piano keyboard that could be "played" with the mouse, and later a simple mouse-operated drawing program called "Doodle" in the software package. An article in *PC Magazine* in 1987 reckoned that mice were "by far the most common alternate input device," [33] being attached to between eight and ten percent of all PCs (not Macintoshes). By the following year, the figure was still ten-percent,[34] which is not so surprising when one considers that, at the time, relatively few pieces of PC software were written to be used with a mouse, and that the expected practice was for users to make their own mouse menus for programs using software provided by the mouse's manufacturer. In 1988, three years after the launch of "Windows" software for PCs, International Data Corporation issued a report which stated that: "Windows and mice apparently haven't caught on with IBM-compatible users." [35] Well into the 1990s, tutorials and games designed to train people to use mice still were included in software from both Apple and Microsoft and, even by 1992, the whole first chapter of Apple's "Macintosh User's Guide" was entitled: "Using the Mouse."

33 Anon, "Mice for Mainstream Applications" in *PC Magazine* (Aug. 1987).

34 T. Stanton, "From Our Maus to Baumaus: Logitech vs. Microsoft" in *PC Magazine* (Feb. 16, 1988): 202. This, too, was in a section called "Alternate Input Devices," indicating that the mouse was in no way the preferred primary input method at this point.

35 Cited in Logitech Inc., *The Computer Mouse: Adapting Computers to Human Needs: The Evolution of Computer Pointing Devices*, Aug.1993 (unpublished report).

The Mouse in Popular Culture

The widespread success of the Macintosh and the novelty of the mouse as an input device made the mouse an instantly recognizable object, to the extent that it very soon began to make an appearance in popular culture. The film *Star Trek IV: The Voyage Home* released less than two years after the appearance of the Macintosh, contains a scene in which the engineer Scotty, transported back in time to Earth in 1986, attempts to command a computer by talking to it (Figure 9). When told to use the mouse, he picks it up and tries to use it as a microphone. During the two decades since *Star Trek IV,* the mouse appeared in advertising and popular culture to a greater and greater extent.

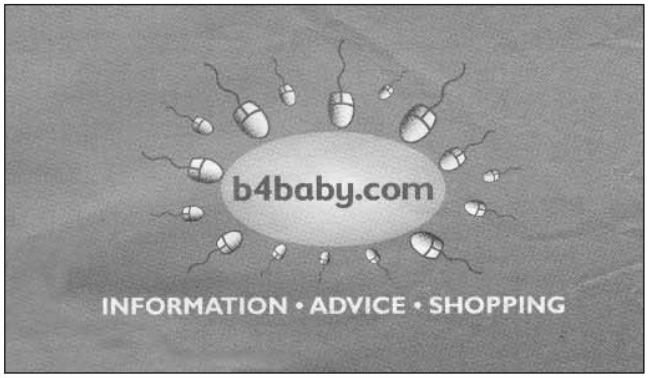
Figure 9
An early appearance of the computer mouse in popular culture, 1986. Star Trek Engineer Scotty tries to operate an Apple Macintosh by speaking into the mouse. Photo courtesy of Paramount Pictures.

Figure 10
The mouse as the Loch Ness Monster, Amazon.co.uk.ad.1999 (© 1999 Amazon.com. All rights reserved).

Figure 11
The mouse as a as hieroglyph . Nationwide Building Society ad. 2000. Courtesy of Nationwide Building Society.

Figure 12
The mouse as a real mouse, cover of *Observer Magazine*, 2002, (© Guardian News & Media, Ltd. 2002).

Figures 13 and 14
Mice as sperm: Encyclopedia Britannica CD-ROM ad, 1999, and b4baby.com ad, 2000.



