Atkinson, Paul

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Submitted in partial fulfilment for a PhD by Publication
Awarded by the University of Huddersfield

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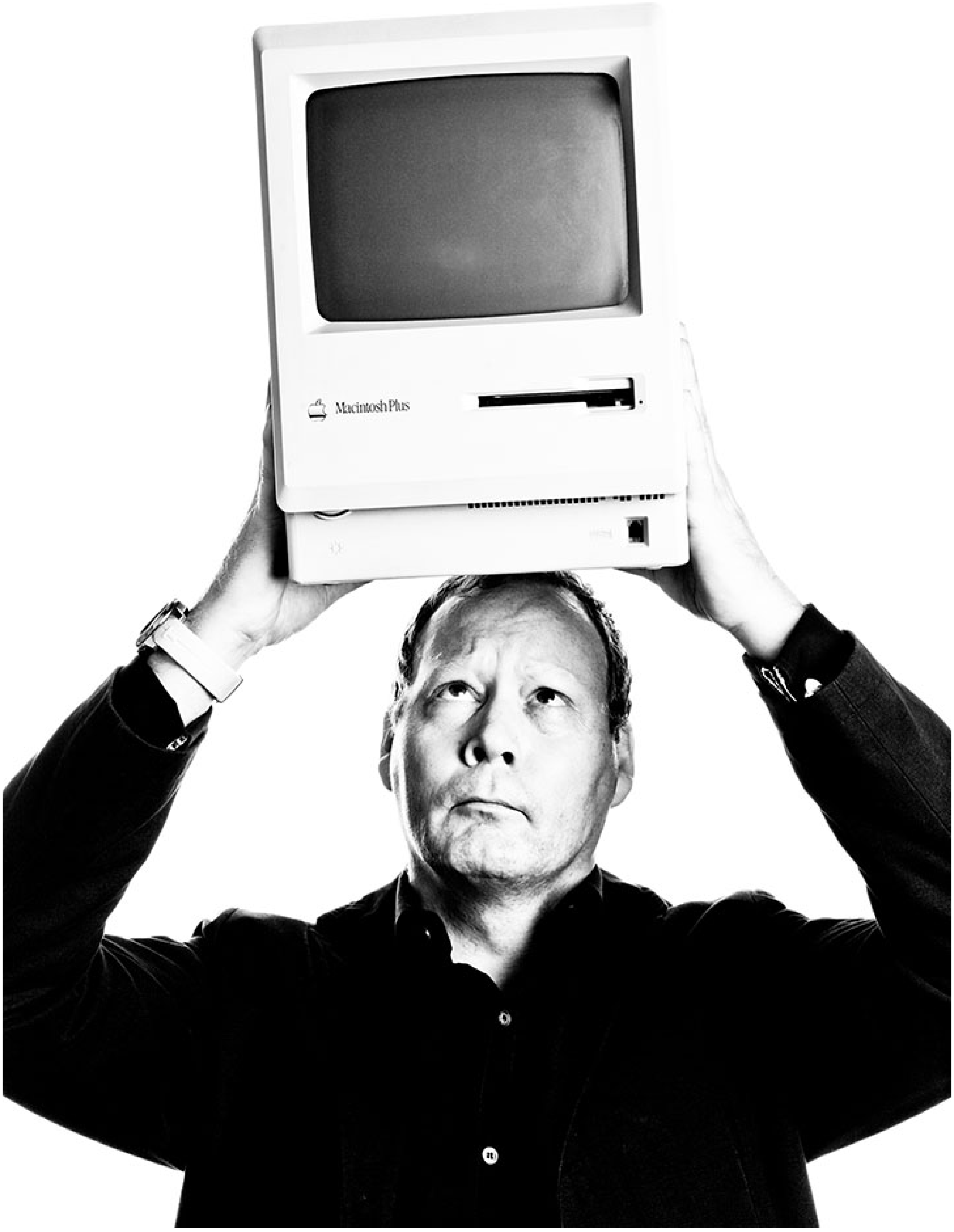

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Contents

Abstract

The electronic computer is the most significant technological product of the 20th Century. It has changed the lives of a vast number of people beyond recognition. It has changed our work, our leisure, and our relationships with each other. Its development has taken place in a period where an increasing amount of information is documented and recorded, and yet elements of its history, particularly its social history are indistinct.

A number of histories have been written about the computer. Mostly, these address the technical developments and economic or business histories behind the products rather than the designed form of the computer itself. They have tended to view the development of computing from a technologically deterministic perspective. By presenting the computer as the result of inevitable technological progress, they have ignored the social agency of their users and the cultural contexts in which they operate.

Over the past ten years, I have researched and published on various aspects of computing technology from a social construction perspective. Using a novel methodology developed and tested over a significant period, this body of work has considered the acceptance and use of computers by different social groups, exploring the role of the computer as a tool of production, a means of control, and as an indicator of status. It has considered the designed form and the depiction of computers in mass media and popular culture to assess the influences on its design and its role in social relations, and in the process has made an original contribution to knowledge in the field of design history.

This submission draws together five published articles from this body of work, which individually trace the history of the conception, production, representation and consumption of different types of computer. Collectively, these articles construct a coherent account exploring the design history of the computer as a social and cultural artefact.

Glossary of Abbreviations

ANT: Actor-Network Theory – a subset of SCOT, which removes the distinction between social (human) and non-human agents in the mediation of technological development

CHM: Computer History Museum, Mountain View, California, USA

CRT: Cathode Ray Tube

DVD: Digital Versatile Disc – where this appears as a picture credit, it refers to a screen grab captured from the DVD itself.

IDEO: an industrial design consultancy based in Palo Alto, California, USA

NAHC: National Archive for the History of Computing, Manchester University, UK

PC: Personal Computer

SCOT: Social Construction of Technology – the view that technological developments are mediated and influenced by social drivers

SST: Social Shaping of Technology – another term for Social Construction of Technology

TD: Technological Determinism – the view of technological development as a logical, linear development outside of societal influence

Acknowledgements

I would like to take this opportunity to thank all those who have helped in the course of my work leading to this submission.

Firstly a thank you to the publishers of the journals in which these articles appeared for allowing them to be reused in this way. A number of people have helped during the research and publication of the submitted articles themselves, in agreeing to be interviewed and in responses to letters and emails, in providing contact information, access to archive materials and sourcing information and images, and in offering valuable feedback to initial drafts. In particular, these include Jon Agar, Celeste Baranski, Paul Bradley, Dennis Boyle, Kate Brinks, Stuart Card, Ken Dulaney, John Ellenby, Doug Engelbart, Jeff Hawkins, Sam Hurst, Alan Kay, Bill Moggridge, Peter Muller, John Neale, Richard Satherley, Ralph Sklarew, Rickson Sun, Bill Verplank, Sarah Wilson, Jim Yurchenco and The Editorial Boards of the *Journal of Design History* and *Design Issues*.

With respect to the writing of this overview I would like to add John Clute, Nic Maffei, and Andrew Sawyer to the above list. My thanks also go to Richard Fellows for allowing me time to write it. In particular I would like to thank my advisor, Keith Laybourn, and Jane Mullen for their advice and feedback.

Introduction: development of a methodology

The starting point for this overarching project and for my interest in exploring the design history of the computer came about during a piece of archival research which involved a trawl through the back issues of *Design* magazine. The 'News' sections of issues from the 1970s frequently contained images of objects referred to as 'computers' designed by prominent practitioners or consultancies of the day. It was striking that the products in these images bore little or no resemblance to the products referred to as computers by current users – the pale grey/beige boxes under CRT monitors with keyboards and mice that seemed to be a permanent feature on the desks of almost everyone who worked in an office. The more I browsed the pages of these old design journals, the more examples occurred. Computers had evidently not always looked the way they did, and they did not all look the same. They had taken a wide variety of forms, been made in different materials and had in fact been brightly coloured, fascinating objects.

My level of interest in this observation can perhaps be explained when seen in the context of my own background as a practising Industrial Designer. I am fully aware of designers' desire to create original forms, and have first-hand experience of the various, sometimes frustrating constraints that can circumscribe these desires. In understanding the designers' drive for originality, I found it quite strange on reflection that the design of computers had turned out to be so formulaic, repetitive and nondescript. I wanted to understand what constraints had prevented the variation in form seen in earlier products.

It was perhaps obvious that early computers had looked vastly different to those of today, as it is common knowledge that early computers, in the late 1940s and 1950s, were large mainframe systems that took up whole rooms. But the objects displayed here were the developmental, often seemingly experimental forms of computers, which appeared between those early mainframe behemoths and the desktop PC that represented computing technology in the 1990s. To a designer and a design historian it was incredible, though perhaps not surprising, to think a whole industry could produce so many items over such a long period that had, for whatever reason, disappeared from the collective memory. These were not well-known products of the past that appeared in design history books, not 'design classics' or 'icons' considered 'important' in design historical terms, yet they were clearly an important part of the history of one of the most influential and important products of the twentieth century – a product that impacted heavily on almost everyone in developed society.

There were some very interesting and potentially important research questions to be explored here. First, it seemed clear from its important role in the lives of people at work (as business equipment) and at home (as a consumer product) that the computer is a significant part of the social and cultural milieu, and yet nothing seemed to be written celebrating the designed form of the computer or positioning the computer firmly as a cultural and social object. Could it be convincingly argued that the designed form of computers has been important and integral to their role as a cultural artefact?

Second, there had clearly been a paradigm shift in the accepted interpretation of the term 'computer'. In semiological terms, the object signified by the word 'computer' had changed over time, and my suspicion was that the interpretation of the term I held was probably similar to the vast majority of people who used computers today but were not involved in the computing industry (i.e. 'lay' users). Yet the word had obviously meant something completely different in design terms in the 1940s and 1950s, although similarly, the interpretation of the term at that time was possibly widely held and understood. As there were such extensive differences between the objects the term 'computer' has referred to, there was likely to be a corresponding shift in the relationship between the object itself and the user even though the term used to describe the different objects had remained the same. How has the relationship between the computer and the user changed over time? In what ways has the designed form of the computer affected this relationship?

Third, there was the question of why the computer had started in one ‘fixed’ form (the mainframe) and ended up in another ‘fixed’ form (the desktop PC) going through so many variations in-between that had largely vanished without trace. It is possible to see this as a similar process to that which occurred with the introduction of other technologies (for example in the design of radio sets) when a number of manufacturers producing similar products tried to differentiate themselves from each other and create the ‘archetypal’ form that would define the product. The difference here, raising an interesting question, is that the various different forms other products have taken are fairly well-documented and known to a wide audience outside of design history. Taking the radio as an example, there is a huge interest in its history – they are collected widely, ‘classic’ examples are selected by connoisseurs as key points of development, which are then displayed in museums and reproduced in design history books. Catalogues exist describing each model produced by different manufacturers. There is a level of interest in the history of the form of the radio that has preserved its heritage on a much larger scale than for the computer. Why is this? Was the history of the form of the computer readily available for examination somewhere, and if not, then why not? My initial reading of secondary sources (see *Literature Review and Update*, p. 19) confirmed that my questions had not been answered in the existing literature, and that primary research was required.

Imagery

My first aim then, leading to the primary aspect of my methodology in image analysis, was to search for as wide a variety of examples of different forms of past computers as possible in order to understand the scope of the subject matter with which I was dealing. Searching for a museum of computing to visit proved to be difficult. An internet search showed that there was a computer museum in the USA, as one might expect given its involvement in the founding of the industry, but there was none in the UK apart from a number of unrelated small collections held by individuals. There were a few on-line, ‘virtual’ museums of computing, but these typically focused on the technical developments involved rather than any aesthetic considerations, and much of the imagery they contained was of very poor quality. Only one reference was made to a ‘professional’ source in the UK, and that was for the National Archive for the History of Computing (NAHC) held at Manchester University. A visit was arranged to meet the curator, Dr. Jon Agar, to see what was contained in the archive.

Sadly, there was not a physical collection of computers as there was not space, but there were a number of filing cabinets holding documentation of the work of the university in the development of computing (as the place where the ‘Manchester ‘Baby’’, the first electronic digital stored-program computer was built in 1948, it is an appropriate place for such a National Archive). Also held were the papers of now defunct British computer manufacturers including International Computers Limited (ICL), Ferranti Ltd and LEO Computers Ltd. The vast majority was specialised technical and business information and had little promise as the source of a visual record of the history of computing. The other main collection held in the Archive, though, turned out to be exactly what I was looking for. The Trade Catalogue and Machine Literature collection consisted of manufacturer’s brochures aimed at business users covering the period from the late 1940s to the early 1980s. These brochures had been catalogued and arranged in alphabetical order of the manufacturer, but had not been published in any way.

My initial use of this archive was an ordered search through all of the brochures (all 96 archive boxes), noting whenever good quality images of different computer forms or relevant text occurred. The images and related texts were copied, creating a slide library of different computer forms and associated contextual information. The different images were dated as accurately as possible and placed in chronological order. Then, the images were split into different groups having similar arrangements of form. For example, computers having terminals that had separate keyboards and monitors were placed together, as were terminals where the monitors and keyboards formed a single unit. Using a number of different features, this process resulted in a ‘taxonomy’ of 21 distinctly different forms of computer, each containing examples over fixed periods of time, which gave an indication as to when each form appeared and how long it lasted in manufacture (the problems associated with this process, and the resulting 21 forms are documented in detail in the first submitted publication, *Computer Memories: the History of Computer Form*).

Although I have mentioned in the submitted articles some of the limitations of the visual material collected for analysis, it would perhaps be useful here to examine them in some more depth. I have repeatedly pointed out in the articles that the brochures collected for analysis must not be confused in any way with documentary evidence. Manufacturer's brochures have a purpose to sell the benefits of their companies' products, not to objectively record reality, and although the actual forms of the computers in the brochures can be assumed to be accurate, it cannot be assumed unquestioningly that the context in which they are shown or described is as veracious. The photographs taken of computers in situ will almost certainly have been staged specifically for the brochure, and it is more than likely that the people shown using the computers are not actual employees of real offices but models engaged for the purpose. As long as these facts are borne in mind, though, the material is valid for analysis. The brochures are aiming to show the use of the products in real-life settings, and the marketing people, designers and photographers involved in their creation will have strived to represent their interpretation of that setting, albeit a sanitised and mediated interpretation. These brochures are mostly aimed at corporate buyers, and in order to show new, unfamiliar products in a familiar setting will therefore portray perceptions of 'typical' office environments and perceived stereotypical roles of various office workers and business managers. The manufacturers' notions of 'ideal users' lead directly to a number of gender and status issues, and It is these perceptions of the workplace that are being semiologically analysed, as opposed to an ethnographic survey of computer users opinions.

Another limitation of the available material reflects a limitation of the work being described. The vast majority of brochures collected originate in either the UK or the USA, with a small number from manufacturers in Western Europe. There are no examples of images from the Eastern Block, for example, or from Russia, Australasia or Asia, other than later material from Japanese corporations – and these have almost always been re-presented for a Western European or American market by overseas marketing divisions. This limitation, though, has not been as significant as it might have been for some products, as the computer is an example of a truly 'global' product. Certainly, over time, the presentation of computers in a single designed form has occurred across the world, although of course, this does not mean that one can assume any level of heterogeneity of usage in the different markets.

Another aspect is important to consider when analysing manufacturers' brochures, but even more so when the search is expanded to cover magazine and newspaper adverts. The target market for brochures, and certainly for adverts obviously has a significant effect on the imagery used and the representation within the adverts of the objects themselves. As an example, computers being advertised in specialist industry magazines, especially technical magazines, do not have the same imperative to place computers in context in order to explain their use in situ, as it can be taken as read that the viewer will understand the role of the computer in question, just as they will understand the technical jargon and acronyms that invariably accompany the text. Although this phenomenon becomes more widespread and to wider audiences as products become more commonplace in the market, the target audiences of mainstream media are more complex. There are significant differences between the target markets of broadsheet and tabloid newspapers, their different weekend supplements and various lifestyle magazines, which are reflected in the adverts appearing in them. I have received copies of a range of adverts from Sony, for example, clearly showing the different advertising campaigns aimed at different fashion magazines targeted at men and at women. Again, as long as these agendas are recognised and understood, an objective reading of the imagery is not too problematic, although it does point to the limitations of the work as far as a comprehensive study of computer advertising is concerned. There is scope, perhaps, for a more in-depth, quantitative analysis of a wider range of material, but this is outside the scope of this project, and moreover, does not invalidate the observations made here.

Finally, there is imagery of computers as represented in film. I have collected examples where computers are seen as new, exciting or threatening and have formed a central part of the plot of the film rather than part of the background environment. Here, it really is the representation that is the issue as these films, largely in the science fiction genre, have specifically used computers as a metaphor with which to explore society's relationship with technology.

Interviews

My own background as an industrial designer and my inside knowledge of the industry and its leading figures led directly to the secondary aspect of my methodology in semi-structured, in-depth interviews. I had come across imagery of computers designed by leading consultancies in my search through *Design* magazine, which mentioned the designers by name, gave short descriptions of relevant or innovative design features and materials used – information often supplied by the designers themselves. On searching the Trade Catalogue and Machine Literature collection at the NAHC, I came across corporate brochures promoting the same computers, which obviously took a completely different approach in focusing on the technical capabilities of the machine, its cost, value and benefits to the purchaser. It struck me that knowing how often corporate design briefs conflicted with, or at least compromised designers' intentions, it would be interesting and fruitful to talk to the designers concerned and hear their perspective on the developments of the products. Being a designer myself, talking to other designers about their work was a 'natural' activity, and held no concerns as I spoke exactly the same language. I am aware, though, that this fact, as well as providing useful insights, means that care has to be taken to maintain objectivity and show no predisposition.

The computer on which I chose to try this method was the ICL DRS20 Model 20 Desktop Computer, which I knew had been designed by Richard Satherley of Satherley Design Associates in 1982. I contacted Satherley, who invited me to his London studio to discuss the design work involved. The interview provided me with primary material which interestingly contradicted information I had read in *Design* magazine articles and was not evident in the trade catalogues. This in itself proved the value of interviews, and the information provided was used in the first article.[1] As I progressed later to cover the development of mobile computing, this aspect became more and more important until by the last submitted article it is the principal source of information used. As described in the following section *Description of the Articles*, the design of a large number of computers has been carried out by a relatively small number of designers, and central to these has been Bill Moggridge, the founder of IDEO design consultancy. Initially providing me with information about his own design work on the first laptop computer, Moggridge has provided access to his own design team as well as to a wide range of industry contacts. His personal endorsement of my work has been invaluable in meeting key people involved in the development of computer design. Additionally, perhaps because I clearly understood the design work discussed in the interviews, Satherley, Moggridge and others have also discussed and provided images of prototype designs which have not gone into production – information which, apart from being unavailable elsewhere, gave a unique insight into aspects of the models which actually had made it into production.

