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The Archaeology of the Digital Periphery: Computer Mice and the Archaeology of the Early Digital Era

Gareth Beale

gareth.beale@york.ac.uk

University of York, UK

John Schofield

john.schofield@york.ac.uk

University of York, UK

Jim Austin

jim.austin@york.ac.uk

University of York, UK

Abstract

The Computer Mouse is amongst the most ubiquitous, widely used and well-known artefacts of the late twentieth and early twenty-first centuries. The essential form remains the same as when it was first invented but during this time the mouse has transformed our physical interaction with and perception of computers. With increased attention being paid to curating and collecting technologies of the contemporary world, and within the context of an archaeological research culture that extends to the contemporary, an archaeological examination of this widely known artefact appeared timely. There are millions if not billions of mice in circulation, some in use and many obsolete. Despite their apparent uniformity they differ in significant ways. Examination of these differences can help us to understand human

experiences of technology in ways that resonate with artefact types of much earlier periods. With that time depth in mind, this paper will therefore focus on the form and function of the computer mouse and its place in the contemporary imagination. This will be followed by a detailed study of five specific examples which together illustrate some of the key issues and challenges that face us, as archaeologists and curators.

Keywords: computer mouse; digital technology; material culture; personal computer

Introduction

During the late twentieth and early twenty-first centuries digital technologies have come to play an increasingly central part in our lives. This has been a period of constant technological change in computing machinery and has led to an increasing abundance of obsolete hardware. Some of these objects have been recognised for their cultural, social and even aesthetic significance (Kirkpatrick 2007; Simon 2007) but the majority have been forgotten.

Within this growing body of redundant technology we encounter massive diversity. Even within a sub-category of peripheral hardware such as the computer mouse we find surprising and significant degrees of variation. Connectors, colours, materials, modes of construction, tracking technology and numbers of buttons have all undergone constant revision and re-design. What may appear at first glance to be one of the most persistent and unchanging features of computing's recent past has, as we shall show in this paper, remained profoundly unstable.

Finding meaning in the variation of the form, function and style of an object type is far from unique in the realm of archaeological experience. Pocket knives, pens, arrowheads and any number of other object types of archaeological interest display substantial degrees of variation. It is possible within this variation to read processes of social change, to identify

personal responses to technology and through the development of deep understandings of these tools it is possible to better understand human engagements with the physical, social and intellectual worlds within which they were used. This is as true for the computer mouse as it is for any of the tool types mentioned above. Just as in these cases, as the circumstances of use alter and as the technology itself changes, it can be difficult to appreciate or to explain subtle variations in the form, function and style of the object.

The computer mouse is, perhaps, on the verge of becoming obsolete (Ackerman 2010). At this distinct historical moment, this paper re-visits the computer mouse as a category of objects with the aim of, (a) recomplicating and even recovering an understanding of the diversity present within mice as a category of objects and (b) further challenging innovation-centred narratives as a means of understanding digital technology.

To this end, the research presented in this paper studied a collection of computer mice using a blend of archaeological object analysis and experimental user testing. This enabled us to observe individual items but also to explore the affordances of each mouse, as an object but also as a representative of its type.

Research Context

The computer mouse has been a ubiquitous characteristic of personal computing since its widespread introduction in the late 1980s and early 1990s. A significant proportion of human computer interactions have involved a mouse and yet with notable exceptions (Atkinson 2007) they tend to feature only very fleetingly in conventional historical accounts of computing and hardware. This can be attributed in part to the broader reluctance within historical accounts of technology to acknowledge the importance of objects (Olsen 2010, 94). It also has to do with the pervasive emphasis within historical accounts of computing upon

innovation and novelty at the expense of widely used everyday objects (Mahoney 1988; Sterne 2003; Boyer and England 2008; Pels 2010; Finn 2013, 3).

The use and form of personal computers during the last 30 to 40 years has been characterised as much by continuity as it has by change (Atkinson 2000) (see Figure 1). Despite much-publicised innovations in performance, connectivity and design the form of the personal computer has remained largely unaltered since its introduction in the 1970s and its popularisation in the 1980s. The geography of the workspace has also remained largely unchanged and in many cases the computer and its peripheral technologies continue to occupy a central position. For a long time the computer mouse was emblematic of this continuity. Its functionality remains essentially unaltered while its design and construction have been modified only very slightly. The history of the mouse can be argued to have more to do with ubiquity than innovation and more to do with users than inventors.