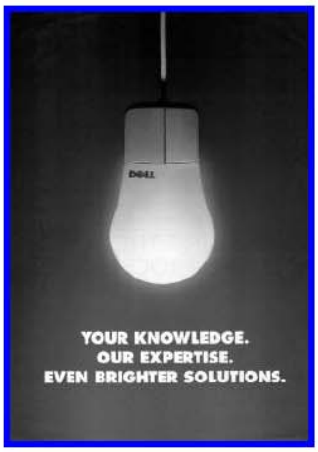
As it has become more commonplace and identifiable as an everyday artifact in its own right, the mouse has taken the form of a wide variety of wildly differing objects, ranging from a tank to an electric light bulb, from the Loch Ness monster (Figure 10) to an alien, and even a fossil, an Egyptian hieroglyph (Figure 11), and a medieval mace. The mouse often has represented itself as a "real" mouse, for example, when promoting Internet dating (Figure 12); and as sperm on more than one occasion—fertilizing the egg of knowledge represented by the CD-ROM version of the Encyclopedia Britannica (Figure 13) and as sperm surrounding an egg-shaped logo of a baby-based Website (Figure 14).

The Mouse as an Abstracted Symbol

An interesting aspect of the mouse and its appearance in popular culture may hold a clue to its evident ability to function as an abstracted symbol. Apart from advertisements placed in specialist magazines by third-party manufacturers,[36] it is rare to see ads by mouse manufacturers promoting their products on a consumer basis as standalone products. Many users have experienced mice only through using them in the context of the workplace, as an object they use but do not actually own, and in which they had little, if any, influence on the purchasing decision. Others own mice they haven't purchased as a separate consumer product, but as part of an integrated computer system. As such, the mouse is an object that just "appeared" in their everyday lives without a conscious purchasing decision. This lack of a direct consumer market for mice may certainly explain the lack of consumer advertising for the mouse itself in popular culture. However, the similarity of form (and color) of most mice, along with their quotidian role as a well-known and easily recognized generic object as opposed to a strongly branded product, may explain the constant use of the mouse as an adaptable signifier rather than a signified.

In fact, shortly after its appearance in 1984, the mouse quickly became a familiar symbol representing anything to do with computers—CD-ROMs, jobs in computing (Figure 15), or even computer companies themselves (Figure 16). The mouse was not shown in use in the "traditional" sense of an advertised object, but its image signified computers per se rather than the use value of the mouse itself. With the Internet's growing popularity in the mid-1990s, however, advertisers of computer-based services were faced with a problem—how to represent the intangible nature of the Internet. The image of the mouse referred to the computer interface, and was strong enough to enable it to be used to explain the "easy access"

36 Jack Hawley's "The Mouse House" and Logitech Inc. were among the first companies to advertise mice. Their advertisements contained text explaining what a mouse actually did, and some included sectional views and electronic circuitry to show the complex technical nature of the device.



Figures 15 and 16
Mice referring to the computer: Newspaper ad for a job in computing, 1996, and a Dell Computers ad,1999.

Figure 17
Internet banking promoted through the use of images of the mouse, Nationwide Building Society brochures from [L-R] 1999, 2001, 2003, and 2004. Images courtesy of Nationwide Building Society.

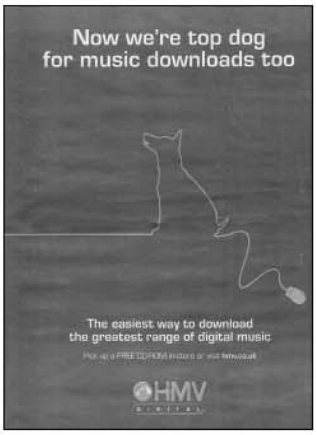


Figure 18
HMV online music sales ad, 2005.
Courtesy of HMV.

Figure 19
Newspaper ad for BT Broadband, 2006.
Reproduced with kind permission of BT.

nature of the delivery of the various services available rather than the computer itself—services such as online banking (Figure 17) or the online purchasing of music (Figure 18).