As with the use of trade catalogues and adverts, the use of interviews such as these has also to be treated with some caution. The information provided is not unadulterated fact but an individual's view on the development of a product from a particular perspective. As stated, one has to ensure objectivity is maintained, and that the information provided is checked against or balanced by alternative sources and viewpoints. The people being interviewed are not historians or academics but practising designers, engineers or business people and are working to a different agenda. More often than not, accurate records have not been kept, and reliance is made on memory. The value of cross-referencing these recollections is demonstrated when interviews with a number of people involved in the same projects have been conducted and have produced conflicting information. Consequently, it has to be acknowledged that the information provided cannot be guaranteed to be perfectly accurate or complete, however honourable the intentions of interviewees. I have occasionally, and unintentionally, dented the ego of people I have interviewed when a finished article has appeared which contradicts statements made in interviews. Such is the price of objectivity.

[1] P Atkinson, 'Computer Memories: The History of Computer Form', *History and Technology*, 15(1-2): 1998: p. 110

Theory

One of the first tensions emerging through the arrangement of collated imagery into chronological groupings as described above was that by creating a taxonomy or ‘family tree’ of computing form, there was an obvious analogy to be made to evolutionary development. The appropriation of the terminology of evolution in design history has been and still is a problematic area. Evolutionary development has at times (particularly in early design historical accounts of product development) been accepted as a suitable analogy to design development, and at other times the approach has been dismissed as wholly unsuitable. I started with the thought that an evolutionary analogy could be usefully adopted. After all, authors such as Henry Petrosky, writing from a technically deterministic point of view, had successfully taken evolutionary development as a model of design development in his book *The Evolution of Useful Things*, and numerous published versions of computer ‘family trees’ could be found (Figure 1), although none of these had any reference to the physical form the computer had taken.

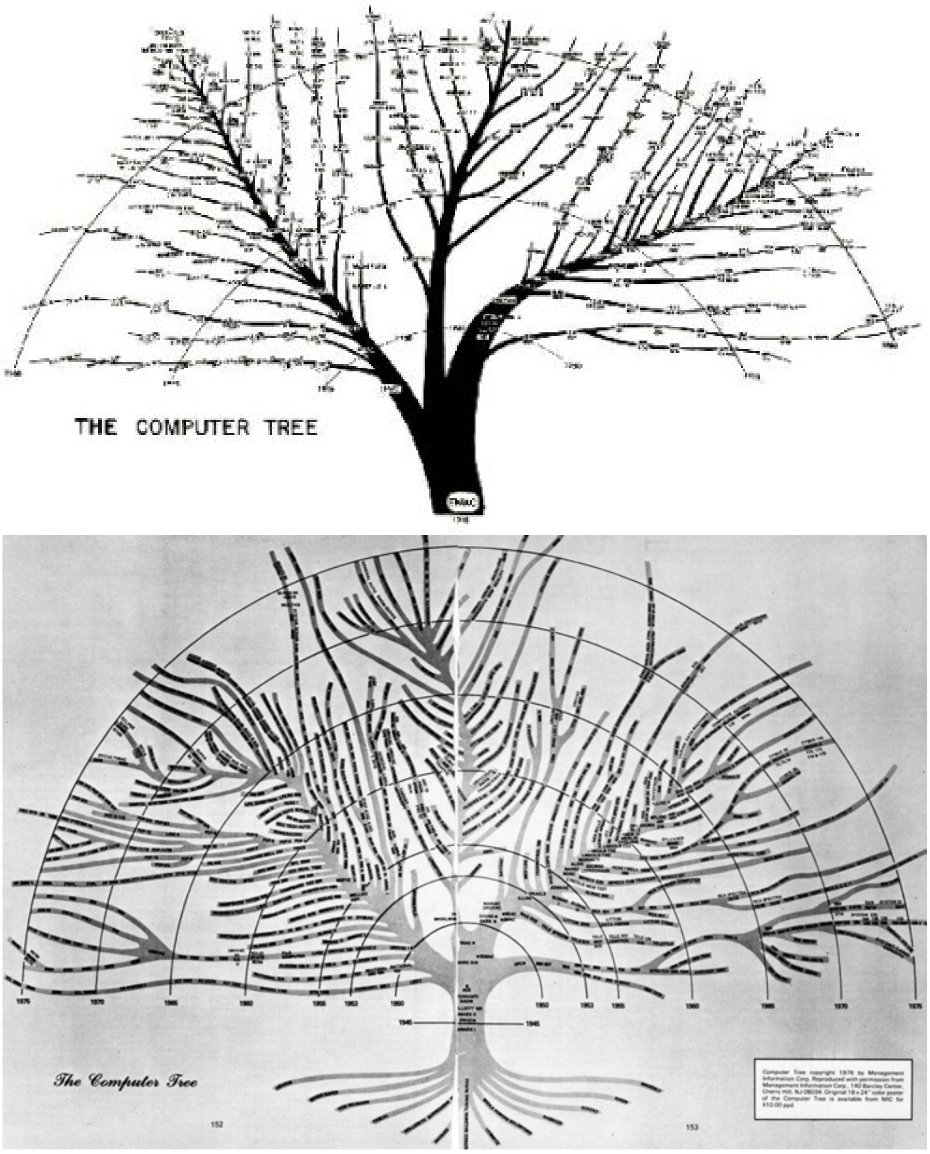

Figure 1: Top: ‘The Computer Tree’ from *Electronic Computers Within the Ordnance Corps* , by Karl Kempf. 1961.[2]‘ Bottom: The Computer Tree (genealogical chart of computer systems)’ published as a poster in 1976 by Management Information Corp.,[3]

[2] Viewed 17 Jan. 2008 <http://ftp.arl.army.mil/~mike/comphist/61ordnance/chap7.html>.
[3] Reproduced in D Ahl and B Green, (eds) *The Best of Creative Computing Volume 3*, 1980. Viewed 18 Jan 08 <http://www.atariarchives.org/bcc3/showpage.php?page=153>.

The notion of an evolutionary account of computing history provided the title 'On the Origins of PCs' – a direct reference to Darwin's *On the Origins of Species*. I even toyed with a visual family tree of computer forms (Figure 2), placing closely related forms together and showing where forms 'split' into different lines of development.

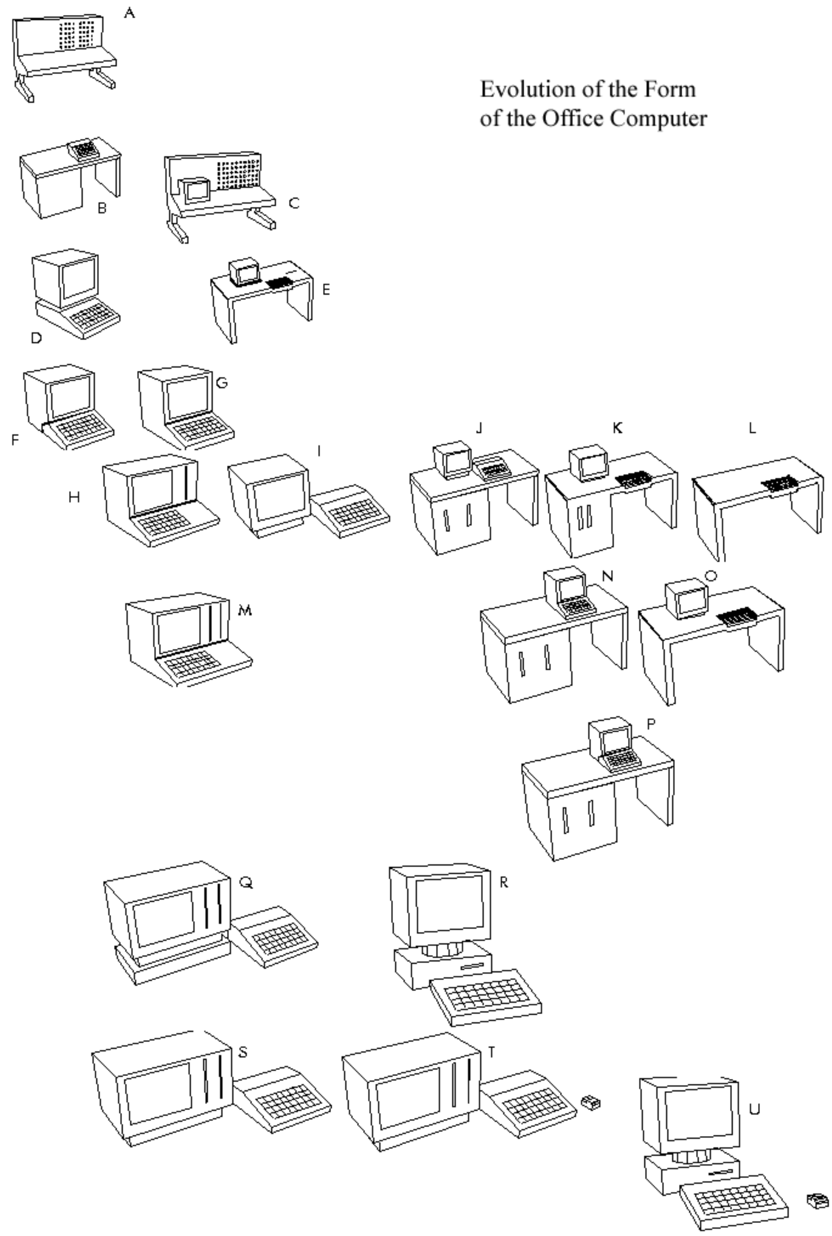

Figure 2: A 'family tree' of the visual form of the computer. Drawn by Paul Atkinson, 2000

It became clear on further reading of secondary sources, though, that evolution was, at that time, out of favour as a method of discussing design development. The term was not mentioned or any arguments from an evolutionary perspective discussed in my first article, or (on the advice of the editor) in my second article. Interestingly, since the time of these articles, a great deal more work has been done in the area of design and evolution, exploring the boundaries where elements of evolutionary theory might be usefully employed as an analytical framework for design history. A number of leading scholars have been publishing in this area (notably Professor John Z. Langrish at Salford), and the notion of evolution has been the theme for at least two recent international design and design history conferences (*Design>System>Evolution*, the 6th European Academy of Design conference, 2005, Bremen and *Design and Evolution* the 2006 Design History Society Conference in Delft).

Even though it has not been used as an analytical framework here, there are a number of similarities between evolutionary theory and the methodology adopted in the submitted work. The Social Construction of Technology (SCOT), as is explained in detail later (see the section *The Social Construction of Technology*, p. 22), is opposed to a simplistic linear model of technological change (as proposed by models such as Technological Determinism (TD)) and proposes instead a 'multidirectional' model of development, whereby a number of alternative technologies (or versions of a technology) are developed and offered concurrently and either succeed or fail in terms of user adoption. Comparisons can easily be drawn, then, between the processes of random mutation, adaptation and natural selection found in evolutionary theory and the processes of design variation and user selection found in SCOT. Indeed, this aspect has been the target of criticism. Stewart Russell argues that the 'evolutionary model' proposed by SCOT is narrow in its scope, assumes that a full range of concepts spontaneously appear, or at least are not open to social analysis, and therefore does not consider possibilities or variations of a technology which, for whatever reason, were not presented to the user.[4] Trevor Pinch and Wiebe Bijker (the main founders of SCOT) completely disagree with this view, arguing that the crucial aspect of their approach, and the one that distinguishes it from TD, is to focus on exactly that – the range of alternative technologies produced, successfully or otherwise. They do not suggest all variations appear simultaneously, and that as an empirically oriented programme of analysis, identifying possible alternatives which might theoretically have appeared but never did is outside the scope of the programme and is problematic in itself (as well as being slightly pointless).[5] These similarities between evolutionary theory and SCOT seem to me to make this a valid theory to adopt as an analytical framework for exploring the design history of the computer.

Summary

On the surface, and especially to readers outside of design history, it may appear that a lot of my writing has been based around very similar issues. With hindsight, though, my first article was not only highly novel in its approach but was also very wide ranging. The article was not focused on one particular question but was more a generalised overview of the historical development of form of one object. Consequently, the conclusions of that article tentatively raised a whole series of research questions that needed to be explored in more depth. The short statements made in the conclusion pointed to some of the themes that would recur in the majority of my work and that would later lead to a much greater depth of analysis.

The common threads identified which run through a number, if not all of the submitted articles have been drawn together and expanded to form separate sections of this overview in order to stress their importance when taken as a whole. The first theme concerns the theoretical aspects of social constructionism and the rejection of technological and economic determinism, which informs the analysis of visual, textual and aural research material throughout, and is discussed in *The Social Construction of Technology* (p. 22.). The second theme considers the importance of power and gender relationships in the acceptance of computer technology and issues of hierarchical status in the workplace, which are discussed in *Power and Control* (p. 28). The third theme looks at the impact of popular culture, including film and advertising, on the designed form of computers, and the changing representation of computing technology in advertising. An aspect of the imagery of early computers I was drawn to is the ways in which manufacturers clearly used their designed forms to reflect received notions of 'futuristic technology' that were propagated through science fiction. The effects that this representation of computing had on our relationship with the technology are discussed in *Futuristic Fantasy* (p. 49).

Computer Memories was really, in retrospect, a positioning paper laying out a whole program of study which would inform my design historical research in this area over the next decade and culminate in the bringing together of that work into this submission.

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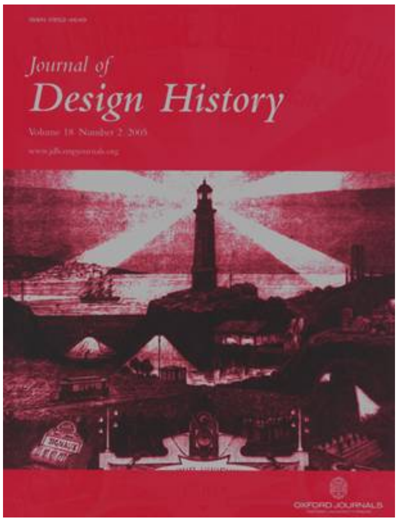
[4] S Russell, 'The Social Construction of Artefacts: A Response to Pinch and Bijker', *Social Studies of Science*: 16: 1986: p. 333

[5] T Pinch & W Bijker, 'Science, Relativism and the New Sociology of Technology: Reply to Russell', *Social Studies of Science*: 16: 1986: p. 352

Description of the Articles: their origins and impact



Synopsis

The five articles submitted for this PhD by Publication form a coherent enquiry into the design history of computing technology and the development of personal computing, and placed together, enhance the canon of published literature in the area.

The articles chart the development of computers from room-sized mainframes of the late 1940s through minicomputers, leading to the desktop PC in the 1980s, and the introduction of the graphical user interface and mouse. The introduction of mobile computing in the 1970s is traced, including the appearance of the laptop in the early 80s along with the inclusion of touchscreen technology leading to the tablet PC and eventually to the personal digital assistant (PDA).

Throughout these individual case histories there is a consistency of research methodologies employed and a number of recurring themes that are explored. The research methodologies include the analysis of visual and textual archival material (manufacturers' brochures) and newspaper advertisements, which directly or indirectly reference computing technology. This analysis has been coupled with semi-structured in-depth interviews and personal communications with the designers, engineers and entrepreneurs involved in the design and production of the various products discussed.

The common themes identified and previously mentioned are brought together, contextualised and expanded in later sections. The approach taken throughout this study has highlighted the differences between the intentions of inventors, designers and manufacturers and the subsequent consumption of technology by relevant social groups, supporting the view that computers are socially constructed rather than merely technologically determined.

Articles submitted:

Article 1) P Atkinson, 'Computer Memories: The History of Computer Form',
History and Technology, 15(1-2): 1998: 89-120.

Article 2) P Atkinson, 'The (In)Difference Engine: explaining the disappearance of diversity in the design of the personal computer', *Journal of Design History*, 13(1): 2000: 59-72.

Article 3) P Atkinson 'Man in a Briefcase: the social construction of the laptop computer and the emergence of a type form', *Journal of Design History*, 18(2): 2005: 191-205.

Article 4) P Atkinson, 'The Best Laid Plans of Mice and Men: the Computer Mouse in the History of Computing', *Design Issues*, 23(3): 2007: 46-61.

Article 5) P Atkinson, 'A Bitter Pill to Swallow: the Failure of the Tablet Computer', *Design Issues*. (In Press)

Other relevant work:

These five articles are part of a larger corpus of work published in the area of the design history of the computer. A full list of other relevant published and disseminated works, including published conference papers, keynote speeches and research workshops appears in Appendix 1.

Article 1: Computer Memories: The History of Computer Form

This article was my first published work in the area of the design history of the computer. It formed part of a Special Issue of the journal *History and Technology* titled 'History of Computing: Approaches, New Directions', which was guest edited by Dr. Jon Agar, who at that time was the curator of the National Archive for the History of Computing at Manchester University. Agar was aware of my research through my visits to the archive in search of images of old forms of computers (See Introduction: development of a methodology). He invited me to submit an article based on that research, as he saw the methodology and approach of a design historian as an interesting contrast or comparison to those taken by historians of technology or economic/business historians:

> The remaining two essays approach history of computing from different perspectives again. History of technology and design history have grown in parallel, but with surprisingly little interaction. Paul Atkinson is a design historian, and the questions he asks are thus different from those of a business historian or a historian of science and technology.[1]

The aim of this article was to show the development of the physical form of the computer over time, and to highlight the manifestly different forms the computer had taken before becoming a 'standardised' form, where all manufacturers' products look incredibly similar. Using the library of slide images of different computers that I had assembled (around 275-300 different images) I proposed that there had, in fact, been 21 distinctly different arrangements of the computer before it became 'fixed' in the arrangement most people were familiar with, the Desktop PC. To illustrate these different forms, I created an outline AutoCAD drawing of each one as a 'generic' reference (so that the drawing could not be related to a particular model or manufacturer), and added a small table describing the arrangement of components and the dates of its appearance/disappearance in the market (which, as described in the article, was problematic). The purpose of the drawings and tables was to allow some kind of direct comparison of the different forms over time. As a consequence of this, the majority of the article was narrative description, with a small amount of analysis at the end. The original aspect of the article was the view that computers were social and cultural artefacts as well as technological objects, and that moreover, the different social roles of different types of computer were in fact reflected in the physical forms and design of those computers.