<FIGURE 1 HERE>

However, changes in the computer mouse, whether they were intended to cheapen construction, add new functionality, update connectors or increase reliability can tell us a great deal about technology during this period (Atkinson 2007). Mice also acquire difference through human interaction; through use and deliberate modification. By studying specific mice we also reveal stories of everyday human interactions with, and attitudes to, computing technology. Historically speaking, the vast majority of human computer interactions have taken place using mass produced and unremarkable peripheral technologies and yet until now our ability to engage with the diversity and significance of these objects has been limited (Edgerton 2006, and see Graves-Brown 2014 for a broadly comparable example of a ubiquitous technology).

The study of contemporary technology has been the focus of study across a number of different disciplines. This has ranged from the analysis and design of computing systems which has taken place in Computer Science and the computing industry through to historical and social studies addressing the cultural impact and significance of computing, and behavioural studies of technology and technological change, exemplified in the work of Michael Schiffer (e.g. 1991, 2011). This research builds upon historical approaches to the study of digital technology which have sought to develop social histories of computational technology and to emphasise the experiences of users as well as those involved in their design and development (Edgerton 2006; Blyth and Prugnon 2015). Our research is also informed by work in science and technology studies (STS) and sociology which has aimed to explore the co-constitutive relationship between technology, society and the self (Turkle 1982; Agar 2006; Borup *et al.* 2006; Doel and Söderqvist 2006). Our goal is to contribute to this body of work by emphasising the materiality and agency of digital hardware, following other archaeological investigations of contemporary computing in the process (Graves-Brown 2014; Moshenska 2014; Morgan and Perry 2015). As in these other archaeological studies we emphasise the significance of the object rather than viewing objects as being symbolically representative of an externalised historical narrative (Buchli and Lucas 2001, 23). We hope to add a new dimension to these analyses by emphasising the physical and intellectual interplay between humans and computers and by exploring the role of computational hardware in our lives today and in the past. As such we are interested as much in the memory (voluntary and involuntary) of digital hardware as we are in the contemporary experience and we will argue that only by understanding these relationships will it be possible to articulate significance as it relates to commonplace mass-produced computational artefacts. Through the close study and use of the material culture of our recent technological past we can develop better

understandings of the impact which these objects have had upon us and the environments which we inhabit today.

We will also explore the use of technology as evidenced by the objects themselves such as use wear, modification and patterns of use and disposal. The form and the tactile experience of using mice has resonance with other artefact types studied by archaeologists.

The Significance of Mass-Produced Computer Hardware

Archaeology has long been concerned with mass-produced objects, of comparable form and function. Archaeologists examine these objects for information about their former use, the mechanics and technology of their manufacture, and the social significance of production, use and after-life. Stone artefacts, ceramic vessels and metal objects including coins present significant curatorial challenges, both for the sheer numbers of objects, and often also for their repetitious and ubiquitous character. In spite of their antiquity questions will remain about the cultural benefits of retention alongside the costs of curation. For modern objects this debate has hardly started, even though the critical engagement with archaeologies of the contemporary past are well rehearsed. In terms of places and landscape, for example, the argument has already been made that, for the recent past, and where the buildings and places form part of our own everyday experience, different rules may apply. Rare examples of built forms surviving over 500 years may merit protection merely because of their age, notwithstanding other justifications. But a 1970s bungalow or office building may hold value instead for its social or communal as opposed to historical, aesthetic or evidential associations (English Heritage 2008).

A similar argument can be presented for objects and artefacts, although here there is also a curiosity value not so evident for the wider built environment. Museums often display

objects that for the adult visitor serve as a reminder of childhood or young adulthood. Early examples of mobile phones appear in museum displays for example, even though these comparatively large, bulky objects are only 20 years old. Personal computers fall into this same category. But this begs the question: for these "familiar" objects, is it merely the curiosity and value as "reminders" that give them significance; the fact that the form itself may be familiar, but early examples highlight progress and development, placing us as individuals within an evolutionary context? We argue here that, while these objects have value as reminders, their true value has deeper roots. Our argument is that a more archaeological explanation is merited, one that headlines and exemplifies the very nature of progress, and the fact that progress can on occasion be characterised by stasis and stability (or – crucially – a *sense* of stasis and stability, even though that may be an illusion, masking subtle variability) in spite of drivers for change, and alongside rapid change and developments in other areas of the same industry. The computer mouse is a good example of this - a form that remains constant while much around it is changing. The mouse did not need to change. It served its purpose well, and it looked good. And with reminders of the feel of a hand axe in one's hand, and the comfort of fit, so it may be with the mouse.