Today, with the widespread business and domestic use of the Internet, the advent of broadband and wireless technologies, and the popularity of real-time global communications, the mouse has moved from being an icon of the computer itself, through being a symbol of Internet services, to become a symbol of a World Wide Web of easily accessible information. The freedom of the wireless mouse has finally removed it from dependence on the tangible computer in any way, and enabled it to represent the intangible freedom of information itself and access to a whole, worldwide, community of computer users (Figure 19).

There is no doubt that the mouse today is a pervasive, easily recognizable image with any number of signifieds including computing technology, e-business, social interaction, and electronic information systems. The question remains, though, of how it attained this status.

The Computer Mouse as an Agent of Change

There are a number of reasons why the mouse became the dominant design of device for interacting with a computer. Technically, this was justified by a number of ergonomic tests. Following Engelbart's NASA-funded experiments, Bill English moved to Xerox PARC. He wanted to conduct more experiments to be sure the mouse was still the optimal selection device. Stuart Card helped with these experiments, and referred to a phenomenon known as Fitts's Law in his tests, a rule that states that the time taken to point to a target goes up as a logarithm of the ratio between the distance and the size of the target. The slope of the straight line produced by this test is a measure of the efficiency of the device used to point. Interestingly, the slope of the line produced by the mouse's test was very close to that of using the hand alone. "So that means the limitation is not in the pointing device itself, it is in the hand/eye coordination of the human. In other words, the device is good enough that the human

constraints show through it."[37] This information silenced the Xerox engineers who were critical of any additional device other than a standard keyboard and, in particular, the mouse with its need for its own work surface. Xerox settled on the direction of developing the mouse. "Actually, Apple, when they were trying to decide whether to do a mouse—it is hard to imagine that Apple would hesitate to do a mouse, but there was a point at which they did—they also called up and got a copy of the paper on this, and helped to convince themselves."[38]

There also are a number of cultural reasons why the mouse may have appealed to so many people. In conjunction with the Graphical User Interface, the mouse enabled new and different groups of users to access computing technology more easily, many for the first time. In particular, very young users with limited vocabularies, and those users more visually than textually oriented, were able to carry out complex processes through the "intuitive" use of computer icons rather than by remembering complicated commands which had to be entered with unerring accuracy. In Paul Bradley's mind, this is a key point:

> I think, for me, one of the most interesting things is how it changed the relationship between kids and computers. I think, even today, young kids would not adapt to computers nearly as quickly as they do without a mouse or some other type of input device other than a keyboard, and so you see kids as young as two or three years old that essentially can navigate on a computer screen and click pull-down menus, and do at least a rudimentary level of surfing on the Web. There's no way they'd be doing that with a keyboard, so it opens the door much wider to a broader part of the population that would not use the computer as much if they had to use the keyboard as the primary interface.[39]

Wholesale Acceptance of the Mouse

Despite its clear ergonomic advantages and appeal for visually oriented users, the facts that the mouse originally was intended for use with text-based systems in conjunction with a chordset; that its complexity meant it took a long time to be commercialized as a product; and that despite its appearance in popular culture, the instruction manuals and training software clearly indicate that, for many people, it was in no way a "natural" input device, all suggest that there was another significant factor involved in the acceptance of the mouse in the workplace, based in social constructionism rather than technological determinism. The history of computing technology is littered with technically superior alternatives which, for one reason or another, failed to be accepted by a relevant social group of users, and so fell by the wayside.[40] It is not clear that the wholesale acceptance of the mouse can be explained purely on the basis it was sold,

37 Interview with Stuart Card at Palo Alto Research Center, Palo Alto, California, April 10, 2006.

38 Ibid.

39 Interview with Paul Bradley at the offices of IDEO, Palo Alto, California, April 7, 2006.

40 This is the "multi-directional model" of the developmental process of any technological artifact from a social construction perspective. See *The Social Construction of Technological Systems,* W. Bjiker, T. Hughes, and T. Pinch, eds. (Cambridge, MA: MIT Press, 1987), 28.

as the most ergonomic device or as an "easier" way of operating the computer. Because of the prohibitive cost of personal computers in the early-1980s, the largest market by far was in business, where they were used by skilled typists or, if not, by literate managers. This dominant group of relevant social users theoretically should have had little or no interest in a device which improved computer access for young or visually oriented people, because they were only using text-based systems. So what was it that made the mouse so acceptable as an interface device for the office computer, and how did its use become so widespread?