The work was clearly new in concentrating on the designed form of the computer, as I had searched and failed to find anything remotely similar. As it was my first published work, and as it was breaking completely new ground, the tone of the article (particularly its conclusions) is perhaps understandably tentative. I had no track record to build on and could not judge the likely response to my methodology or hypothesis. Despite this, the article presented a new direction for the analysis of the designed form of the computer (as per its role in the special issue) that made connections between design history, the history of technology and the history of computing, and reached a wide audience, with information from my chronology of computers being cited in an academic article by a group of Dutch authors[2].

I now know that this study appeared at the forefront of what has since become a lively area of debate. Since the publication of the article, the canon of works exploring the subject matter of the designed form of the computer and its consumption has grown significantly, as described in the following literature review.

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[1] J Agar, 'Introduction: History of Computing: Approaches, New Directions and the Possibility of Informatic History', *History and Technology*, 15 (1-2): 1998, p. 2

[2] O de Wit *et al*, 'Innovation Junctions: Office Technologies in the Netherlands, 1880-1980', *Technology and Culture*, 43(1): 2002: 50-72

Article 2: The (In)Difference Engine: Explaining the Disappearance of Diversity in the Design of the Personal Computer

The second article submitted built substantially on the pioneering work of *Computer Memories*. In between the first article and this one, I had carried out a small research project and written a conference paper titled *Work, Rest and Play*[3]. This piece of material culture writing was a study of the ways in which people decorated and personalised their workspaces based on rapid ethnography research methods and semi-structured in-depth interviews with a range of office workers. Although this was not to do with the design history of computers, an element that I had identified in *Computer Memories* found some resonance here. The interviewees reacted to the computers on their desks with some indifference, describing them as bland, boring grey boxes. The attitude reflected the lack of design variety I had noted in the design of computers. I used this element of indifference as the starting point for the article, framing the research question of why the form of the computer had become so standardised.

The introduction to this article referred directly to the research and methodology that had resulted in *Computer Memories*, and took two of the themes of that article forward in much more depth to try and explain this lack of diversity in the design of the computer. *Computer Memories* had hinted at the impact of popular culture, and in particular the zeitgeist of the 1960s space race on the designed form of the computer. The first part of *The (In)Difference Engine* took this further, exploring the futuristic aspects of computing technology, often informed by popular culture and in particular, science fiction films. The other aspect mentioned at various points throughout *Computer Memories* was the role of gender, status and power relations of males and females in the workplace. The second part of *The (In)Difference Engine* looked at this aspect in more depth, showing how these power relationships had been reflected in the creation of different types of computers. A key insight of this article was the realisation, evidenced through many of the images collated, that up until the mid 1980s, whenever men were shown using a computer they were never shown as actually typing, but shown as using the computer to access information. This confirmed written references I had found stating that typing in the office was, until that time, seen as women's work. This observation was later referred to and developed as a key reason for the widespread acceptance of the computer mouse in the fourth article submitted, *The Best Laid Plans of Mice and Men*.

The (In)Difference Engine reached a wide audience and sparked quite a bit of further interest in the subject. As a result of its publication I was invited to lead a PhD research workshop at Manchester Metropolitan University[4], and later, to lead a PhD research workshop and deliver a keynote lecture at a research symposium at the University of Turku, Finland,[5] as well as being asked to give a keynote lecture at a research conference at the Design School in Kolding, Denmark.[6] The article was also cited in an academic journal article by a Greek author[7], as a comparative example of products taking a standardised form and the consequent affect on the perception of those products.

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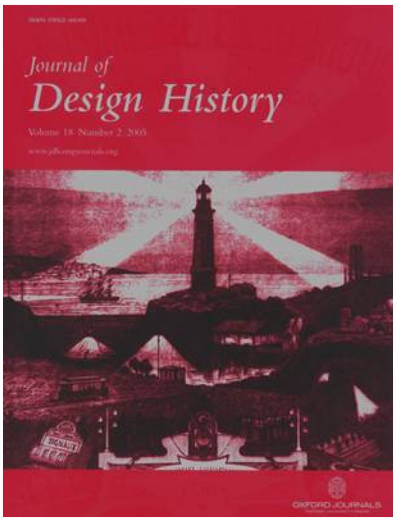
[3] P Atkinson, 'Work, Rest and Play', *Design Cultures: Proceedings of the 3rd International Conference of the European Academy of Design*, Sheffield, April 1999 Vol. 1, pp. 26-56 1999 ISBN 0902896210
[4] 'The material culture of the office computer', Manchester Metropolitan University, Sept 2000
[5] 'The design history of computing technology', University of Turku, Finland, Sept 2002, and P Atkinson 'Gifs, Tiffs and Jpegs: Materiality and Museology in a Digital Age', *Symposium on Design, Technology and Cultural History*, Turku, Finland, Sept 2002
[6] 'Man in a briefcase: the social construction of the laptop computer', *Digital Design Products Conference*, Design School Kolding, Denmark, Jan 2004
[7] A Yagou, 'Shaping Technology for Everyday Use: the case of radio set design', *The Design Journal*, 5(1): 2002: 2-13



Article 3: Man in a Briefcase: The Social Construction of the Laptop Computer and the Emergence of a Type Form

The introduction to *The (In)Difference Engine* explained that the laptop computer had not been included in the analysis because it was an object that carried 'a host of unique hierarchical, status and role-setting meanings' and did not form a part of the development of the standardised office-bound Desktop PC. However, taking the wider long-term view of constructing a design history of the computer and its consumption, the development of the portable computer was a 'logical' next step to explore.

In a chance meeting with Clive Grinyer (now Head of Design at 'Orange') I discussed my research and interest in laptops. Grinyer had worked at the design consultancy IDEO, and heard interesting stories about the development of a key product claiming the title 'first laptop' - the 'GRiD Compass' computer. I interviewed Grinyer and, through his introduction, the founder of IDEO, Bill Moggridge. This provided primary research material which I combined with archival research at NAHC and telephone and email interviews with John Ellenby (founder of GRiD) and others. This research was published in the proceedings of an international conference at the University of Aveiro.[8] An opportunity to write a different aspect of the laptop's history came later that year with a research conference at the University of Helsinki.[9] For this, I analysed the changing representation of the laptop over time, as seen in manufacturer's brochures, augmented with current brochures and newspaper adverts.

When invited as a keynote speaker at 'Digitale Design Produkter' at the Design School Kolding in Denmark, I combined elements of the development of the laptop from the Aveiro paper with elements of the representation of the laptop from the Helsinki paper to create *Man in a Briefcase*. This represented the development of my research methodology, combining primary interview material with archival research and current advertising. I restructured the text, expanding elements concerning the influence of popular culture, and submitted it to the *Journal of Design History*. The key aspect of the article was the use of social construction theory (placing social drivers as the key element of technological change) to support the view of laptops as successful because they enabled the owner to portray himself as a 'playboy adventurer'.

Man in a Briefcase proved to be very popular, of interest to a wide audience. Following the Denmark lecture, I was interviewed by Danish Radio for their popular technology programme *Harddisken*, and for some years the interview was available on their website. As an article, publisher's figures show it was the most accessed PDF file in 2005/6, downloaded 365 times over the year.[10] Three years later (November 2007), it was still the 35th most downloaded article.[11]. It has been cited in numerous places – in *Designing Interactions,* Bill Moggridge cites the article as providing the authoritative definition of a laptop[12]; and different aspects of the methodology are referenced in academic articles –as an example of oral interviews being used as a research methodology in design history,[13] and as an example of the use of contemporary adverts to contextualise the consumption of products in design history.[14]

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[8] P Atkinson, 'The Laptop ~ Design or Desire?', *d^3 desire, designum, design. Proceedings of the 4th European Academy of Design Conference*, Aveiro, Portugal, April 2001, pp. 390-395 ISBN 972-789-024-5
[9] P Atkinson, 'The Material Culture of the Laptop', *Material and Ideal Research Conference,* Helsinki, Finland, May 2001
[10] Oxford University Press Publisher's Report, 19th June 2006
[11] http://jdh.oxfordjournals.org/reports/mfr1.dtl (accessed 20 November 2007)
[12] B Moggridge, *Designing Interactions*, Cambridge, MA, MIT Press, 2006, p. 9
[13] L Sandino, 'Oral Histories and Design: Objects and Subjects', *Journal of Design History*; 19(4): 2006: 275–282
[14] M Groot, 'Crossing the Borderlines and Moving the Boundaries: 'High' Arts and Crafts, Cross-culturalism, Folk Art and Gender', *Journal of Design History*, 19(2): 2006: 121-136.

Article 4: The Best Laid Plans of Mice and Men: the Computer Mouse in the History of Computing

One aspect of the history of computing had always puzzled me. The story of the launch of the Apple Macintosh in 1984 was a well-known one, and the consequent success of the Graphical User Interface (GUI) operated through a mouse was everywhere to be seen. Yet it is almost as well-known a story that the mouse was invented 20 years earlier by one Douglas C. Engelbart. Why had such a successful design taken so long to move from an invention to a product, especially in an industry recognised for rapid progress?

Researching this further, it became clear that the team of people that had developed the first Apple mouse were a consultancy called Hovey-Kelly, which had since merged to form IDEO. Bill Moggridge extended an invitation to interview that design team, as well as the person who had designed the most successful Microsoft mouse, who also happened to work there (for a large industry, many of the important pieces of design work have been done by a relatively small group of people). Bill Moggridge, having worked in the industry for so long, has an impressive list of contacts, and put me in touch with Douglas Engelbart himself, and with Stuart Card, who was involved in the development of the first Graphical User Interfaces at Xerox PARC in the 1970s, and published ergonomic analyses of the computer mouse which influenced its progress.

I had been collecting adverts showing computers since the beginning of my research, and had compiled a large collection of adverts depicting the computer mouse as various objects – as animals, monsters, cars, aeroplanes and even sperm. Surprisingly few adverts depicted the mouse as just a mouse, which was interesting. Following the same methodology as for *Man in a Briefcase*, the primary interview material telling the story of the development of the mouse was combined with an analysis of how the mouse had been represented in advertising material, with the aim of giving a more complete picture of our relationship with the computer mouse as an object and a symbol. Once more using the theory of social construction of technology as an analytical framework, a novel conclusion was reached. The accepted wisdom of the reason for the success of the GUI and the mouse was not simply that such a system is easier or more intuitive to use, but that its ability to transform the computer from an extension of the typewriter into a product in its own right was in fact far more important than previously realised. It allowed male managers to use the computer freely without fear of being seen to be performing a low-level, feminised activity, and allowed a single designed form of computer to be employed by all levels of the corporate hierarchy.

This article has not been in print long enough to be referenced as yet, but anecdotal feedback on its success from a number of people at international conferences, and emails received from design historians internationally have been very positive. One published author from Norway has indicated that he will be referencing the paper significantly in his forthcoming PhD submission.

Article 5: A Bitter Pill to Swallow: the Failure of the Tablet Computer

As described above, the design history of portable computing was a logical next step in the overall project. The research for *Man in a Briefcase* highlighted a range of products attempting to develop the laptop into a new product that had never taken off – tablet computers. These aim to allow the user to operate the computer with a pen or stylus, as if writing on a pad or tablet.

Through the network of contacts already developed and with a successful bid to the British Academy for funding, I managed to interview Jeff Hawkins, the inventor of one of the first of the product type. This interview provided the story of that particular product and the necessary leads to follow up through primary and secondary sources. The development of the technologies necessary for these products – the pen as a computer input device, touch screen technology and handwriting recognition hardware and software were explored. As far as can be ascertained, this is the only work on tablet computers that has brought these three disparate strands of development together into a single narrative, reflecting the development of the product itself. People involved in the development of pen-based interfaces were interviewed, including Human-Computer Interface experts such as Bill Verplank and Stuart Card and, by email, Samuel Hurst, the inventor of touch screens, and the computer guru Alan Kay, who first envisaged this type of computer and predicted its development in the late 1960s. In addition, the archives of the Computer History Museum in California presented many little-known examples of tablet computers, including numerous prototypes that had never gone into production.

As the key theme for the article was the failure of the tablet computer as a product type, social construction theory was used to explain its lack of success. The conclusion through this theory alone, though, seemed problematic in this case as there were so many possible causes for the product's demise which went beyond acceptance by users. The numerous factors included the economic problems of small companies developing resource intensive products, and a number of technical reasons to do with the limitations of handwriting recognition technology and slow processor speeds as well as social causes around the 'feel' of writing on glass screens and my own observations that the semantics of the product resembled an electronic clipboard to take into account. Consequently, a more complex theory developed from social constructionism was considered – actor network theory (ANT), which takes into consideration the social, technical and economic pressures (i.e. human and non-human factors) in the development and acceptance of technological products. However, as the vast majority of technical and economic problems have now been solved and tablet computers are still being manufactured, it seems that again, social factors and user acceptance are the primary causes of product failure.

This article was accepted for publication in *Design Issues* without amendments or corrections. A letter confirming its acceptance for publication appears in Appendix 2.

Literature Review and Update

The restrictions on length of this overview prevent a fuller and more in-depth literature review. Nevertheless, it would be useful at this point to describe briefly the state of play in the field of the design history of computing at the start of my research and the situation today, in order to contextualise the positioning of the submitted articles in the canon of published works, and to emphasise the growth in interest in the topic over the course of my research. In other words, where do the submitted articles fit in the development of the design history of computers?

The history of computing technology has been of interest to scholars for some time, and the subject has produced a large body of published work. The vast majority of these works, however, have little if anything to say about the designed form of the computer itself (it is common for books on the history of computing to have no images at all), concentrating instead on the technical developments achieved in creating them or the business practices that produced them. Almost all of the works produced before 1998 (the date of publication of the first submitted article, *Computer Memories*) present the computer as the result of an inexorable, linear process of technological or economic determinism, not as a socially constructed, cultural artefact. Consequently, these have been valuable only in pointing to areas of interest for analysis, and in providing details of chronology. A bibliography of pre 1998 works addressing the history of the technology of the computer includes:

W Aspray, 'The History of Computing within the History of Information Technology', *History and Technology*, 11: 1984: 7-19
C Evans, *The Making of the Micro*, London, Gollancz, 1981
T Forester (ed), *The Microelectronics Revolution*, Oxford, Basil Blackwell, 1980
T Forester (ed), *The Information Technology Revolution*, Oxford, Basil Blackwell, 1985
S Hollingdale, & G Tootill, *Electronic Computers*, London, Penguin, 1965
M Holoien, *Computers and Their Societal Impact*, Chichester, John Wiley & Sons, 1977
Shallis, M, *The Silicon Idol*, Oxford, Oxford University Press, 1984
R Slater, *Portraits in Silicon*, Cambridge, MA, MIT Press, 1987
T Trainor, & D Krasnewich, *Essentials of Personal Computing*, New York, Mitchell McGraw-Hill, 1992
M Williams, *History of Computing Technology*, Los Alamitos, CA, IEEE Computer Society Press, 1997

Published works pre-1998 addressing the history of the computer industry include:

M Campbell-Kelly & W Aspray, *Computer: a history of the information machine*, New York, Basic Books, 1996
M Campbell-Kelly, *ICL: a business and technical history*, Oxford, Oxford University Press, 1989
R Cringeley, *Accidental Empires*, London, Penguin, 1996
J Cortada, *Before the Computer*, Princeton, NJ, Princeton University Press, 1993
J Heskett, *Philips*, London, Trefoil, 1990
J Kaplan, *Startup: a Silicon Valley adventure*, London, Penguin, 1994
S Kircherer, *Olivetti*, London, Trefoil, 1990
S Levy, *Insanely Great: The Life and Times of Macintosh*, London, Penguin, 1994
M Moritz, *The Little Kingdom: The Private Story of Apple Computer*, New York, William Morrow & Co, 1984
J Sculley, *Odyssey: Pepsi to Apple*, New York, HarperCollins, 1988

The history of IBM was of particular interest, and produced many books, including:

N Foy, *The IBM World*, London, Eyre Methuen, 1974
F Fisher *et al., IBM and the U.S. data processing industry: an economic history*, Westport, CT, Praeger, 1983
D Mercer, *IBM: How the World's Most Successful Corporation is Managed,* London, Kogan Page, 1987
J Chposky, *Blue Magic: The People, Power, and Politics Behind the IBM Personal Computer*, London, Grafton, 1989
E Pugh, *Building IBM*, Cambridge, MA, MIT Press, 1995

There are few examples pre-1998 of articles or chapters approaching the history of computers from a social construction standpoint, and even these do not address the designed form of the computer. However, they have been extremely useful in supporting the arguments put forward in the articles:

W Aspray and D Beaver, 'Marketing the Monster: Advertising Computer Technology', *Annals of the History of Computing*, 8: 1986: 127-143

L Haddon, 'The Home Computer: The Making of a Consumer Electronic', *Science as Culture*, 2: 1988

G Kirkup, 'The Social Construction of Computers: Hammers or Harpsichords?', in G Kirkup, & L Keller, (eds) *Inventing Women: Science Technology and Gender*, Cambridge, Open University Polity Press, 1992

J Webster, 'From the Word Processor to the Micro: Gender Issues in the Development of Information Technology in the Office', in Green, E. *et. al.* (eds) *Gendered by Design? Information Technology and Office Systems*, London, Taylor & Francis, 1993

In the context of the published work above, *Computer Memories* certainly stood out in addressing the changing form of the computer. I have developed this topic significantly over the past decade, exploring in more depth the social and cultural agents and the subtle and complex influences driving the development and acceptance (or rejection) of different types of computer. In exploring this aspect I have made use of a number of methodological and theory texts which do not appear in this review, as they concern a slightly different area of study than the articles per se. However, a critical review and analysis of these texts appears in the following section, *The Social Construction of Technology* (p. 22).