The Computer Mouse and the Early Digital Age

The mouse and keyboard together form the most widely used toolkit for human–computer interaction in the late twentieth and early twenty-first centuries. The ubiquity of the windowed graphical user interface for personal computing helped to carry the computer mouse into homes and offices across the world. Until the development of the touchscreen and trackpad it became an inevitable part of the computing experience for most people. However, the predominance of the mouse was far from inevitable and can be attributed to a range of

social and historical factors. Furthermore, the mouse helped to normalise a wide range of assumptions about the nature of work and home life.

Initially the vast majority of personal computers did not have mice. Most of the first computers to become commonplace within homes, schools and workplaces were controlled with only a keyboard. The idea of the mouse as a device with which to point and click in order to manipulate content on the screen was developed in 1975 by Bill English at Xerox for the Xerox Alto computer, seven years after he and Douglas Englebart invented the mouse at Stanford Research Institute. Prior to this the mouse had been used only as a means of moving the cursor within blocks of text, not as part of a true graphical user interface as we would recognise it today (Atkinson 2007). The first commercially successful system which employed the mouse was the Apple Macintosh in 1984. After this initial mainstream commercial success the mouse became increasingly prevalent but it wasn't until the early 1990s following the release in the mid to late 1980s of UNIX, Macintosh and Microsoft operating systems with graphical user interfaces, that the mouse became ubiquitous, long after the computer became a fixture of many homes and workplaces. As such, the commercial success of the computer mouse is intimately connected with the development and success of the graphical user interface and in combination these technologies signalled a fundamental change in the use of personal computers within the home and office (Engelbart and English 1968; Mahoney 1988; Grosz 2005).

These changes helped to shape the configuration of the contemporary office environment (at home and work) as well as profoundly altering the role of computers in contemporary life (Haigh 2006). In conjunction with the keyboard and operating systems rich in skeuomorphic representations of analogue office life the mouse helped to reinforce established patterns of work. The homogeneity of computing systems both in terms of

interface design and input devices helped to normalise expectations of "computers" as a technology and led to the cultivation of a range of (particularly gendered) behavioural dynamics (Webster 2014, 54). The mouse enabled new forms of digital practice including the introduction of new graphics applications and design tools which had, in their analogue manifestations, been primarily male domains. This stood in contrast to the primarily female activity of typing and (subsequently) word processing (Atkinson 2007, 10). The fact that the computer mouse required a desktop upon which to function helped to ensure the persistence of the desk-based working environment and in so-doing played a part in ensuring the continuity of a physical work environment which was designed with analogue technologies in mind (Strom 1994; Baldry *et al.* 1998). While to the contemporary computer user the mouse may seem to be trivial, it is in fact a pivotal technology which has been actively engaged in the construction of many elements of contemporary social and cultural life.

The phenomenon of personal computing has been studied from a wide range of disciplinary perspectives ranging from technical analyses through to social and historical approaches (Clegg 2001). However, few if any accounts have dwelt upon the material history of personal computing at any level of granularity. Personal computing has been intertwined with a wide range of shifting social and cultural dynamics including transformations in methods of manufacture, globalisation of production, shifting gender roles and changing aesthetics. These changes are evident in the design and manufacture of mice and the study of mice as objects can provide new, often critical, insights into the manner by which these concepts were materialised. However, computing is also a personal experience and through the study of mice, including the ways in which they have been used and modified, we hope to highlight the importance of personal histories of computing. In summary, the goal and the challenge of our archaeological analysis of computer mice is to see beneath these social and

technological meta-narratives in order to gain an insight into quotidian and everyday interactions with digital technology in the early digital age.

Methodology

The testing and analysis of the computer mice was undertaken over several days both at the Jim Austin Computer Museum and at the Department of Archaeology at the University of York (see Figure 2). This work took place in two stages. The first stage involved the group testing of a series of five computer mice on computers for which they were designed or on which they were used during their active lives. In addition to this core collection of mice, observations were made across the collection in the form of notes and photographs. Some of these "field notes" have been included in the text below.