Analysis of the visual material surrounding computer technology in the period between 1970 and 1985 suggests a possible reason for the wholesale adoption of the mouse by the business world. Although the images in this visual material are selected from an archive of brochures and ads created by the computer manufacturers, rather than documentary photographic evidence, they nevertheless clearly reflect the stereotypical attitudes and social mores of their day. It also should be made clear that the images shown here are not isolated occurrences, but are representative of a large number of similar images, from different manufacturers and across the whole period, which show exactly the same scenarios.

It is well documented that, with the invention of the typewriter and its adoption into the office, the role of typing came to be seen as a feminine activity.[41] This situation certainly had not changed by the time that computers first made an appearance into the office. Indeed, at this point in time, there were distinctly different types of computers, being marketed for different uses—both as a tool of office production for (female) data input, and as a tool of (male) managerial control.[42, 43]

The gender politics of the time meant that, more often than not, women shown using computers were presented as office juniors or secretaries, and the activity they were carrying out was clearly the learned skill of typing—whether dutifully inputting data or producing documents to order (Figure 20). The same gender politics meant

41 See V. Guiliano, "The Mechanization of Office Work" in *The Information Technology Revolution*, T. Forester, ed. (Basil Blackwell, 1985), 299.

42 See P. Atkinson, "The (In)Difference Engine: Explaining the Disappearance of Diversity in the Design of the Office Computer," *Journal of Design History* 13: 1 (2000), 59–71.

43 Hiltzik states that the Xerox Star computer's "deliberately stately design" was due to the fact that "its target users were not secretaries and clerks, but their bosses who were executives and professionals." The potential market for an easy-to-use computer for managers had not gone unnoticed by Xerox. A 1981 promotional brochure stated that the Star was "designed specifically for professional business people with little or no typing skills." (M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, 247). The driver of this aim, though, was ease of use rather than an overt intention to overcome any gendered resistance to typing. In addition, as described above, the cost of the Xerox Star kept it from reaching the office.

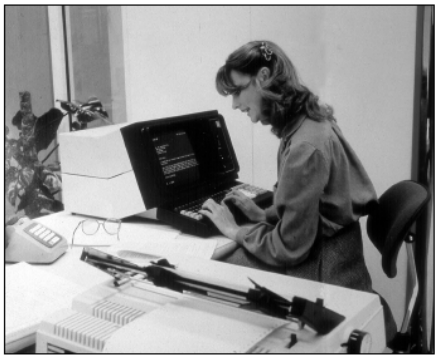


Figure 20
ICL Text 25, 1982. Females shown using computers in the late-1970s and early-1980s were shown carrying out the feminized skill of typing. Image courtesy of the National Archive for the History of Computing, University of Manchester.

Figure 21
IBM System/370, 1976. Male managers were shown standing next to seated female operators in computer manufacturers' literature. Image courtesy of the National Archive for the History of Computing, University of Manchester.

that males were shown in managerial positions, and when they appeared in these brochures alongside women using computers, the females tended to be shown seated and typing while male managers stood around dispensing snippets of wisdom, handing over pieces of paper, or looking over the women's shoulders to make sure that everything was safely under control (Figure 21).

Yet when males were depicted using computers by themselves, it is interesting to note that they almost were never shown using the keyboard for typing (Figures 22, 23, and 24). There was always a clipboard or a pad being written on, an important telephone call being made, and the computer was being used to provide important information to make managerial decisions. (The text accompanying these images backs up this position—managers consulted computers to obtain forecast data, not to input information.) If a hand was shown to be touching the keyboard, it was a single hand—command keys being individually pushed. The resistance to the act of typing in these images is quite evident.