In the submitted articles, I have also made references to a number of texts discussing different aspects of popular culture, where they have been relevant in supporting my arguments for societal and cultural influences on the design of computers. As these have otherwise been tangential to the main topic under discussion here, there is no real point in repeating all of these references. They are, of course, fully referenced in the articles themselves. The academic field of popular culture studies and visual culture studies is a broad and well-established one, covering a number of different aspects and having its own journals, and is continuing to grow. Certain texts on aspects of social and cultural theory, though, have consistently been more relevant and therefore more central to my work than others, and these are listed here:

M Csikszentmihalyi & E Rochberg-Halton, *The Meaning of Things: Domestic Symbols and the Self*, Cambridge, Cambridge University Press, 1981

M Douglas & B Isherwood, *The World of Goods: Towards an Anthropology of Consumption*, Harmonsworth, Penguin, 1980

D Hebdige, *Hiding in the Light: On Images and Things*, London, Routledge, 1988

G McCracken, *Culture and Consumption*, Bloomington, Indiana University Press, 1988

J Williamson, *Decoding Advertisements*, London, Marion Boyars, 1978

As the computer has become an increasingly significant part of people's lives, interest in its history has continued to grow. Since the late 1990s, a number of new works have appeared. As the technology has matured, there are fewer recent works that focus solely on technological developments. An interesting example, yet which is very visually biased, comes from the Computer History Museum itself:

J Alderman, *Core Memory: a visual survey of vintage computers*, San Francisco, CA, Chronicle Books, 2007

Other 'illustrated histories' have appeared, and these too are interesting studies but do little to analyse the form of the computer, and consequently they have not been that relevant to my work, other than to confirm an interest in the subject from a wider audience:

M Frauenfelder, *The Computer: An Illustrated History*, London, Sevenoaks, 2005

G Laing, *Digital Retro*, East Sussex, Ilex Press, 2004

C Wurster, *Computer: An Illustrated History*, Köln, Taschen, 2002

Interest in the computer industry itself has remained high, and case studies of several computer companies are now available, as well as more general histories and histories of software. Again, their subject matter means they are useful as references to chronology more than anything else, although the Ceruzzi text is perhaps closer to my own work. A full list would be too long, but a selection of the more interesting and relevant ones is shown here:

B Bagnall, *On the Edge: The Spectacular Rise and Fall of Commodore*,
New York, Variant Press, 2006
M Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog*,
Cambridge, MA, MIT Press, 2003
P Ceruzzi, *A History of Modern Computing*, Cambridge, MA, MIT Press, 1998
S Cohen, *Zap!: The Rise and Fall of Atari*, Philadelphia, PA, Xlibris Corporation, 2001
M Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*,
London, Orion Business Books
D Kaplan, *The Silicon Boys and their Valley of Dreams*, New York, William Morrow, 1999
J Livingston, *Founders at Work: Stories of Startups' Early Days*, Berkeley, *CA, A*press, 2007
J Markoff, W*hat the Dormouse Said*, London, Penguin, 2005

The vicissitudes of Apple Computers have perhaps understandably eclipsed IBM as a topic of interest, and numerous works have appeared containing differing, often contradictory personal accounts of the development of the Macintosh computer:

J Cruikshank, *The Apple Way*, New York, McGraw-Hill Professional, 2006
A Deutschman, *The Second Coming of Steve Jobs*, New York, Broadway Books, 2000
A Hertzfeld, *Revolution in The Valley: The Insanely Great Story of How the Mac Was Made*,
Sebastopol, CA, Oreilly, 2005
L Kahney, *The Cult of Mac*, San Francisco, CA, No Starch Press, 2004
O Linzmayer, *Apple Confidential 2.0*, San Francisco, CA, No Starch Press, 2004
S Wozniak, *I, Woz: Computer Geek to Cult Icon*, New York, WW Norton & Co, 2006
J Young & W Simon, *iCon Steve Jobs: The Greatest 2nd Act in the History of Business*,
Chichester, John Wiley & Sons, 2005

Few books have been written about the product design process involved in the making of computers, with books such as those by Paul Kunkel being part design and part corporate history, or others being the view presented by design consultancies that happen to have been involved in the design of numerous computers. Interestingly, considering that the focus on design in these texts would suggest they might be closer to my own works, I have actually found them of little use other than to confirm details of people, dates, and the preconceptions of the designers. The focus on design and production has tended to eclipse the issues of consumption and the role of the user in these texts, and so their use for my purposes has been limited:

P Kunkel, *Apple Design, The Work of the Apple Industrial Design Group*,
New York, Graphis, 1997 [appeared as *Computer Memories* was being written]
P Kunkel, Digital Dreams: *The Work of the Sony Design Center*, New York, Universe, 1999
B Moggridge, *Designing Interactions*, Cambridge, MA, MIT Press, 2007
J Myerson, *IDEO: Masters of Innovation*, Amsterdam, BIS, 2001
F Sweet, *frog: Form Follows Emotion*, London, Thames and Hudson, 1999

The above are a small selection of potentially huge lists, many of them very specialised pieces on various aspects of the history of computing, as the subject develops. The above list, then, presents only the more relevant texts rather than aiming for completeness, and in contrast to a more ‘traditional’ literature review, does not discuss wider issues, as these are addressed in the following sections and the articles themselves. It also aims to show how the different strands in my methodology have been brought together, indicating the extent to which my work crosses a number of boundaries and to some extent, disciplines. The number of published works addressing the form of the computer has, as shown, increased greatly, and the number of these concerning themselves with the consumption of computing as well as its production is significant. Despite this growth, the particular angle taken in the submitted articles and the methodology contained therein remains highly original, and together they form a significant addition to the body of knowledge in the area.

The Social Construction of Technology

The theoretical and methodological analytical framework increasingly referred to in the submitted articles is the Social Construction of Technology (SCOT), which proposes that human action is not determined by technology; rather that human action shapes or constructs technological development. SCOT is sometimes referred to as the Social Shaping of Technology (SST). The terms are interchangeable, the distinction between 'construction' and 'shaping' being one of personal choice. Some authors prefer 'shaping' as it refers to a tangible action, whereas the term 'construction' can also be taken to mean something misleading or a falsehood. This section will provide a descriptive overview of SCOT and its relation to other, associated theories, perspectives or standpoints. It will also indicate where various aspects of SCOT are referred to and employed in the submitted articles.

The following overview is mostly compiled and in part paraphrased from the introductions to what I consider to be two of the most useful texts on the topic:

W Bijker, T Hughes, & T Pinch, (eds) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA, MIT Press, 1987
D MacKenzie & J Wajcman (eds) *The Social Shaping of Technology* (2nd Edition), Buckingham, Open University Press, 1999

Other texts have also been consulted, to a lesser degree:

W Bijker & J Law, *Shaping Technology/ Building Society*, Cambridge, MA, MIT Press, 1992
W Bijker, *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Sociotechnical Change*, Cambridge, MA, MIT Press, 1995
R Pool, *Beyond Engineering: How Society Shapes Technology*, Oxford, Oxford University Press, 1997

The positioning of the Social Construction of Technology

The introduction to the first of these texts positions the Social Construction of Technology as a theoretical approach within the broader field of the study of science and technology that builds on previous work carried out in the area of the sociology of scientific knowledge. As a theoretical framework, SCOT can be seen to be at the intersection of three related but disparate fields: The Sociology of Technology, The Philosophy of Technology and the History of Technology (Figure 1).

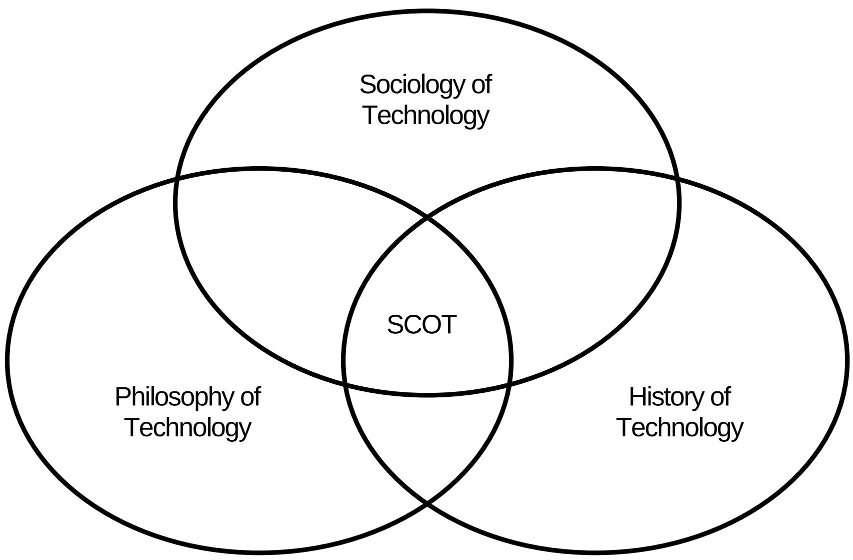

Figure 1: The positioning of the theory of the Social Construction of Technology

With respect to the analysis of technology, SCOT proposes that consumption of any technology can only be understood by placing it in its social context. Three trends are stated to characterise analyses employing SCOT as a methodology. Firstly, SCOT moves away from the notion of the individual inventor or 'genius' as a central explanatory concept. This echoes developments within the study of Design History, where earlier methodologies inherited from one particular kind of Art History that celebrated the individual, named designer, have been replaced with analyses that stress the consumption of design over its production. Secondly, SCOT moves away from the theory of Technological Determinism. As a conflicting view of technological development and its social impact, this theory will be defined later. Thirdly, SCOT moves away from making distinctions among technical, social economic and political aspects of technological development, opting instead to adopt a view of these aspects as a 'seamless web'.

SCOT is also stated to adopt three approaches, consisting of the main theory and two subsets. The main theory, Social Constructivism, – states that 'technological artefacts are open to sociological analysis, not just in their usage, but especially with respect to their design and technical 'content''[1]. The first subset, Technology as a System metaphor, pays attention to different but interlocking elements of physical artefacts, institutions and their environment, thereby integrating technical, social, economic and political aspects. The second subset, Actor Networks, extends this perspective further by breaking down the distinction between human actors and natural phenomena, allowing them both to be treated as elements in a network.

Social Construction as a response Technological Determinism

The topic of SCOT is the intertwining of 'society' and 'technology', and is proposed as a response to what is seen as a naïve view of Technological Determinism (TD). TD states that the technology developed or adopted by a society determines its structure, values and history, and as such is the key force governing a society. Technological development is seen as being outside of political and cultural influence, and its effects are seen as intrinsic rather than socially conditioned.

TD sees technology as 'a separate sphere developing independently of society, following its own autonomous logic, and then having 'effects' on society'.[2] MacKenzie and Wajcman have objections to this view, namely that politically, TD encourages a passive attitude to technology, leaving only a limited set of responses – an uncritical embracing of technology, a defensive adaptation to technology, or an outright rejection of technology. In addition, intellectually, TD reduces the intertwining of society and technology to a simple sequence of cause and effect. It neglects how the relationships between people affect the things they make, and it neglects the social shaping of technology.

An important principle in SCOT, which stems from its origins in the sociology of science, is that of 'symmetry'. This proposes that in assessing the success or failure of a technological product or system, the same kind of explanation should be deployed – i.e., that the analysis should be neutral (this aspect is even relevant within the two subsets of SCOT, Technology as a System metaphor, and Actor Networks). The notion of symmetry is a difficult one to apply to TD, as its bias in reporting successful innovations 'contributes to an implicit adoption of a linear structure of technological development, which suggests that

> the whole history of technological development had followed an orderly or rational path, as though today's world was the precise goal towards which all decisions, made since the beginning of history, were consciously directed[3]

[1] W Bijker, T Hughes & T Pinch (eds), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA, MIT Press, 1987, p. 4
[2] D MacKenzie & J Wajcman (eds), *The Social Shaping of Technology* (2nd Edition), Buckingham, Open University Press, 1995, p. xiv
[3] E Ferguson, 'Toward a Discipline of the History of Technology', *Technology and Culture*, 15: 1974: 13-30, cited in Bijker, W, Hughes, T & Pinch, T (eds), *The Social Construction of Technological Systems*, p. 22

It is easy, following the development of technological constructivism (as SCOT is also known), to dismiss completely the ideology of technological determinism. But there are elements of TD that do contain at least partial truths. Technology, of course, does matter, and does affect the ways in which society behaves. But the view that this behaviour is inevitable and outside of influence is incorrect. In effect, TD oversimplifies the case.

The adoption of any technology by a society is subject to economic, political and cultural issues, as well as technical issues. In SCOT, the development of a technological artefact is seen to follow a 'multi-directional' model as it alternately follows a process of variation and selection. In contrast, TD is presented as a linear process of development having a single trajectory and makes reference to 'technological paradigms', where exemplars of technology are introduced (often by a single inventor) and form the basis of further development. SCOT, however, proposes that these exemplars are arrived at more by incremental development by collective forces than by individuals, and their impact is dependent on their adoption, development and appropriation by society, which can (and does) occur in different ways. It is the ways in which a technology is adopted which is important. This gives rise to the notion of 'path dependency', which states that the outcome is dependent on whichever path is followed, or to put it another way, whichever particular alternative of a range of competing technologies is adopted will attract more attention and therefore develop more quickly than the technologies which have been overlooked and so will quickly become 'superior', irrespective of its inherent characteristics. This is not to say that a new and competing technology will not appear at a later stage and replace the earlier technology altogether (as in, for example, CDs replacing vinyl records or digital photography replacing film), but that after a long process of investment and development, the system has 'momentum', and the replacement technology must be unequivocally viewed as superior in order for it to be adopted. This is relevant to the notion of 'interpretive flexibility' (see below) as one type of technology may be seen to 'work' better than others because of its path, or history of adoption rather than being intrinsically superior (as, for example, in the case of the VHS video format over Betamax). However, existing technology is agreed as being an important precondition for the development of new technology, it is just that this is not the only force in play.

Technology as a System

The subset of SCOT, the Technology as a System metaphor, views technologies not as isolated devices, but as components within a whole system. The whole system, which is organizational, economic, political and cultural as well as technical, is seen as a major factor on how that component is developed. An interest concept arising from the approach of the Technology as a System metaphor is that of the 'reverse salient' or 'critical problem'. In this context, the reverse salient is that part of the system that is weakest or most inefficient, which presents a problem to the whole, or which is seen as preventing the system from developing. This part of the system will attract more attention and effort to solve the problem and allow the system to move forward, and thus it becomes the driving force for technological development.

A result of this concept of the 'reverse salient' is the elevation of the importance of economic factors in the system (although not to the point of economic determinism). An element viewed as 'holding the system back' only makes sense if the system has a goal to achieve in the first place. Those goals are usually economic, revolving around the creation of wealth, and the reverse salient is the inefficient, or uneconomic part of the system. And, if systems are economic enterprises, technology is not therefore outside of society, but part of it. Technological development, therefore, is forced on the system in order for it to compete, and its direction and nature of development is conditioned by the society of which the system is a part. Economic shaping, therefore, is still social shaping.

Actor Network Theory

One problem with the Bijker/Pinch approach to SCOT identified by MacKenzie and Wajcman is the 'reciprocal relationship between artefacts and social groups'[4] and the elevation of social factors over technical factors – which can suppress the fact that technology does affect social

[4] D MacKenzie & J Wajcman (eds), *The Social Shaping of Technology*, p. 22-23

relations. In one way, SCOT sees technology and society as separate spheres that influence each other, whereas, in fact, technology and society are mutually constitutive. Actor-Network Theory (ANT) has addressed this by (controversially) removing the distinction between human and non-human agents, allowing material relations (between people and people or people and institutions or people and things) and semiotic relationships (between people and ideas, or between ideas and ideas) to be considered as equally important within a single network. Within this network, all agents (or actants) are seen as being equally significant, with the differences between them created by the network itself (unlike Technology as a System, which places economic factors above others) and able, at any point, to become the single most influencing aspect of a networks' development. This view sees that social structures are not fixed entities, but are constantly renegotiated by the impact of the introduction of new technologies or ideas. An example would be the ability of the World Wide Web to create new interactive social groups, which then have an impact on the future development of the Web itself. ANT, then, sees any social theory as having to take technological factors into account in order to be valid. The biggest contribution of ANT, therefore, is to social theory, rather than the sociology of science and technology.

Key Concepts of Social Constructionism and their application

SCOT contains some key terms and core concepts, which I have applied in my analyses of computing technology at various points in my articles.

Multidirectional model

Within SCOT, technological development is seen to follow a 'multidirectional' model. That is, that in the development of a technology, a variety of alternatives is usually presented which are seen as quite different to each other and at the same time, equally serious rivals to each other in the solving of a particular problem. The adoption of one alternative over another happens for a variety of reasons, only some of which may be technical. When a particular alternative becomes successful or dominant, Technological Determinism views the successful route taken as a linear path which occurred because the selected alternative was an intrinsically 'better' technological answer to the problem and tends to ignore completely the alternatives which were not taken forward.

The linear model of technological development has been particularly prevalent in the writing of the history of computing technology, perhaps because it has in many cases been written about by people coming at the subject from a technological or economic perspective rather than a social perspective. This issue has been discussed in a number of places. *Man in a Briefcase* (p. 194) discusses the concurrent development of a variety of types of portable computer as opposed to the TD view of the laptop as a series of continuous improvements of an existing exemplar. The article *A Bitter Pill to Swallow* gives an overview and comparison of SCOT to TD (including the multidirectional model vs. the linear model), Technology as a System and ANT as analytical approaches, and in conclusion describes a number of different factors which might have contributed to the failure of the tablet computer as a product type.

Relevant Social Groups

The multidirectional model and the adoption of a particular alternative by users raise the issue of who is seeing the problem as being solved by that alternative. This is where the notion of the 'relevant social group' appears, as it is the group of people for whom the product solves a particular problem; and a problem is only defined as a problem when there is a social group for which it constitutes a problem. The term is used to denote institutions and organisations, as well as organized and or unorganized groups of individuals. To operate as a group in this context, it is important that the constituent members of a group share a set of meanings or interpretations of a particular artefact or technology.

An example of this is used in *Man in a Briefcase* (p. 192), where, for largely economic reasons, the relevant social group for portable computers was seen as travelling executives, and the problem was to create a product which not only worked technically, but projected an appropriate image and status to suit the constructed or imagined identity of the 'playboy adventurer' created through popular culture.