<FIGURE 2 HERE>

Our research was autoethnographic in character and was exploratory, with each of the user-testers considering and sharing their historic and contemporary relationship with these technologies. The testing of mice was inspired by methods in experimental archaeology whereby understandings of objects are derived and refined through use (Strand *et al.* 2016; Lin *et al.* 2017). Through this kind of experimental practice we hoped to highlight the subjective and personal ways in which people respond to technology. There are also strong links between our experimental research methodology and other forms of practice in contemporary archaeology (for examples, see Harrison and Schofield 2010). We very quickly recognised the need to be reflexive and to embrace the ontological strangeness of the scenario which we had created; despite our efforts at authenticity we were not 1970s computer users any more than we could be paleolithic knappers. For some of the group this was an exercise

in remembering, in a sensory and intellectual dialogue with the machinery, while others were using all of these devices for the first time. Through discussion and sharing of insights were able to reach more nuanced and sophisticated understandings of what makes each of these objects distinctive and why this might matter.

Mice to be tested were connected to working examples of the computers with which they would originally have been used. The authors and a small team of heritage professionals used the mice to carry out a series of simple computing tasks and discussed their responses to the mice as a group. In this way, the historic computers were able to serve as a catalyst for discussion. The precise tasks undertaken differed based upon the capabilities of the system and on the availability of software for the machines in question. However the mice were tested on a variety of surfaces including a mouse pad, directly on the desk and on other improvised surfaces. The goal of this part of the process was to allow the researchers to compare and to contrast different experiences of using mice in order to add nuance to our understandings of these objects and the variations which may have existed across time or between contemporary objects.

The research was inductive and exploratory with participants encouraged to discuss and to critically analyse the experience of using the technology as well as providing personal responses. Each mouse was tested in turn with participants being given an opportunity to use the mouse and to discuss this experience with the other participants as they walked around the museum where much of the testing was undertaken. These conversations were recorded throughout using voice recorders, cameras and in some instances film.

Each of the mice was comprehensively photographed using a combination of formal artefact photography and creative/documentary photography. The first category of images were staged in order to document the mice as artefacts and to provide a visual reference for

the research team and for our readership. The latter category represented a personal response to the handling and close study of the objects. Image making was employed here as a form of interpretive practice with new knowledge emerging from the internal discourse between image maker, objects and medium as discussed by Bunnell (2004) and Ferraby (2016).

These image-making processes were intended to act as a visual aid to subsequent analysis but also to provide a means by which to closely study and to explore the materiality of the objects away from the circumstances in which they might ordinarily be encountered. One of the major challenges in the study of contemporary (and often therefore familiar) material culture lies in overcoming preconceptions about what may or may not be relevant or interesting about the object of study. The image-making process provided a means by which to engage with the computer mice in an unfamiliar way, to consider the mice not just in terms of their apparent familiarity or similarity to contemporary equivalents but as distinct objects with their own characteristics. Within the context of this methodology, visualisation provided a framework within which to engage with the objects at a multi-sensory level, handling and disassembling the mice as well as studying them. The images produced during this phase of the research project informed subsequent discussions and the production of this paper in a number of different ways and have been embedded within the text below. Some of the photographs take the form of personal sketches and were produced as a means of considering the form of the object and also as a means of stimulating the study of small details which may not have been obvious while using, handling or visually inspecting the mice.

Mouse Selection

The five mice which formed the primary focus of this study were selected from a collection of several hundred at the Jim Austin Computer Museum and from the personal collections of

the authors. The primary basis for selection was that the mice should be useable on the machine for which they were designed and/or used. The mice were chosen in order to represent a chronological cross section of computer mice with the earliest mouse featured being from the early 1980s and the latest being from 2015, the range approximately spanning the history of the commercially available mouse. Mice were also selected to include a wide range of popular technologies and features from this period such as different button combinations and different tracking systems.

The mice chosen for study were:

Hewlett Packard 46060A (1984)

Macintosh M0100 (1984)

Logitech M-PF7 (1990)

Generic Mouse (probably early 2000s)

Apple Magic Mouse 2 (2015)

The User-Testers

The user testing group consisted of researchers from a variety of relevant backgrounds including contemporary archaeology, science and technology studies, computer science and museum studies. The user testers included the authors but the group was expanded in order to include specialists from other disciplines. The user testing experience was led by User 1.

User 1: is a computer science researcher with a specialism in neural networking. As well as conducting research on the development of entirely new forms of computing hardware they

also have a passion for historic computing machinery and have researched and restored a huge number of computers of all ages.

User 2: is a computational archaeologist who routinely used computers for the first time when at university in 2000. User 2's experience of mouse use has been characterised by being left handed (the mouse wire is never long enough). The computer mouse is the only technology which has enforced ambidextrous use through practice. User 2 went over to using a touchscreen and stylus as soon as possible.