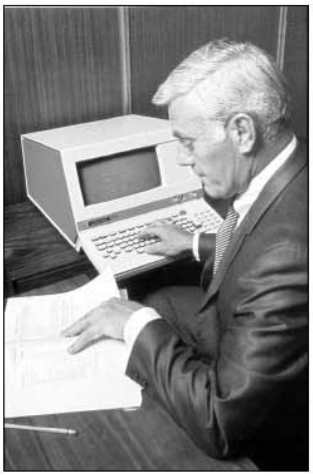
Clearly, there were contemporaneous and significant social changes taking place during this period of the late-1970s and early-1980s, most notably around the awareness of feminist issues and sexual equality, which had a considerable impact on the perception of male and female roles within the office. However, I would argue that these gender politics were a fundamental issue leading to the mouse having such a significant impact on computing history. Despite its massive capability and the huge changes that computing technology brought to bear on office practice, the office computer had, up to this point, maintained a physical form which presented itself as little more than an advanced electronic typewriter. Regardless of what it could be used to achieve, the only way of operating it remained the then feminized act of typing.

The introduction of the computer mouse into the office changed all that. Suddenly, here was an object that not only changed completely the way in which a computer was operated, but also changed the perception of the computer itself. Using the mouse, there was not the same need to type. Instead, one could point, click, drag, and drop. Actions perhaps far more acceptable to a user group of male managers, since they were actions that could mask the feminized use of typewriter keys.

Conclusions

The theory of the social construction of technology as discussed by Pinch and Bjiker includes the element of "closure," when a consensus is reached that a "truth" has been found, or a problem has been "solved." As they explain, "To close a technological 'controversy,' one need not *solve* the problem in the common sense of that word. The key point is whether the relevant social groups *see* the problem as being solved." [44] Other historians and sociologists of technology

44 T. Pinch and W. Bjiker, "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other" in *The Social Construction of Technological Systems*, W. Bjiker, T. Hughes, and T. Pinch, eds. (Cambridge, MA: MIT Press, 1987), 44.



Figures 22, 23, and 24
Male managers using computers were shown accessing information, rather than typing. (L-R) Racal-Redac Executive, 1977; Univac Uniscope 100, 1975; and Control Data Corporation CDC Cyber18, 1976. Images courtesy of the National Archive for the History of Computing, University of Manchester.

have argued that, while not dismissing the role of the social in technological change, it should not be privileged, but seen to be acting in conjunction with other factors, natural, technical, and economic, in a network or "organic whole."[45] In the case of the adoption of the computer mouse as the preferred selection device, it seems that there are three discrete relevant groups of users, that saw the problem being solved, but from different perspectives. The engineers at Xerox and Apple, among others, were convinced by Card's use of Fitts's Law that the mouse was ergonomically an almost optimal device, despite its complications from an engineering point of view. Young users, visually oriented users, or users unaccustomed to computers found using a mouse in conjunction with a GUI to be a more intuitive way of accessing computer technology, despite their initial wariness of using one. Finally, and perhaps most important, the largest relevant social group of user, business users, achieved closure with the computer mouse because of its ability to overcome the need to perform a stereotypically gendered activity.

The mouse, then, in a way that none of its designers originally intended, acted to remove the office computer's association with the typewriter, changing it from what was perceived as a low-status piece of office equipment into a completely new piece of technology, operated in a unique way. The mouse also enabled the different computers targeted at female office workers and male managers to become a single product. I would argue that the mouse played a significant role in the wide-scale adoption of the computer—a computer without preconceived status and gender associations—and in doing so, made a substantial contribution to the development of today's workplace.

45 See M. Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis" in *The Social Construction of Technological Systems*, 84.

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