Interpretive Flexibility

SCOT assumes the position that technological artefacts are culturally constructed and interpreted. It follows, therefore, that for different groups of individuals, who hold different sets of meanings of a particular technology, there will be different interpretations of any given product. That is to say, the interpretation of an artefact is not fixed, but flexible, depending on the group which is interpreting it. Additionally, there is flexibility in how an artefact can be designed – there are a number of possible ways and no 'best way' to design a product. This is regularly seen in action when different corporations attempt to dominate the market with different approaches to the same problem (which is currently happening with High Definition DVD formats).

A Bitter Pill to Swallow contains examples of interpretive flexibility and design flexibility. The former in the different interpretations of tablet computing technology held by field workers and executive users, accentuated, it is argued, by the fact that the resulting product contained semiotic elements of the clipboard, and the latter in the attempts by different companies to develop radically different, competing software interfaces which could cope with operation by a stylus.

Closure and stabilization

Closure here refers to the stabilization of an object's development and the 'disappearance' of problems. *Computer Memories* (p. 119) refers to the issue of stabilization when the static nature of the design of the office computer over a prolonged period is discussed as being less problematic, removing the fear of constant change by creating an object in which the designed form, if not the technology, remained 'fixed'. Pinch and Bijker refer to two mechanisms that achieve this closure as 'rhetorical closure' and 'closure by redefinition of the problem'.

Rhetorical Closure

Closure of a technological problem does not necessarily involve 'solving' the problem in the traditional sense of the word, as long as the relevant social groups 'see' the problem as being solved. In *The (In)Difference Engine* (p. 65) for example, reference is made to the fact that the styling of the IBM PC, instead of following a trend for brightly coloured and overtly styled computers, reflected the functional and mundane elements of existing office equipment, and, as with the use of word processing computers following closely the design of typewriters, reflected the desire for a continuation of existing work practices rather than radical new processes.

Closure by redefinition of the problem

An alternative mechanism by which closure occurs involves the redefinition (or reinterpretation) of the problem. In discussing the widespread adoption of the computer mouse in *The Best Laid Plans of Mice and Men* (p. 61), reference is made to the fact that different relevant social groups of users achieved closure – some by rhetorical closure, seeing the mouse as an easier or more ergonomic way of operating the computer, and others by redefining the problem. For business users, it is argued, ease of use or ergonomics were not really the issues. By redefining their problem as one of gender association, they saw the need for a computer that could be operated in a way that did not involve the then feminised act of typing as being solved by the appearance of the mouse.

As can be seen by the reading of the submitted articles, the theories and methodologies of social constructivism have become more important over the course of my research. As the articles explore computing technologies in increasing depth and with more subtlety, I have read, learned and understood more about this perspective and the different approaches it provides as an analytical methodology.

Criticism of the Social Construction of Technology

Of course, it would be unwise to espouse a social constructivist standpoint and to employ it as a methodological framework without being aware of its perceived limitations and weaknesses. SCOT certainly has its critics, particularly in Philosophy of Technology and Political Theory.[5]

Philosophers of Technology such as Langdon Winner have argued that Social Constructivism is a narrow perspective that concentrates on the origins of a technology rather than the consequences of it being the prevailing solution, or why innovations are important in the wider context. Winner (and others) are also concerned at the notion of 'Relevant Social Groups', asking 'Who says what are relevant social groups and social interests? What about groups that have no voice, …., groups that have been suppressed or deliberately excluded?'[6] Stewart Russell also sees the social groups aspect as 'an inadequate conception of social structure'[7], arguing that the groups need locating in a structured and historical context. Pinch and Bijker accept these criticisms, but point out that by that definition, no form of sociological explanation can be adequate when 'all groups and structures are themselves embedded within an endless web of other groups and structures'[8]. They argue that for most technologies, the analysis in terms of social groups is perfectly adequate, although admit that other technologies may require more elaborate concepts. They also point to the subsets of SCOT, which use system and network models as approaches that stress the integration of different technical, social, political and economic factors.

Critics have also noted that the Social Construction of Technology is not a unified theory, and that the various elements contain important differences. As one of the more controversial aspects of SCOT, Actor-Network Theory has been a particular target for criticism. Opponents argue that ANT's insistence on treating all elements of a network as equal fails to take into account pre-existing structures (such as power relations and gender stereotypes, for example), which, it is argued, can have an overly dominant impact on a network. Accepting (as ANT does) that structures arise only from the actions of actors within the network can be seen as a deterministic perspective – in essence it could state that particular technologies were successful because they were successfully adopted by that network. In a similar vein, ANT accepts the agency of non-human elements of a network as a given, whereas critics see agency as having an aspect of 'intentionality', and obviously, non-human actants cannot possess intentionality. Adherents counter this argument by stating that their conception of agency does not presuppose intentionality, and in any case they do not locate agency in either human subjects or inanimate objects, but in heterogeneous associations of humans and non-human actants. Finally, the view of all actors within a network as being equally important is seen by some as working to deny analysis, or more accurately judgement, as to the most important factors in a technology's success (or failure), seeing it as leading to purely a description of the network rather than analysing its impact.

Despite the above criticisms, the social shaping of technology has now ceased to be seen as an 'alternative' view in the social sciences, and as MacKenzie and Wajcman note, between the first edition of their book (in 1985) and the second edition, it has become something of an orthodoxy. The discussion of 'technology' and 'society' as distinct entities is now usually seen as misleading. Instead, technology is seen as both socially shaped and society-shaping. Yet, outside of academic circles, and particularly in mass media, any discussion of technological development is by and large still framed in technologically determinist terms. It remains an entrenched position understood and held (actively or passively) by many.[9]

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[5] See, for example, L Winner, 'Upon Opening the Black Box and Finding It Empty: Social Constructivism and the Philosophy of Technology', *Science, Technology & Human Values*, 18(3) : 1993: 362-378; and S Russell, 'The Social Construction of Artefacts: A Response to Pinch and Bijker', *Social Studies of Science*: 16: 1986: 331-346

[6] L Winner, 'Upon Opening the Black Box and Finding It Empty', p. 369

[7] S Russell, 'The Social Construction of Artefacts', p. 334

[8] T Pinch & W Bijker, 'Science, Relativism and the New Sociology of Technology: Reply to Russell', *Social Studies of Science*: 16: 1986: p. 353

[9] D MacKenzie & J Wajcman (eds), *The Social Shaping of Technology*, p. xv

Power and Control, Status and Image

Figure 1: Brochure for Muldivo 'Digiputer' Computers, 1968
(National Archive for the History of Computing (NAHC))

Any survey of the visual material produced to promote and advertise computers prior to the mid 1980s will clearly display strongly gendered attitudes reflecting the socio-political agendas and accepted work practices of the time. There was little written on the subject as my research began, and the submitted articles comment on the roles played by computers in reflecting and maintaining this phenomenon. My work has been unique, though, in stating that not only were different types of computers used in different ways to reflect status, power and control, but that the designed form of those computers involved clearly displayed design elements aligning them to specific types of users.

This section draws together those elements of the submitted articles that describe this position and explores the relevant gender and status issues. These issues do not follow a strict chronology, and vary for different types of computer due to the different social drivers involved. Consequently, it makes sense to explore these issues as they relate to three different types of computer: the office computer, the home computer and the mobile computer.

Issues of status and gender politics in the development of computers are important in this particular discussion because they relate directly to the social construction of technology. To deny the role of status and gender issues is to deny their influence and ignore the agency of social factors, leaving a purely technologically deterministic perspective of the development of computing technology.

Office Computers

As stated, few texts have directly addressed the social construction of computing, and of these a number are feminist critiques questioning the reality and the validity of the gendering of computing technology. Juliet Webster, for example, has researched and published on the gendering of information technology in the workplace, supporting a social constructivist view of, in particular, the development of word processing and its move from a feminised role to a role performed by all with the advent of the 'all-purpose computer'. Her take in 1993 was that 'the boundaries of the old gendered division of labour in the office are being redrawn' and that 'no longer is keyboard operating the sole province of women office workers'[1] (although there is no mention at all of the role of the Graphical User Interface and the computer mouse in this process). Gill Kirkup, at more or less the same time, wrote that computers were 'designed and manufactured with particular purposes and users in mind which produced a gendered social construction'[2] and called for women to modify the social construction of computers by rejecting the male domination of computing culture.

The analysis of the visual material around the office computer before the mid 1980s presents a remarkably sexist state of affairs when viewed through the politically correct eyes of today, (Figure 1 and Figure 2) although of course the material did nothing but reflect the socio-political mores of the day. Generally speaking, women were shown in stereotypically subservient roles to males, and the use of computers by women was presented in images and text as a low-grade role of data input, or at best secretarial support for male managers. Interestingly, this reflects a dual history of the association of women with computing.

[1] J Webster, 'From the Word Processor to the Micro: Gender Issues in the Development of Information Technology in the Office' in E Green, J Owen, & D Pain (eds), *Gendered by Design? Information Technology and Office Systems*, London, Taylor & Francis, 1993, p. 120.
[2] G Kirkup, 'The Social Construction of Computers: Hammers or Harpsichords?' in G Kirkup & L Keller (eds) *Inventing Women: Science, Technology and Gender*, Cambridge, Open University Polity Press, 1992, p. 268.

Figure 2: "Behind the range of advanced NCR computers is an even more important product – the men whose knowledge and experience can put computers to work in your business with speed, efficiency, economy." Advert for NCR Computers, 1966 (British Library)

The relationship of women to the roles of word processing and of data input have separate, if related roots, depending on the equally valid views of the office computer as either a development of the typewriter or a development of the mechanical calculator. It has been well documented that women have been associated with the role of typing since the introduction of the typewriter into the office towards the end of the nineteenth century. Females were cheaper to employ to fulfil the required roles created by the huge increase in demand for office labour. Between 1861 and 1911, the number of male office clerks increased five-fold. In the same period, the number of females clerks increased 500 times over.[3] The departure of men into the armed forces during the First World War only served to fuel this expansion and consolidate typing as a feminine activity.

Similarly, women have been associated with the inputting of computer data since the earliest use of computers.[4] The Electronic Numerical Integrator and Calculator (ENIAC) developed at the University of Pennsylvania and completed in 1946 is considered by most to be the first electronic computer, and was constructed in order to relieve a bottleneck in the production of military ballistics information during World War II[5]. This clerical role was performed using desktop mechanical calculators and, like typing in the office, was seen as a suitable activity for well-educated women to carry out. At one point, the US military employed 'more than 100 female students to carry out firing table calculations.'[6] The ENIAC's data was fed into the machine via punched computer cards using an IBM card reader, and the practice of preparing the cards with card punches was transferred to, and therefore became associated with, the female workforce.

[3] A Delgado, *The Enormous File: A Social History of the Office*, London, John Murray, 1979, p. 37.
[4] As a matter of interest, a number of women have played key roles in the development of computing. Ada Lovelace helped Charles Babbage with the theoretical work behind his analytical engine in the 1840s, and in the 1940s, Adelle Goldstine co-authored important papers in the development of ENIAC, while Grace Hopper developed easier methods of programming computers using a compiler and the COBOL programming language.
[5] However, the ENIAC was not actually completed in time to contribute towards the war effort.
[6] H Polachek, 'Before the ENIAC', *IEEE Annals of the History of Computing,* 19(2): 1997, 25.

Thus, the early use of computers in the office was charged with socio-political overtones, and the functions of computers designed specifically for word processing and for data input (Figure 3) had socially constructed reasons to look markedly different to computers that were designed for providing management information (see *Computer Memories* p. 118). In discussing the development of word-processing, Webster wrote:

> Many word processors …. emulated the typewriter, in order to make the new technology as accessible to the typist as possible. In terms of its operation and design, it was a relatively minor departure from the old technology, for it was one that incorporated office activities done traditionally by women into its construction and was designed for use specifically by women office workers. It brought electronic technologies to the typewriting task, rather than taking text production technologies to the computing activity.[7]

Whereas, as described in *The (In)Difference Engine* (p. 69), computers intended to aid management decision making, both in their physical form and their nomenclature, prioritised the screen output of information over the keyed input of data; their roles as enabling the control of work processes reflected in their design as suitable objects for the executive desk (Figure 4).

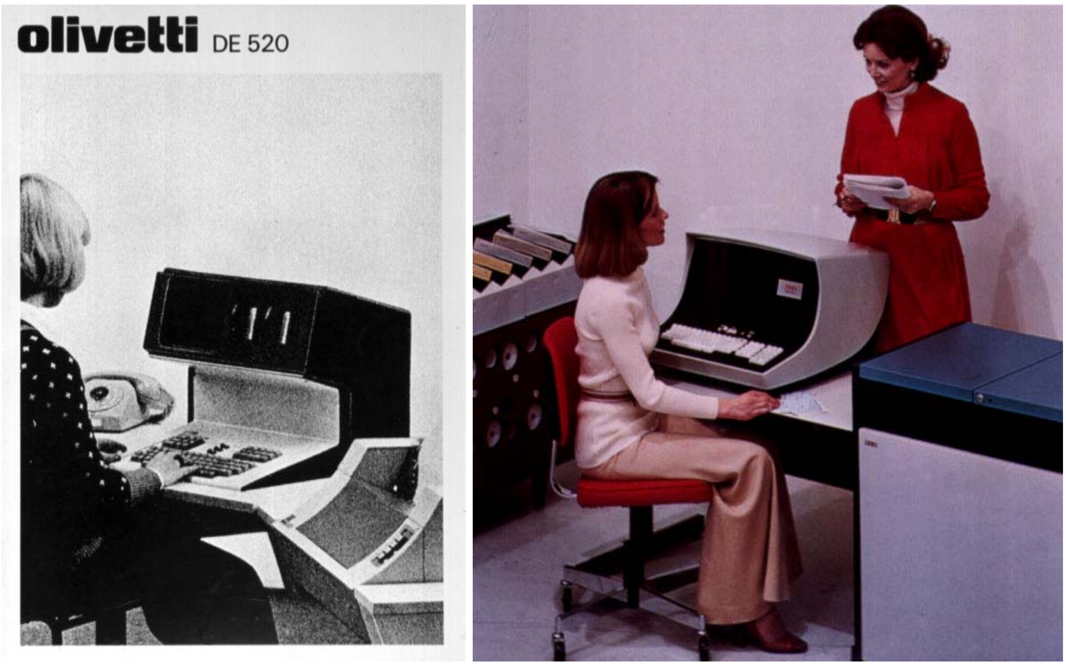

Figure 3: Low-level Data Entry computers:
Left: the Olivetti DE520, 1976, Right: the NCR Document Processor, 1974 (NAHC)

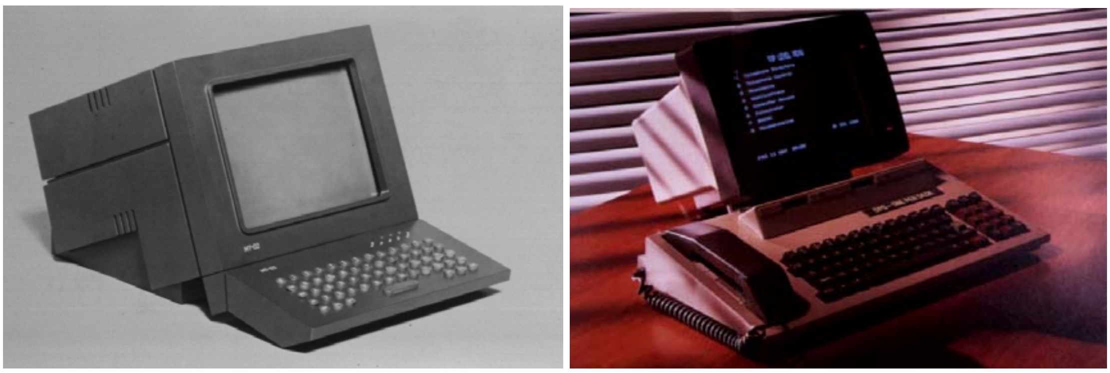

Figure 4: Executive desktop computers:
Left: the QED MT-02, 1981, Right: the ICL One Per Desk, 1984 (NAHC)

[7] J Webster, 'From the Word Processor to the Micro', p. 114.

This state of affairs, of having significantly different computers performing discrete roles for different divisions of the office remained in place well into the 1980s, and even the introduction of the first machines marketed as ‘personal computers’ by IBM and ICL saw their association with secretarial roles continue for a number of years (Figure 5).

Figure 5: Left: The IBM PC, 1981, Right: The ICL Personal Computer Model 30, 1982 (NAHC)

The mid 1980s saw a marked increase in sexual equality in the workplace, as attitudes instigated and reinforced through legislation took hold.[8] Even though the sexual stereotyping of the use of office computers may have continued in advertising for some time after, the introduction of the GUI and the computer mouse in the mid 1980s (as described in *The Best Laid Plans of Mice and Men)* wiped the slate clean and transformed the computer into a single, multifunctional machine devoid of the gender and status associations of its predecessors.

[8] In the US, gender equality and equal pay were incorporated in the Civil Rights Act of 1964. In the UK, these issues were addressed in the Equal Pay Act 1970 and the Sex Discrimination Act of 1975.

Home Computers

The home computer, it has been noted, had historical roots different again from those of the office computer.[9] Whereas the office computer was developed from large-scale information processing machines, and so was infused with the mindset of existing business practices, the home computer (which has now arguably disappeared as a discrete product type) had its roots in hobbyist activities as an extension of the pastimes of do-it-yourself radio enthusiasts and electronics devotees. Early home computers did not have the utilitarian image of the office machine, being instead 'a marginal, esoteric, hobbyist item'.[10] In conjunction with this do-it-yourself approach came an aesthetic carried over from the radio and electronic hobbyists. Flat-panel surface-mounted toggle switches, buttons and lights; folded sheet steel enclosures or hand-made wooden boxes; screen-printed graphics and a tolerance of exposed parts and wiring, all marked the early home computer as the continuation of existing practices of garage/tool shed construction or at best, low-volume production.