User 3: wrote their PhD thesis on a communal departmental PC that they had to book by the hour. Whether there was a mouse involved they cannot recall. But since that time they have used a mouse most days, at work and at home. Having spent 21 years with English Heritage they moved to the Department of Archaeology at University of York in 2010. They now have a PC with two screens, two laptops, and a MI-2150 Optical USB Mouse that has the word "Trust" written on it. They assume that is the manufacturer!

User 4: is a digital archaeologist with a background in computer graphics and archaeology. They learned to use computers before mice became common and learned to use a mouse when mice still had three buttons. User 4 has long dreamed of an effective 3D interface but has been unpersuaded by any that he has tried.

Results

Hewlett Packard 46060A Mouse

The first mouse which we tested was the Hewlett Packard 6460A (see Figure 3). It was packaged with a series of HP machines in the mid 1980s. It has two buttons and uses a proprietary HP-HIL connector. The example which we tested was manufactured in 1987 and

was tested on an HP Integral “luggable” PC (see Figure 2). The operating system is HP-UX, a proprietary implementation of Unix. Basic operations were performed including the movement of files and re-sizing of windows. This was a computer that two out of the four user testers had experience of using during the 1980s.

<FIGURE 3 HERE>

The first reaction to this mouse was emotional. User 3 reflected on using this computer very early in their career and described a feeling of great fondness towards it and talked about a feeling of pride at being given a PC to work on. The first thing which Users 1 and 2 commented upon when using this mouse was the pleasantness of the tactile experience which it offered. Both users agreed that the mouse felt as though it was ergonomic and fitted well into the hand. All users agreed that the “action” of the buttons provided a very satisfying click which would be very unusual in a contemporary mouse.

The simplicity of the mouse was seen by all users (with the exception of User 4) as being superior to increasingly complex human computer interaction devices such as multi-touch pads and the Apple Magic Mouse which is tested below. Explanations for this had to do with the simplicity of the experience and the fact that actions performed using the mouse had a clear mechanical basis. User 2 observed that the mouse had a 1:1 spatial relationship with the computer screen meaning that 1 cm of movement in the position of the mouse corresponds to 1 cm of movement of the on-screen cursor. User 2 expressed a preference for roller ball motion tracking systems over optical systems and stated that: “They are easier to use because you are doing something mechanical. I have always really struggled with mice because the extension of what you are doing to the screen is hard.” Other users

were surprised at how unresponsive this mouse felt in comparison to modern optical mice. The buttons on this mouse can be differentiated by touch using a raised dot on the left hand button. All users discussed the fact that these physical features to differentiate mouse buttons seem to have fallen out of use despite previous prevalence. User 1 (an historic computing specialist) reminded the group that this device would have been very expensive in comparison to the average modern mouse, costing $148 in 1986.[1]

One factor which became evident while testing was the extent to which the perception of the mouse was linked to the character and functionality of the operating system with which it was used. The use of a mouse for the HP Integral PC was optional and the use of the mouse as an input device was designed to be augmented through the use of the keyboard. User 1 explained this process to the user group and showed us how to use the function keys to alter the functionality of the mouse. User 1 also commented that the mouse feels really optional on this operating system and recalled using a similar machine without a mouse.

The style of this mouse and the quality of finish were noted by all users prompting a discussion about whether, and if so how, design features from this mouse might be incorporated into contemporary product design. This discussion began as a joke about the possibility of "retro mice" but quickly developed into a serious conversation around the perceived prevalence of low quality of design and construction in the contemporary design of input devices and other peripheral technologies.

Macintosh Mouse M0100

The M0100 (see Figure 4) was tested on a Macintosh Lisa computer. This mouse was released in 1984 and is the second mouse released by Apple. Its single button was a

[1] http://www.hparchive.com/Catalogs/HP-Catalog-1986.pdf

distinctive feature of Apple mice from their introduction until 2006. User 4 remarked immediately that this mouse looked "weirdly contemporary, perhaps because of the continuity of Apple's visual identity through the decades". Basic operations were performed using the mouse including the movement of windows around the screen and the copying of files from one location to another. The single button and the need to augment the use of this button with keyboard shortcuts such at the "crtl + mouse button" to raise a menu made its use unintuitive to all user testers. Users 2 and 4 both expressed surprise at just how different this user interface was to contemporary computers, with User 4 commenting, "the whole experience is just so strange, every basic function requires yet another combination of buttons, it is like a puzzle!"