In reflecting on this position, Kirkup states that:

> In general male hobbies can be distinguished from female hobbies in that the latter need little capital outlay and have a useful end-product (they are often related to pre-industrial crafts), such as knitting, sewing, embroidery, even flower-arranging, whereas the former need a large capital outlay and produce little or no end-product, being done for the pleasure of the activity itself, for example, fishing, photography, ham radio and electronics.[11]

The view that the output of these male-oriented activities provides no useful end product is highly questionable, particularly in the areas of DIY and electronics, where the magazines supporting these practices are largely based around projects producing finished goods and devices. However, it is clear that there is an element of truth in the notion of males association with and interest in technology for its own sake. Leslie Haddon's research has confirmed there was a direct lineage to be found between male hobbyists involved in the construction of electronics projects who gave up their old interests to become 'immersed in the world of microcomputing' and that the take up of the microcomputer by 'early (male) adopters …. helped to give the home-based machine its 'masculine' image'.[12]

It is the concept of male involvement with technology for technology's sake that is at the heart of Haddon's view of the first home computers as 'self-referential' machines.[13] That is to say that even though the home microcomputer became far more successful than was expected (despite manufacturing companies arguing that without offering some benefit 'people will not buy technology for its own sake'[14]), the first home computers could actually do very little, having no base of software applications to run, or few peripherals with which to interact. Consequently, Haddon argues, involvement with the home microcomputer was carried out purely to engage with computing technology itself. It was, in fact, a machine for learning about computers.

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[9] See *The (In)Difference Engine*, p. 60.
[10] L Haddon, 'The Home Computer: The Making of a Consumer Electronic', *Science as Culture*, 2: 1988, 7.
[11] G Kirkup, 'The Social Construction of Computers', p. 271.
[12] L Haddon, Researching Gender and Home Computers in Sørensen, K and Berg, A (Eds) *Technology and Everyday Life: Trajectories and Transformations*, University of Trondheim, 1990, p. 6. Viewed 5 Feb 2008 <http://www.mot.chalmers.se/dept/tso/haddon/GenderPC.pdf>
[13] L Haddon, 'The Home Computer', p. 27.
[14] L Haddon,& D Skinner, 'The Enigma of the Micro: Lessons form the British Home Computer Boom', *Social Science Computer Review*, 9(3): 1991, 445.

Examples of these early machines show the limitations of the technology at that time. The Kenbak-1 (Figure 6) is considered by many to be the first personal computer (although the term was not in common use then) and cost $750 in 1971. The only input was through switches, the only output was via a row of lights, and it had only 256 bytes of memory. After selling only 40 machines, the company closed in 1973.

Figure 6: The Kenbak-1, 1971 (Computer History Museum (CHM))

Evidencing the link between amateur radio and home computing, the Mark-8 Microcomputer (Figure 7) was based on the first 8-bit processor from Intel, and appeared as a 'minicomputer' kit project in the July 1974 issue of Radio-Electronics (the term 'microcomputer' hadn't been coined at this point). However, the $55 kit consisted only of the circuit boards and plans, and customers had to source all the components themselves (including the then hard to come by processor chips). As a result, it was not overly successful.

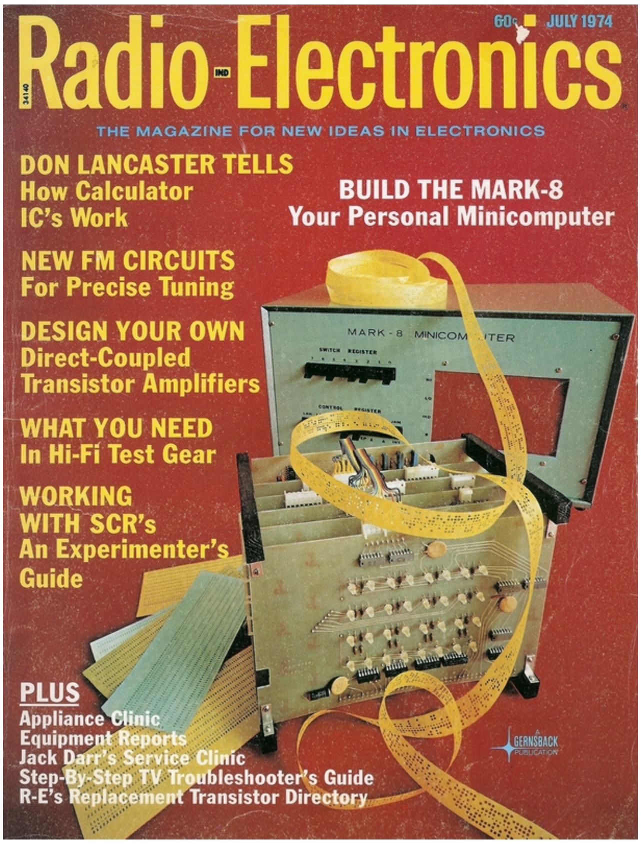

Figure 7: The Mark-8 computer project appeared in Radio-Electronics, July 1974 (vintage-computer.com)

Perhaps the most famous (and successful) mail-order computer kit of all was the Altair 8800 by MITS (Figure 8). Developed by Ed Roberts during 1974, it appeared on the cover of the January 1975 edition of Popular Electronics. Roberts, whose company which sold calculator kits was having financial difficulties, hoped to sell 800 kits in total and thought he could sell 200 in the first year to break even. Due to Roberts' experience of negotiating low prices for bulk buying of components, the kit only cost $397 including the cabinet, and within weeks MITS were inundated with orders. Selling up to 200 units a day, the company struggled to meet orders.[15] The BASIC software language licensed to the Altair was written by Bill Gates and Paul Allen, who went on to form Microsoft and write the operating system for the IBM PC.

Figure 8: Popular Electronics, January 1975, and the 'Altair' home computer kit (virtualaltair.com)

[15] F Delaney, *History of the Microcomputer Revolution*, transcript of radio series, KPBX Radio, 1995. Viewed 11 June 2004 <http://www.virtualaltair.com/virtualaltair.com/mits0015.asp>

Advertised in kit form in the same magazine, “Popular Electronics”, in October 1975, the IMSAI 8080 (Figure 9) was developed as a direct response to the unprecedented demand for the Altair, and as such is considered to be the first ‘clone’ computer. Like the Altair, it could run a 4K or 8K BASIC operating system, and could be used with peripherals such as floppy disc drives, printers or monitors. Around 20,000 units were sold, and reproductions of the original are still manufactured for sale to hobbyists.

Figure 9: The IMSAI 8080, 1975 (CHM)

A number of well-known, male-dominated self-help groups were formed around developments in computing. The earliest hobbyist computer club had grown out of the MIT based 'Tech Model Railway Club' founded in 1947. These people used mechanical computer relays to control model railways, and their interest in computing technology grew as the research computers at MIT were developed, using them to create some of the earliest videogames[16]. The home computing boom launched many other groups, most notably the Californian groups 'The People's Computer Club' in the early 1970s and the 'Homebrew Computer Club' in 1975 (Figure 10). The latter spawned a total of 23 computer companies[17], including Apple, and the Apple 1 computer. Around 100 of these were sold in kit form and placed in wooden cases built by their owners (Figure 11), helping to fund the founding of Apple Computers Inc. and the development of the highly influential Apple II (also developed with input from the Homebrew Computer Club). It is Haddon's view that it was the activities of such hobbyists that 'created a form of the micro which reflected their own values and was the machine they wanted to 'consume'.'[18]

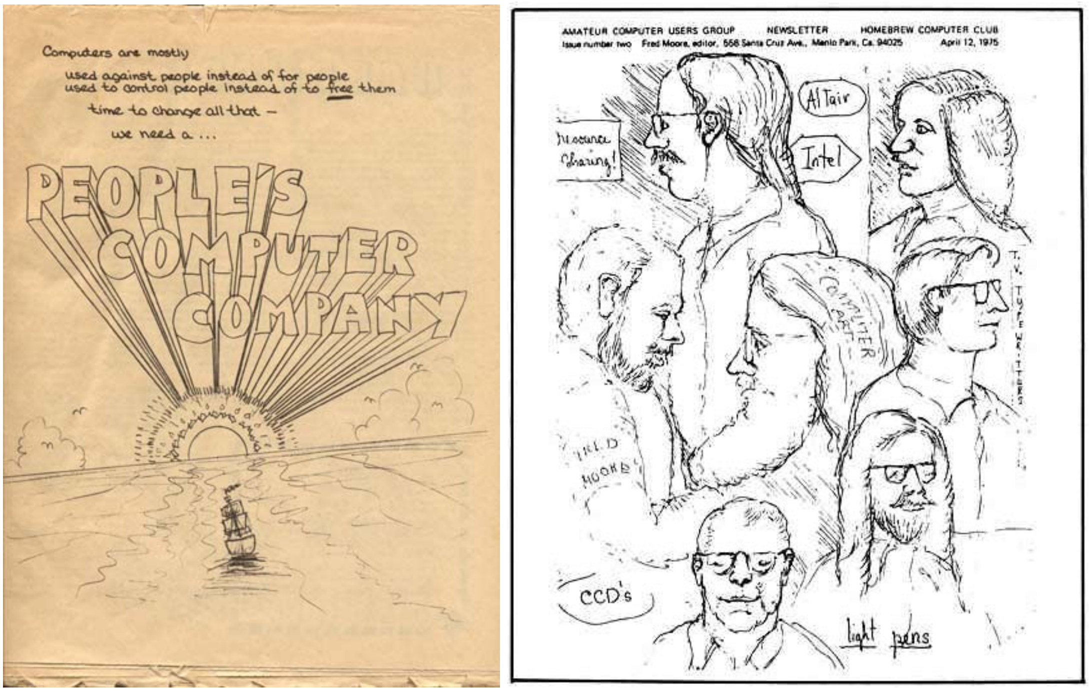

Figure 10: Covers of computer hobby club newsletters: the People's Computer Company, 1972 and the Homebrew Computer Club, 1975 (www. digibarn.com; www.atariarchives.com)

Figure 11: Examples of Apple 1 Computers in wooden cases made by owners, 1976 (Apple Computers Inc.; www.our-picks.com)

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16 V Burnham, *Supercade: a visual history of the videogame age 1971-1974*, Cambridge, MA, MIT Press, 2001, pp. 34-50.

17 J Markhoff, *What the Dormouse Said: How the Sixties Counter-culture Shaped the Personal Computer Industry*, London, Penguin, 2005, p. 282.

18 L Haddon, 'The Home Computer', p. 14.

By 1977, the home computer had developed into a consumer product aimed at the general consumer as opposed to a specialist hobbyist kit, but it continued to be a distinct product from the office computer. Three products of this year were significant in the development of home computing. The Commodore PET (Personal Electronic Transactor) came fully assembled and was the first all-in-one, self-contained home computer. It was easy to operate and had a built-in cassette drive, monitor and membrane keyboard. Tandy's entry into the computer market, the TRS-80, had the advantage of being sold directly from the company's 'Radio Shack' chain of electronics stores. The manual assumed the user had no prior knowledge of computing. It sold 10,000 units in the first month, where the company had projected sales of 3,500 units a year (one for each Radio Shack store in the US).[19] Apple also launched its first commercial home computer in 1977. The Apple II (Figure 12) made great play of its colour graphics capability and was an instant success. Famously, the 1979 spreadsheet software program 'VisiCalc' turned the Apple II into an indispensable business tool (as discussed in *The (In)Difference Engine*, p. 60). The Apple II, then, marks the point of convergence between home computers and office computers as discrete products.

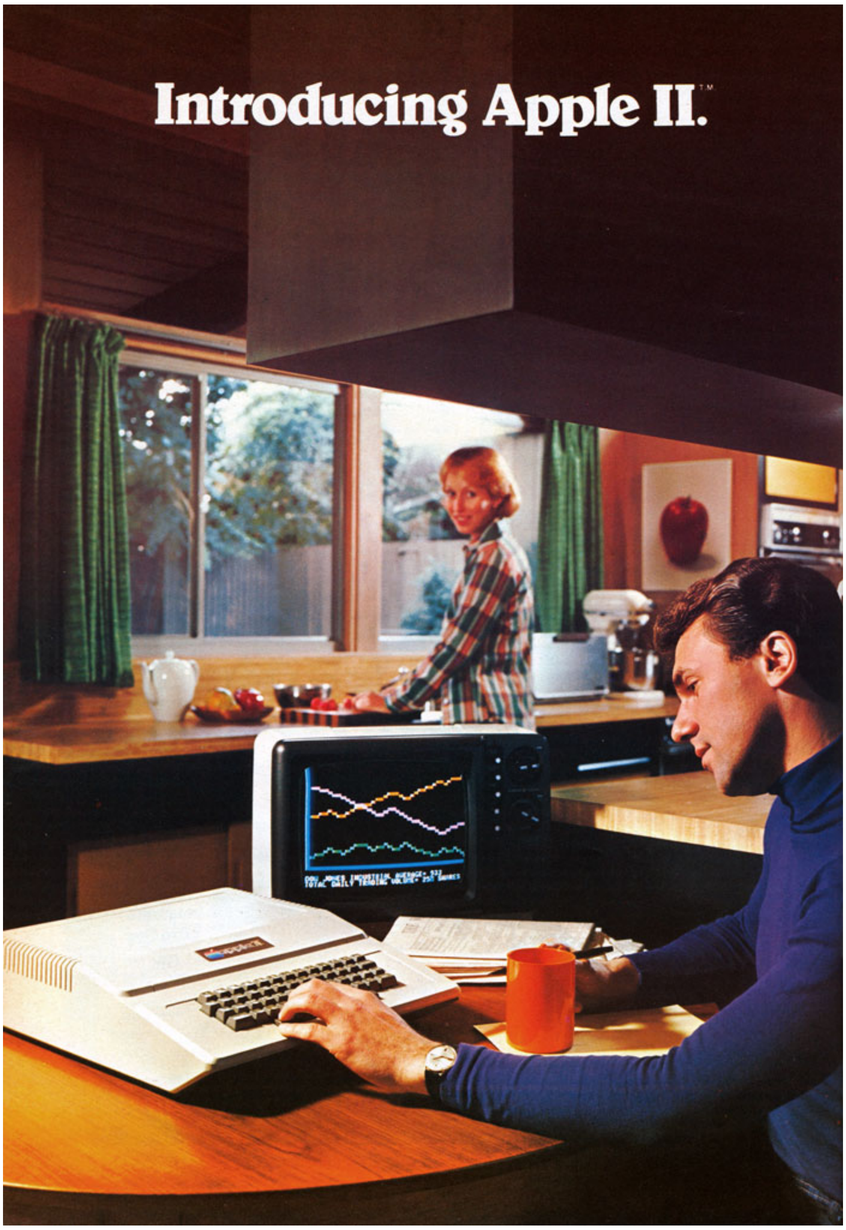

Figure 12: Apple II home computer brochure, 1977. Sexually stereotyped roles still evident (www.macmothership.com)

[19] G Laing, *Digital Retro*, East Sussex, Ilex Press, 2004, p. 28.

Even at the height of the boom in interest in home computers as a host of new products emerged in the mid 1980s, Haddon has noted that 'interest in home computing remained heavily gendered, with an emerging preponderance of male teenage users'[20] – an association reinforced by the view of early home computers (certainly in Britain at that time) as little more than games machines.[21] The phenomenon of male bias in the consumption of technology in the home has been well documented.[22] Yet while it is difficult to ascertain accurately the usage of computers by gender in the home today, particularly with respect to the increasingly blurred boundaries between work and home, it is almost certainly not as male dominated as described above – particularly amongst younger users brought up with the technology and exposed to it as an educational tool. However, as Lally has (quite recently) written, in a chapter titled 'Is the Home Computer Pink or Blue?':

> Computers are, in many ways, still designed and manufactured in ways that exclude or discourage women and girls. Parents complain of the difficulty of finding computer games suitable for their daughters, and powerful role models for women are less visible than the stereotyped gendered representations of computer advertising.[23]

Home computers, then, came from a grass-roots activity largely carried out by men, and in many ways with an anti-establishment attitude that removed it from any association with the office, the typewriter and the associated socio-political agendas. This distance, though, along with the historical connection to hobbyist activity in electronics, imbued the home computer with its own aesthetic and socially constructed identity, and allowed it to move into the realm of being a consumer electronic product distinct from the office computer. It was the software programme 'VisiCalc' that moved the trajectories of home computers and business machines closer together; eventually resulting in a universal machine that would fit both uses and could move between both environments, leaving the home computer free to develop into a specialised games console.

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[20] L Haddon, & D Skinner, 'The Enigma of the Micro' p. 439.
[21] Ibid., p. 442.
[22] See, for example, R Silverstone & E Hirsch (eds), *Consuming Technologies*, London, Routledge, 1992, passim.
[23] E Lally, *At Home with Computers*, Oxford, Berg, 2002, p. 167.

Mobile Computers

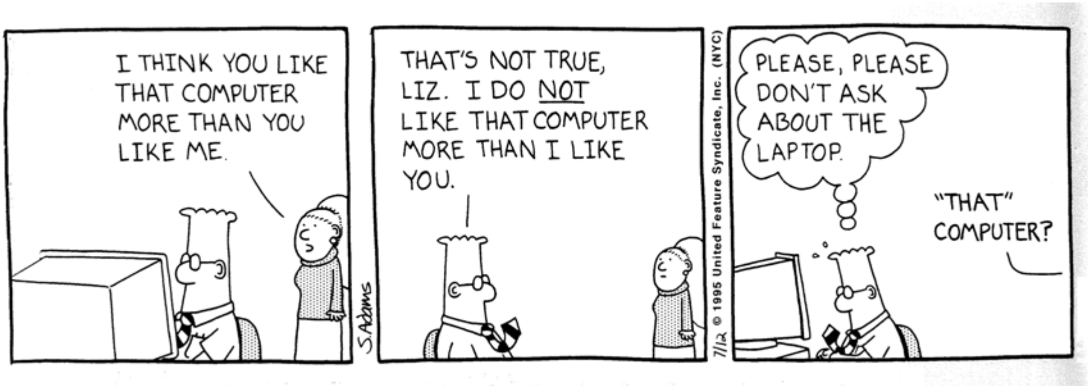

Figure 13: Dilbert strip by Scott Adams, 1995. (Knight Features)

The relationship between users and mobile computers has historically been very different to those of the office and home computer (Figure 13). Office computers displayed the hierarchies of their users and were used as role-setting objects, but were viewed in the main by other members of the office workforce. Home computers were largely devoid of status issues (other than being an overt display of technical knowledge and superiority), being seen only by the immediate family or like-minded members of computer clubs. Mobile computers, on the other hand, were from the outset a display object seen by everyone, and were deliberately intended to blatantly project a suitably high-status image that could be easily read by all.

As discussed in *Man in a Briefcase*, even before the technology became available to produce them, there was a clear aim and intention to produce portable computers. Clearly, as cutting edge technology, such a product would be expensive to produce, and therefore it would automatically act as a status symbol. Additionally, the product would clearly indicate that its owner was travelling as a business user, and had the necessity, authority and freedom to work away from the confines of the office. It is no surprise, therefore, that the early products in this market were aimed solely at the travelling business executive, who at that time was almost exclusively male. The nature of the target market for these products can be assessed from the promotional material produced by the manufacturers, portraying the users of these objects as 'world citizens', who not only travelled, but travelled in style (Figure 14).

The lifestyle portrayed in these images, I have argued, stems from popular culture's representation of masculinity at that point in time. Films and television programs of the period such as James Bond, The Saint, The Avengers, The Man from U.N.C.L.E., Department S and Mission: Impossible, played an important role in redefining the self-image of the male and his relationship with technology in both America and Britain:

> The 1960s incarnations of both Bond and Templar [The Saint], therefore, testify to a shift in dominant articulations of masculinity. In an age increasingly pervaded by consumption, advertising and style, 007 and the Saint both became agents for the upwardly mobile jet-set—the two characters breaking with the constraints of traditional masculinity and moving into a mythologized world of hedonism, consumer pleasure and individual autonomy.[24]

[24] B Osgerby, 'So you're the famous Simon Templar' in B Osgerby & A Gough-Yates (eds) *Action TV: Tough Guys, Smooth Operators and Foxy Chicks*, London, Routledge, 2001, p. 44. (as cited in *Man in a Briefcase,* p. 193).

Figure 14: Transdata 'Executive Terminal', 1974 (John Plimmer)

The role of technological products in this denotation of masculinity is important and is widely understood. Summed up by Anna Lombardi in her essay 'Sex Objects: Portrait of a Real Man':

> Technology heightens his performance, and so he indulges in a passion for microscopes, telescopes, still cameras and video cameras, the most powerful stereos, the most up-to-date computers, the biggest screen television sets, and the latest-model cell phones.[25]

These images of early portable computer users provided escapism through the promise of adventure – a life to be lived away from the drudgery of the desk. The truth of the situation, though, was somewhat different. As can be seen from closer examination of the photographs, the 'portable data terminals' (they had no computing power of their own) being carried were not as portable as might be hoped. The Texas Instruments 'Silent 700' terminal for example was sold as being particularly lightweight for the period, weighing 'only' 13 lbs (nearly 6 kgs), and that was just for a terminal without any power source of its own (by way of comparison, a laptop weighing less than half of this would be considered 'heavy' by today's standards, yet would be fully self-contained and powered). Even so, the image of portable technology promising a 'James Bond' lifestyle of independent freedom was a strong and clearly attractive one, and, as described in *Man in a Briefcase*, various attempts to produce portable computers failed because they could not fulfill this promise.

The argument of 'interpretive flexibility'[26] states that different groups of people (i.e., different relevant social groups of users) can have differing views and understandings of a technology and its characteristics, and so, understandably, will have differing views as to the extent to which a particular technology 'works' or does not 'work' for them. Therefore, in order for a product to succeed, it has to not only 'work' in a functional sense, but it has to 'work' for the relevant social group of users in a completely subjective manner (for example, by displaying a suitable self-image or transferring desired characteristics onto the owner).

The process above accounts for the form of the laptop computer as it stands today. Many attempts were made by manufacturers to create a suitably high-status portable computer. However, even though they appeared in an executive briefcase-type form, the portable data terminals of the early 1970s shown in Figure 14 were overly heavy, and did not perform well. They had no computing power of their own, had to be connected to computers over a telephone line via acoustic couplers (which had their own problems) and had no display technology, only paper print-out facilities. The situation was only slightly improved by the end of the 1970s when similar looking products became 'Portable Memory Terminals' as they gained enough on-board memory to edit around four pages of text before transmission over the telephone line.

Detailed in *Man in a Briefcase*, two products designed concurrently but taking very different approaches highlight 'interpretive flexibility' at work. The first commercially successful portable computer was the 'Osborne 1' of 1981 (Figure 15). This product had the required computing capabilities missing from the data terminals, but its weight at 28 lbs (13 kgs) was a very real restriction, and that was without the optional battery packs that came later. Rather than being called 'portable', these units were referred to as 'luggable', and many accounts of their use suggest that only a small fraction of them were moved on anything like a regular basis. Even the inventor, Adam Osborne, admitted that 80 per cent of them never left the office.[27] Quite apart from its weight problem, the Osborne 1 was criticized at the time for looking like a 'World War II field radio' rather than a device suitable for executive use. Its rapid success in the market, and equally rapid demise reflect the ready acceptance and attraction of the notion of portable computing and the following realization of its drawbacks in that form.

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[25] See A Lombardi 'Sex Objects: Portrait of a Real Man', in G Malossi, (ed) *Material Man: Masculinity, Sexuality, Style*, New York, Harry N. Abrams, 2000.
[26] See T Pinch & W Bijker, 'The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other' in W Bijker, T Hughes & T Pinch (eds), *The Social Construction of Technological Systems*, Cambridge, MA, MIT Press, 1987, p. 40.
[27] M Aartsen, 'Portable Computers, a buyer's guide', in *Design*: March 1984: p. 48.

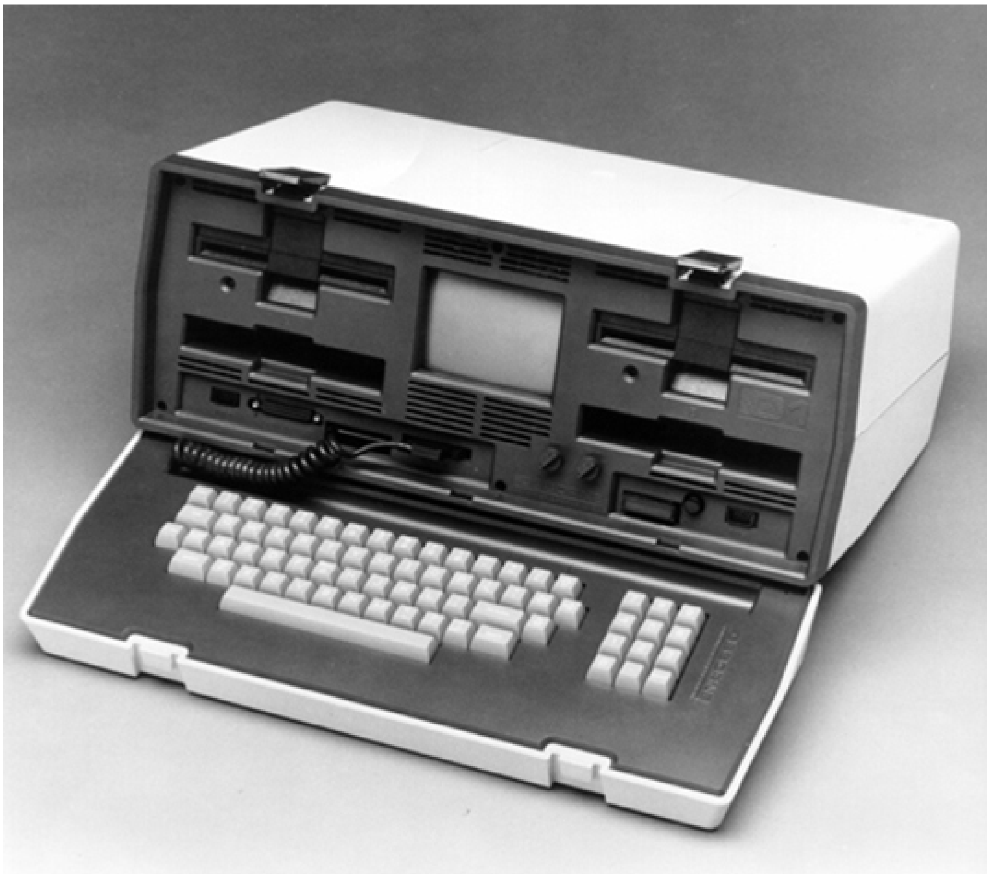

Figure 15: The ‘Osbourne 1’ Portable Computer, 1981. (CHM)

Figure 16: The ‘Compass’ Portable Computer by GRiD was the first product to satisfy both the functional and aesthetic requirements of the travelling executive. (IDEO)

Designed at the same time as the Osborne 1, (and launched at the same event), was the GRiD 'Compass' computer (Figure 16). Utilising the latest advances in technology, this had more than twice the computing capability of the Osborne, a significantly larger screen, and thanks in part to a magnesium casing, was significantly lighter at only 8.5 lbs (4.3 kgs), including batteries. This was the first portable computer that took the now-familiar 'clamshell' form, with the lid folding over the keyboard. In creating this product, which can be safely stated to be the first laptop as we understand the term today, the design team presented the user with an object which finally delivered on all fronts. It was highly desirable as well as highly functional, and was a suitably fashionable signifier of executive status. Portable computers never really took off until they took this form, and the clamshell design of the 'Compass' computer quickly became the norm for the whole industry. (As a matter of fact, through licenses and royalties the intellectual property in the patented hinge and clamshell design features generated far more revenue than the computer itself ever did). All this advanced technology, though, came at a price. At $8,000 dollars, the GRiD was expensive by anyone's standards (twice the price of a premium desktop unit), and while it provided the archetypal form for its (cheaper) followers, the 'Compass' quickly became a niche rather than a mainstream product.

The key point of this story, though, is that the technology itself, advanced though it was, was not enough on its own to secure acceptance among the relevant social group of users. The physical form of mobile computing had to reflect the 'high technology' fashions of the 1970s, and in particular the glamorous image of masculinity emerging from the notion of the 'playboy adventurer'. Through displaying ownership of a mobile computer, the owner had to be able to be recognized as a member of the executive hierarchy of the corporation. Where other products had failed to do this, the laptop succeeded. The ritual of use and the body language displayed when operating a laptop remain to this day a reflection of the briefcase. Placed across the knees or on a table, the lid slowly lifted to reveal the contents, the laptop is a simulacrum of the executive attaché case.

The importance of self-image and body language in the use of these mobile technological products is, I believe, a far more significant element than has previously been acknowledged. The semantic associations of the use of the laptop as described above are far more in tune with the role-setting expectations of the product than were the associations of operating, for example, the military field radio-like Osborne 1. A similar fate, I suggest, happened with the supposed successor to the laptop, the tablet computer. As described in *A Bitter Pill to Swallow*, these devices, combining the portability of the laptop with the ability to write information and commands directly onto a touch sensitive screen, were lauded by the industry in the late 1980s and early 1990s as the next significant advance in mobile computing. Millions of dollars were invested in developing the necessary handwriting recognition technology and suitable user interfaces for these products, and numerous start-up companies attracted venture capital to develop hardware, but the end result when in use bore a remarkable similarity to a clipboard. This was not so much of a problem when the products were aimed at field workers in the insurance industry (as was a typical target market for the GRiD 'GRiDPad' (Figure 17)) but when the same product type was aimed at an executive audience (as was the Momenta 'Pentop') the result was a 'monumental flop'[28] (Figure 18).

[28] B Breen, 'Fresh Start 2002: Starting Over… and Over', in *Fast Company*, 54: 2001, 77.

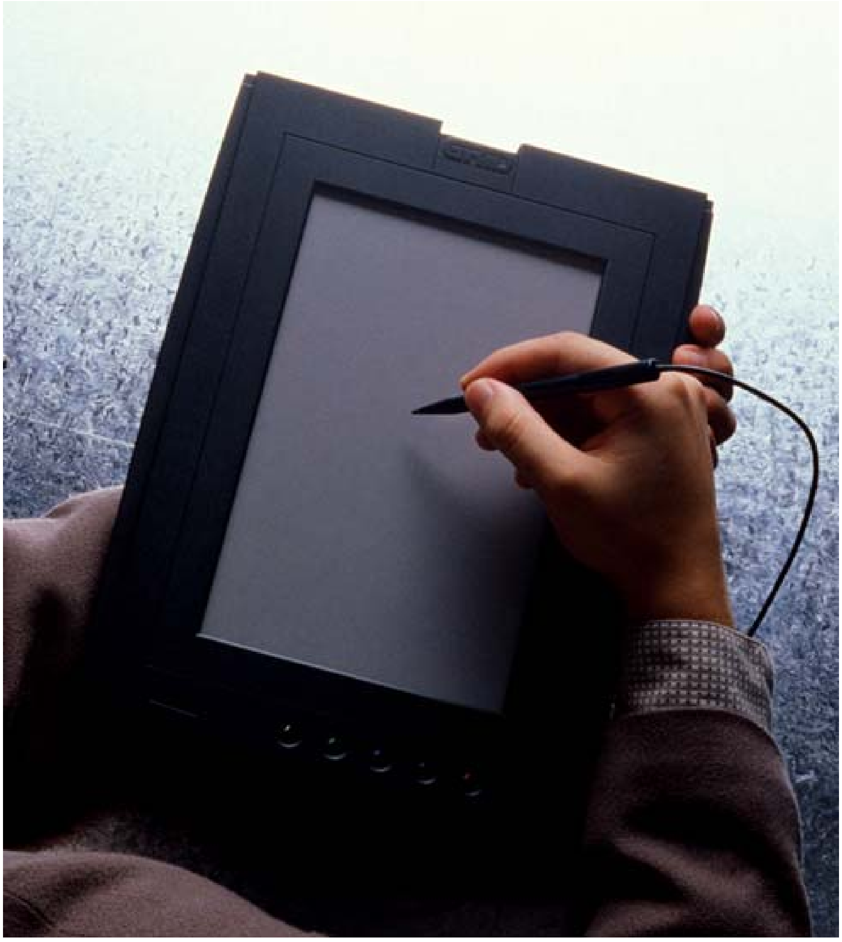

Figure 17: The first self-contained tablet computer, the ‘GRiDPad’, 1989 (IDEO)

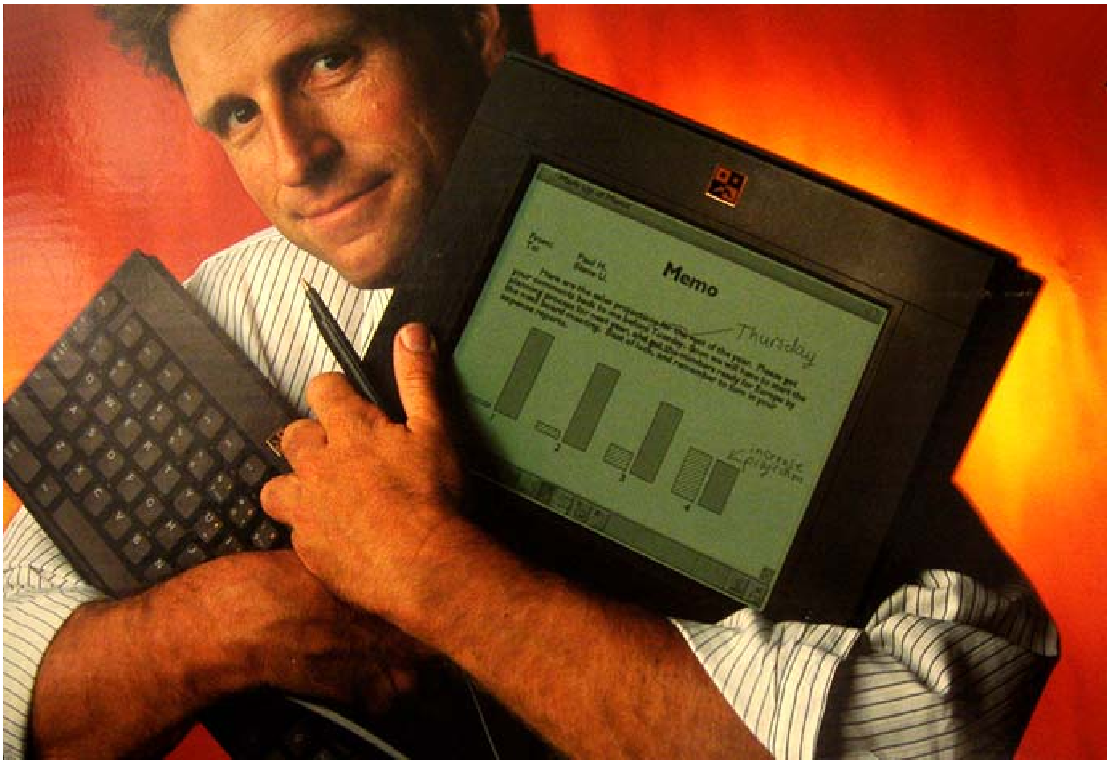

Figure 18: the Momenta ‘Pentop’, 1991. Aimed at executives, but not well received (CHM)

Although the removal of typing as the input to these products would have been seen as a benefit by male executives, it turned out that no one really liked to write on the computer screen. This may have been due to the ‘feel’ of writing on glass compared to paper, the difficulty of trying to operate with a stylus interfaces originally designed for keyboard and mouse input, or the frustrating inaccuracy of handwriting recognition technology (which is still an issue today). But it might just as easily be the case that carrying these products and writing on them semantically associated the owner with the less than executive role of completing pro-forma questionnaires and ticking off checklists. Even the accepted advantage of these products in business meetings in that they do not create a barrier between attendees when laid flat on a meeting table, and that there is no noisily distracting keyboard being used, does not detract from the fact that executives might have thought that they should not be the one being seen to take minutes. Although they remain in production as niche products, tablet computers clearly failed (and still fail) to portray a suitably fashionable self-image for the executive user, but seem to be readily accepted for educational use.

The technology contained within the tablet computer was being simultaneously developed by a large number of computer manufacturers. Apple were concerned that the tablet computer they were developing might detract sales from the Apple Macintosh, and so decided to change direction. The resulting product was the Apple Newton MessagePad PDA launched in 1992. Although for various technical reasons the Newton MessagePad failed to reinvent personal computing (as promised by Apple), it did define the product type for future developments. In the format of the tablet computer, this technology had not succeeded, but in the form of a PDA, the product type was readily accepted and spawned an industry of its own. Size was obviously an issue, and being seen to write on a handheld object resembling a reporter’s notepad was clearly more acceptable than writing on a large object resembling a clipboard.