<FIGURE 4 HERE>

The M0100 used a trackball motion tracking system which was familiar to all user testers from mice which they had previously used at home or work. As with the Hewlett Packard 46060A, the trackball was found to be less reliable than optical systems particularly on uneven surfaces. User 4 commented that the trackball system only worked when upright. This was not felt to be an issue by the rest of the group but did reveal the extent to which different tracking systems enable different ways of working with technology. The user, when questioned further, explained that they very rarely sat at a desk to use a computer but that they often used a mouse (with an infrared optical tracking system) for precision graphics work, often sat cross legged and using the mouse sideways on their leg. Another user commented that they liked the "tactile" feeling of the trackball and the sense that it offered

the perception of a physical engagement with the movement of the cursor in contrast to contemporary optical mice.

The mouse, like all mice with trackball systems, had a tendency to gather dirt on its underside (due to the complex details associated with the tracking ball) and in the trackball cavity itself. User 1 recalled the amount of cleaning which had been required when using these mice and commented that trackball mice located in communal offices had often been "disgusting" due to long intervals between cleaning.

This distinctiveness extended to the appearance of the mouse which was oddly proportioned in comparison to the other mice tested, being very high in profile. The shape of the mouse was found to be uncomfortable after around five minutes of use due in large part to its height and the narrowness of the top surface. User 1 said that they "hadn't remembered how strange this mouse was to use". It was observed by User 2 that the mouse was very definitely styled to fit with the aesthetic of the computer. This differed from some of the other mice which were in some instances colour coordinated but which didn't coordinate with their computer in a stylistic sense. User 2 suggested that "this attention to detail is something which might be brought back to computing design today".

The mouse was felt to be well built and to have a satisfying weight by all testers. It was expensively built being constructed out of a plastic shell with a steel plate screwed into the base. The action of the button click was felt by User 1 to be plasticy and unsatisfying in comparison to the Hewlett Packard 46060A.

Logitech M-PF7 Mouse for Acorn A3000

The Logitech M-PF7 mouse (see Figure 5) was manufactured by Logitech but was shipped with the Acorn A3000 computer and was widely used in British schools during the 1990s.

The mouse has three buttons which was standard for Acorn's RISC Operating system. The mouse uses a standard DIN connector and has a roll-ball tracking mechanism. The mouse was made from plastics with no visible metal in the outer shell.

<FIGURE 5 HERE>

This mouse was tested on an Acorn "Archimedes" A3000 and for Users 2 and 4 this was a very nostalgic experience because they had both used these computers while at school in the early 1990s. User 4 immediately began to drum his fingers on the three buttons and describe how he had "annoyed teachers by drumming tunes on the loud clicking buttons during Year 7 IT classes". The tracking system was felt by the majority of users to be very smooth and reliable but Users 2 and 4 encountered difficulty with the ball "sticking" particularly on slightly uneven surfaces. This problem was partly addressed by taking out and cleaning the ball and mechanism. This procedure was undertaken by User 1 who reiterated that this was a standard part of the computing experience throughout the 1980s and 1990s and was "no more pleasant now than it had been then".

Nobody was sure initially what the three buttons were for, despite the fact that Users 1, 4 and 5 had experience using this operating system in the early 1990s. Users discussed the fact that the "muscle memory" which users tend to develop when they are familiar with an operating system had almost completely been lost in the intervening period. User 1 explained that the right button was known as the "adjust" button and would perform a variable function depending on context. Despite repeated testing none of the users was entirely clear on when this function would be of value. The feel of the buttons was agreed by Users 2, 3, 4 to be

"satisfying". Users 2 and 3 commented that the action of the mouse was very soft and short with very little effort required to press the button.

User 4 expressed frustration that they were not able to remember what all the buttons were for, "it feels weird to recognise something so instinctively but to have forgotten completely how to use it, it's like a forgotten technology but it is only 30 years old!"

Generic Mouse (Probably Early 2000s)

The next mouse tested was a generic mouse from the office of one of the authors which appears to date from the early 2000s (see Figure 6). The mouse was originally found in an office at the University of York and is still in regular use. The painted surface of the mouse shows signs of heavy use. The mouse has a curved "ergonomic" profile with a comparatively large surface area on the flat underside. The mouse has a USB connector, four buttons and a scrolling wheel.

<FIGURE 6 HERE>

The mouse uses an optical tracking system which was felt by all users to be effective and reliable. The feel of the mouse in the hand was also mentioned by all users and was felt to be pleasant in contrast to some of the other mice tested. Users 2 and 4 suggested that this was a result of the relatively high profile of the mouse and the use of a curved upper surface which splayed out towards the base. User 1 said that the mouse "was definitely part of the fad for 'ergonomic' design which usually meant making it curvy and adding far too many buttons".

The mouse has more buttons than any of the other mice tested (five including the dual function trackwheel/button). Initially users were unclear what the additional side buttons were for (these are the dark plastic wave-shaped panels on the sides of the mouse) but User 2 remembered having used a mouse before which was advertised as having buttons like these to operate forward and backward buttons on a web browser. This was tested and it worked without adjusting any settings. User 4 commented that these "vestigial features" were interesting as they represented "speculative and uncertain attitudes towards technology during the early years of the web". The action of the buttons was thought to be unpleasant by all users with User 2 remarking on the "springiness" of the buttons and the "twanging" noises made when buttons were released.

The design of this mouse was remarked upon as being quite unusual by Users 2, 3 and 4 but was felt to be very cheaply constructed. No brand name is present on the base of the mouse, indicating that it was sold as a generic commodity rather than as a branded product. The entire mouse is built from plastic with translucent red panels revealing internal LEDs. The surface shows signs of use-wear and a grey plastic has been revealed where the paint has worn away. All other mice tested used solid coloured plastics and had retained their colour even where they had been worn from use.

This mouse left all users with a strongly negative impression which led in turn to a discussion about the value of remembering bad and frustrating technologies as well as good ones. User 4 thought that they remembered using a mouse at a painfully slow Italian internet cafe in the early 2000s which enhanced the feelings of frustration.

Apple Magic Mouse

The most recent mouse tested was an Apple Magic Mouse from 2015 (see Figure 5). At the time of writing it is the current model of Apple Mouse and it is a recent acquisition for the Computer Museum. In addition to conventional buttons the mouse incorporates an acrylic touchpad on its upper surface, enabling a range of gesture controls. The mouse is compatible with Apple computers running the versions of the Apple OSX operating system later than OS X El Capitan which was issued in 2015. The mouse connects to the computer using a wireless bluetooth connection and is powered by a lithium ion battery which is charged through a USB connection.

<FIGURE 7 HERE>

The mouse had been charging prior to use and users discussed the fact that the mouse had to be connected via a cable plugged into the base of the mouse and thus preventing it from being used while charging. Once testing commenced, one of the first things discussed by the user testing group was the feel of the click when the button was pressed. The significance of the button action was one of the most prominent features of each discussion but was particularly significant in this case. Part of the reason for this was that one user (User 1) felt that the mouse had a satisfying click while User 2 found the absence of physical buttons to be extremely frustrating. The Magic Mouse has an unusual hybrid system in which the surface of the mouse can be depressed with the position of the finger on the surface dictating whether this represents a right or a left click. In this way Apple have retained the apparent simplicity of the single button (see the M0100 mouse described above) while incorporating the functionality of a two button mouse.

The multi-touch surface of the mouse also divided opinion. Users were asked to scroll through a document by pulling two fingers back across the surface of the mouse. Again, Users 1 and 4 found this to be relatively intuitive while Users 2 and 3 found the lack of a physical device (e.g. a mouse wheel) to be problematic.

One feature identified by all users was the low profile of the mouse. In each case users felt that this required the hand to be held in an uncomfortable position. The mouse uses an optical tracking system which all users felt to be smooth and responsive.

All users acknowledged the apparently high-build quality of the mouse and the use of high-quality materials. User 4 observed that Apple seem to be attempting to, "re-introduce the idea of the mouse as a desirable specialist piece of equipment", as an attempt to reverse the trend towards commodification which has taken place since the introduction of the M0100 mouse. User 1 stated very emphatically that he thought that this would be unsuccessful.

Analysis and Conclusions

The nature of the reactions from our group was revealing of the complex relationships which exist between people and historical and near-contemporary technology. The responses to computer mice described within this study are representative of an accumulated personal and cultural history of technology. These stories are sometimes evident in the objects themselves if they show physical signs of wear or have been deliberately modified. Perhaps more significantly though, the use of these objects acts as a catalyst for memory. Experiences of computing which are of great personal or social significance may be forgotten, or at least harder to recall or less accessible, without these collections.

Superficially, computer mice seem like a homogenous category of objects. However, even the brief user testing undertaken in the writing of this paper demonstrated substantial variations in user experience. Perhaps the most striking example of this was the discomfort felt by the user testers when confronted with a one- or three-button mouse on the Macintosh and Acorn computers. These designs were once commonplace and their use was an essential part of mainstream home and office computing. In the successive 15-20 years, intuitive knowledge of these systems and how to use them has become less commonplace. It is possible, through documentary research, to relearn the use of these kinds of devices and their operating systems but they are no longer part of the popular understanding of computer use. The fact that all but one of these mice are redundant within 30 years of production is telling of the era within which these technologies were developed. Falling costs of production (as evidenced in the change in place of manufacture from USA to China between the early and late examples) have created a situation in which it is cheaper to discard and replace than it is to re-engineer and reuse existing technology.

It may be argued that the loss of shared memories of computer mice does not pose a fundamental threat to our understanding of technological change or our understanding of the human experience of technology in the late twentieth century. However, such loss is representative of a broader trend facing the tangible and intangible heritage of digital technology: the erosion, often without record, of everyday quotidien technologies and the places most associated with them; the loss of the everyday texture and fabric of technology use during this period.

This paper critically examines the impact which a peripheral technology has had upon the experience of computing in the late twentieth and early twenty-first centuries, and the importance of this material culture as a document of this past. We are not necessarily

suggesting the preservation or retention of thousands of mice in museum collections, for future study and display, or even that places associated with mice should be preserved – their places of manufacture for example. Rather we argue merely for their significance as everyday objects, suggesting that quotidian digital technologies have been instrumental in shaping social and cultural milieu of this period, mediating our interactions with and understandings of computational technology and shaping our understandings of technology as part of everyday life. They also provide a valuable material record of our relationship with technology during this period. The detailed visual and tactile study of these objects has allowed us to add nuance and complexity to our understanding of this understudied technology and adds a significant material dimension to our understanding of objects (Jones and Alberti 2013, 22).

Our analysis of these computer mice has revealed that despite their superficial similarities these objects exhibit considerable evidence of diversity and change over time. These changes relate to the style, materials, methods of manufacture and underlying technologies. This diversity affects the experience of the user and the affordances of the device. These differences are, therefore, instrumental in any assessment of historical significance. In the history of computer mice we see the early history of human computer interaction in microcosm.

The computer mouse remains an intuitive device for most computer users. The use of very early mice in this study helped to reveal the extent to which the practical affordances of the technology have changed. These changes include but are not limited to the smoothness with which user gesture is translated into motion on screen, the range of features (scrolling wheels, touch sensors), and the robustness of the technology (how often is the signal disrupted?). These experiments provide a reminder that tiny iterative changes can, over time,

create a fundamental transformation of a technology. In the case of the computer mouse these changes reflect the interplay between physical use patterns (how viable is a rigid dedicated mouse pad in the era of lightweight laptops?) and the requirements of increasingly complex graphical user interfaces.

For the first time since the introduction of the graphical user interface, declining sales of mice have recently been reported (Auchard 2015). This changing trajectory does not necessarily mean the beginning of the end for mice but we are certainly witnessing a greater diversity of human computer interaction technologies than existed previously. It is important then at this stage to retain our understanding of early digital technologies such as the computer mouse and to assess the ways in which these technologies have shaped contemporary digital technologies and our understandings of them.

Computer mice also reveal the extent to which understandings of technology are dependent on use. We cannot afford to ignore materiality if we are to understand the impact which technology has had on human experience in the past. The study of mice has the capacity to tell us much about the social and cultural dynamics which surrounded the birth of the personal computer industry. Everyday hardware such as computer mice has played a significant role in our experiences of technology in the early digital age. By failing to focus on things and over emphasising innovation, conventional historical narratives will fall short of telling the full story, something we – as archaeologists – are well placed to observe, placing our contemporary views and perspectives in longer-term context.

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Gareth Beale is <ADD BLURB> Address for correspondence: Department of Archaeology, University of York, The King's Manor, York, YO1 7EP, UK.

John Schofield is <ADD BLURB> Address for correspondence: Department of Archaeology, University of York, The King's Manor, York, YO1 7EP, UK.

Jim Austin is <ADD BLURB> Address for correspondence: Department of Computer Science, University of York, Deramore Lane, York, YO10 5GH, UK.

Captions