Since the introduction of the PDA, and the concurrent introduction of the mobile phone, there has been a continuing attempt to converge the two products. Mobile phones have incrementally increased their computing capabilities through embedded software programs, and PDAs have added the facility to make phone calls to their touch-screen operated computing functions. With the advent of ‘live’ email capability to both, today’s PDAs and Smartphones are almost indistinguishable as product types, with the preference for one or the other largely a cultural preference.[29] The introduction in 2007 of the Apple iPhone represents the first significantly new product to really achieve such a level of convergence. Its fashionable status is not in question, but that alone will not guarantee its acceptance. Its success or failure will be an interesting case study to follow.

So, the desire by executive business users to project a suitably fashionable self-image through the use of technological products as role-setting objects and status symbols can be seen to have been a significant factor in the success or failure of mobile computers, and has subsequently affected their physical design in the wider marketplace[30]. Despite a number of technological developments, laptops remain the most successful form of mobile computer, and as such, their design has diversified to attract different markets. Lower-priced laptops are now marketed as commodity items (Figure 19), whereas the more advanced and expensive versions clearly retain elements of the fashion accessory (Figure 20). Status and image remain crucial factors in this area of computing.

[29] Japan, for example, has a far more mature, complex and embedded mobile phone culture than many other countries, and as a result the PDA never succeeded there. Smartphones, however, have been readily accepted.
[30] P Atkinson, ‘Upwardly Mobile: the role of fashion and image in the development of mobile computing’, *Proceedings of the IFFTI 08 Conference*, RMIT University, Melbourne, March 2008.

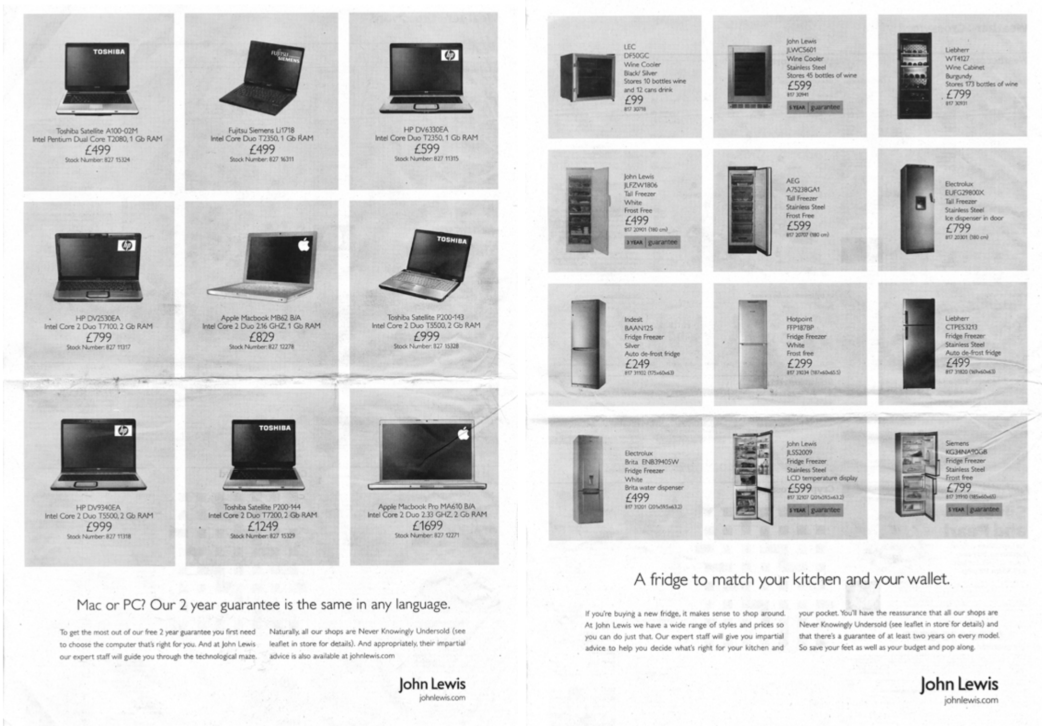

Figure 19: John Lewis Department store newspaper adverts, 2007. Laptops and Fridges both presented as commodity items. (Guardian)

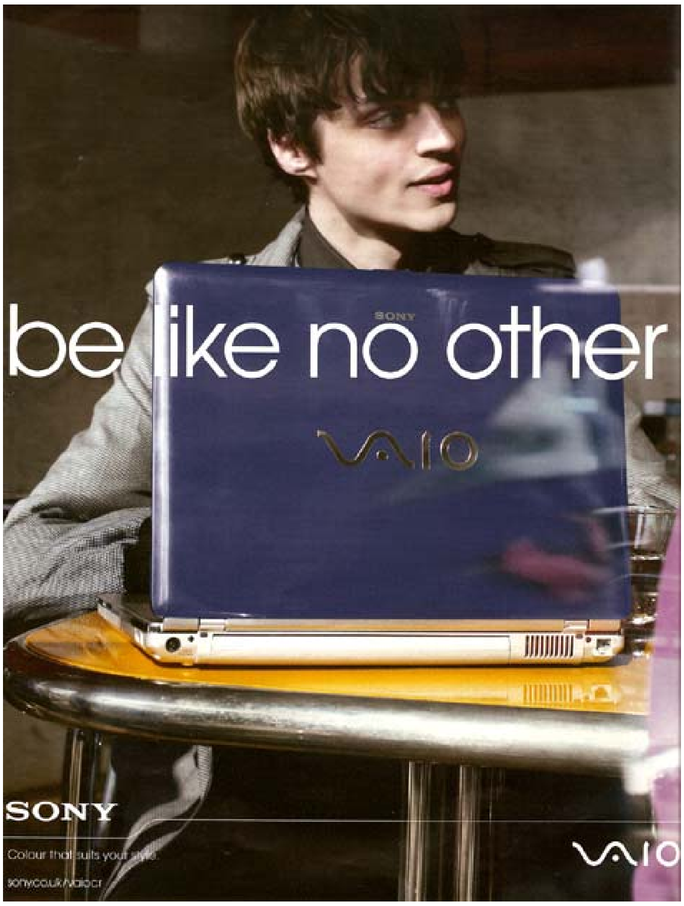

Figure 20: Sony Vaio Laptop Advert, 2007. The laptop as fashion statement. (Sony Corporation)

Power and Control, Status and Image - Conclusion

It is clear, then, that the technological development, and more significantly the designed form of computers intended for the different environments of the workplace, the home and public spaces have not been the result of a purely technologically determined path of progress but have been significantly affected through their reception and social use by consumers. In this process of selection, the issues of power, control, status and image have been key elements in the ‘interpretive flexibility’ of different designs by different relevant social groups of users.

In the workplace in particular, gender issues having historical roots reaching back to the nineteenth century have affected the physical design of office computers, making them acceptable or unacceptable to different hierarchies of users, and reinforcing existing social structures and power relations. In domestic spaces, gender bias in the exploration, adoption and consumption of technology had significant agency in the form taken by home computers and their later development into the games console. In the public arena, images of popular culture and contemporary fashion were appropriated to promote mobile computers to executives in order to imbue status and provide important elements of their self-image and identity.

Office computers, home computers and mobile computers have all been subject to multi-directional models of development, with a significant number of product types failing for one reason or another to be adopted by users. Computers are obviously in no way neutral. Their development has not taken place in isolation from society, but has been inextricably linked with a variety of social drivers and agents. As such, computers are social and cultural artefacts of the highest importance.

Futuristic Fantasy

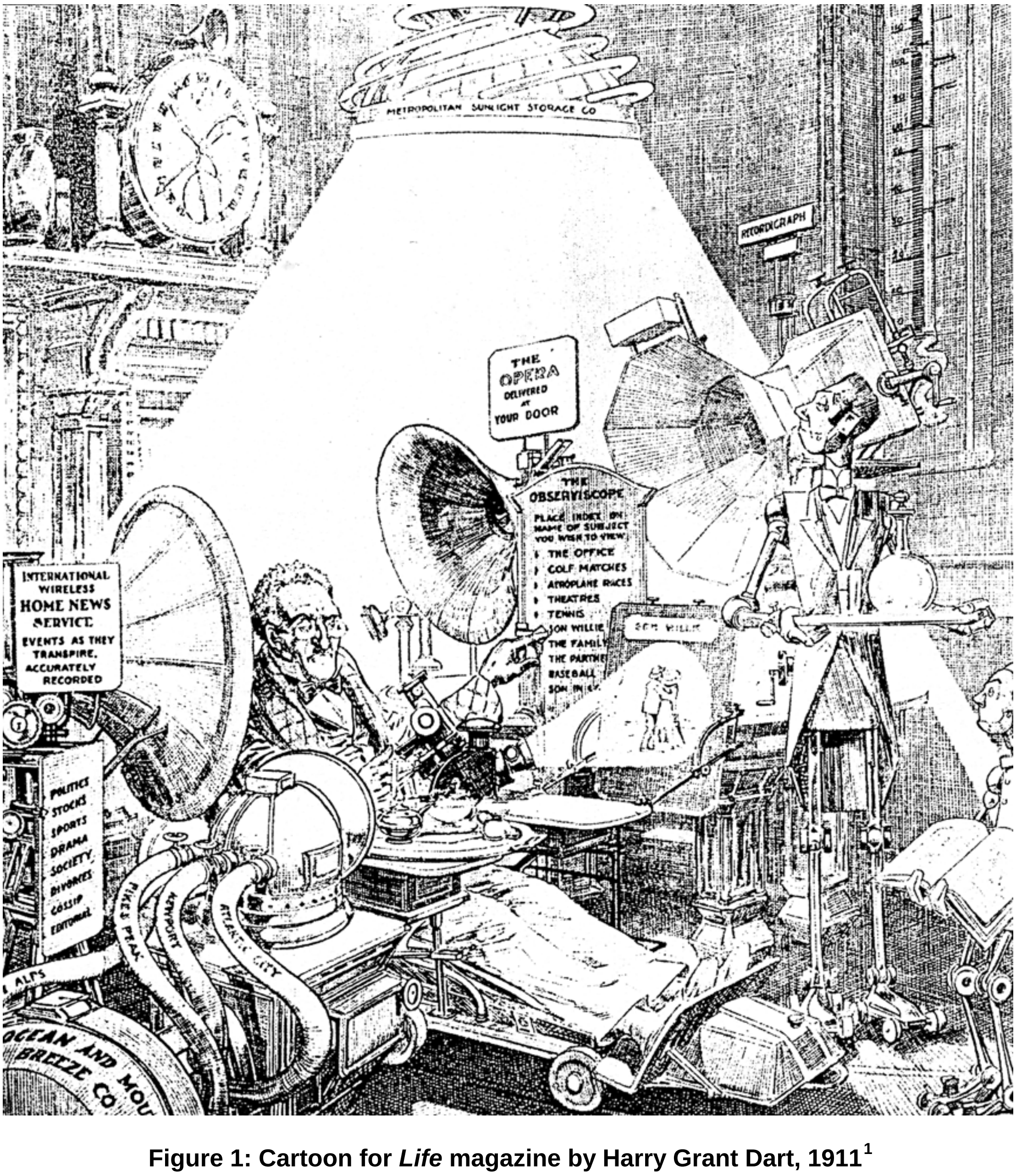

Figure 1: Cartoon for *Life* magazine by Harry Grant Dart, 1911[1]

[1] From J Durant, *Predictions*, New York, A. S. Barnes, p. 148.

A theme running through a number of the articles submitted concerns the one time 'futuristic' aspect of computing technology, and the role of film (especially the science fiction genre) and popular culture in the development of the designed form of computing technology. There are three related questions to be explored here. The first is 'in what ways have computers and computing technology been represented in popular culture?' The second is 'in what ways, if any, has this representation affected our relationship with computing technology?' The third, perhaps most difficult question is 'has the representation of computers in popular culture had any influence on the designed form of actual computers?'

The representation of computers in popular culture

The entertainment and communication abilities of computers have long been the focus of future predictions of technology, and were represented in novels and cartoons many years before they became a reality. The representation of the future capabilities of the computer before their possible appearance is perhaps further evidence of a social drive for computing technology as opposed to technologically determined development. An example of such a prediction appeared in an illustration in *Life* magazine (Figure 1), which in all but name forecast the internet – a networked communications system with on-line news and entertainment services and remote visual observation capabilities - as early as 1911. It is interesting to note in this image that while various technologies have been envisaged with some accuracy, including central heating, air conditioning, on-demand information and CCTV, webcam or videophone communication, electric wheelchairs and so on, various aspects remain determinedly as they were at the time of publication – notably clothing fashions and master/servant relations. Robotic or not, domestic staff continue to wear the uniform of servitude and work to serve their master, who is relaxing in a smoking jacket.

While part of this may be intentional – to show the unfamiliar in the context of the familiar to aid interpretation and heighten the impact of the illustration, it remains a truism that predictions of the future tend to extrapolate existing technological developments with ease, but struggle to foresee (and to depict) sociological developments. Here, the illustrator in a way predicts the information technology revolution, but fails to predict the social revolution following the First World War and the near disappearance of domestic service.

The image of the robot, though, is a familiar and powerful one in science fiction. Technology was seen as there to help mankind, and the connection between human and mechanical servants was an easy link to make. Images of 'mechanical men' were a common theme in cartoons of the early 1900s as people looked forward to the exciting possibilities of the twentieth century. The term itself, 'Robot', comes from the Czech word 'Robota' meaning 'indentured labour' or 'hard work' and was coined in 1920 by Josef Čapek for use in his brother Karel's play *R.U.R. Rossum's Universal Robots*[2]. From this point forward, the robot became the icon of the 'Golden Age of Science Fiction', appearing regularly from the mid 1920s on in science fiction stories and on the covers of pulp magazines such as *Amazing Stories* and its followers *Wonder Stories*, *Astounding Stories* and *Startling Stories*. The same phenomenon occurred (and still occurs) in film. From 'Maria' in Fritz Lang's 1929 *Metropolis* through 'Robby' in Fred Wilcox's 1956 *Forbidden Planet*, to the renegade replicants in Ridley Scott's 1982 *Blade Runner*, James Cameron's 1984 *The Terminator*, and Alex Proyas' 2004 *I, Robot*, the robot/android has long been popularised through film as the ultimate embodiment of future technology. Indeed, it has been noted that prior to its appearance in reality, 'the SF genre paid almost no attention to the computer',[3] and focussed instead on anthropomorphising machinery into a variety of vaguely humanoid figures as perhaps an obvious form in which technology could either serve, or alternatively threaten, mankind.

[2] D Jerz, R.U.R. (Rossum's Universal Robots) Viewed 14 Dec 2007. <http://jerz.setonhill.edu/resources/RUR/index.html>

[3] J Clute, *Science Fiction: The Illustrated Encyclopaedia*, London, Dorling Kindersley, 1995, p. 74. However, there is an exception that proves the rule: *A Logic Named Joe*, an unillustrated short story by Murray Leinster describing home computers connected over a network was published in 1946!

Commercially available business computers first appeared in 1951, in the UK produced by Ferranti and Lyons (yes, the tea shop people!) and in the USA in the form of Remington Rand's UNIVAC (Figure 2). These 'electronic brains' (as they were referred to at the time) quickly began to be represented in popular culture. A fictional electronic brain named EMERAC was the central focus of the 1957 film *Desk Set*, directed by Walter Lang and starring Katharine Hepburn and Spencer Tracy (Figure 3).

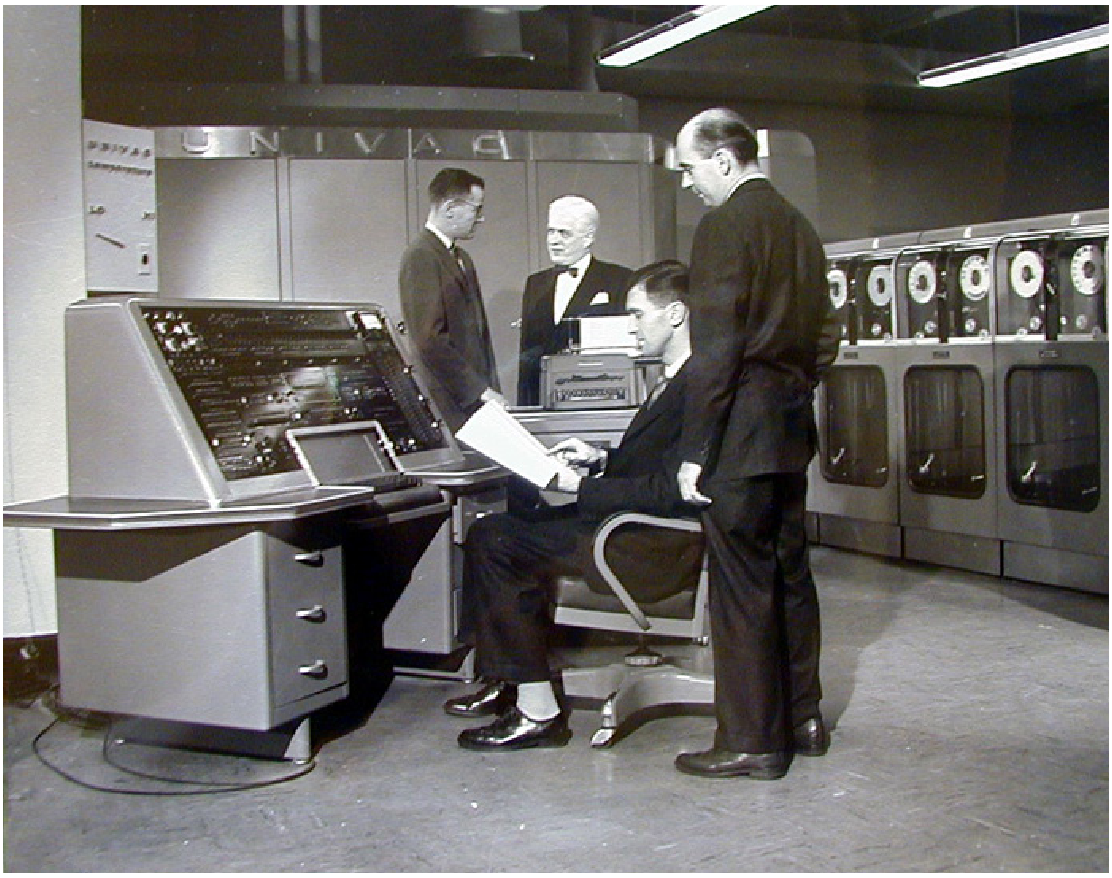

Figure 2: UNIVAC – a real computer produced by Remington Rand (1951) (www.computermuseum.li)

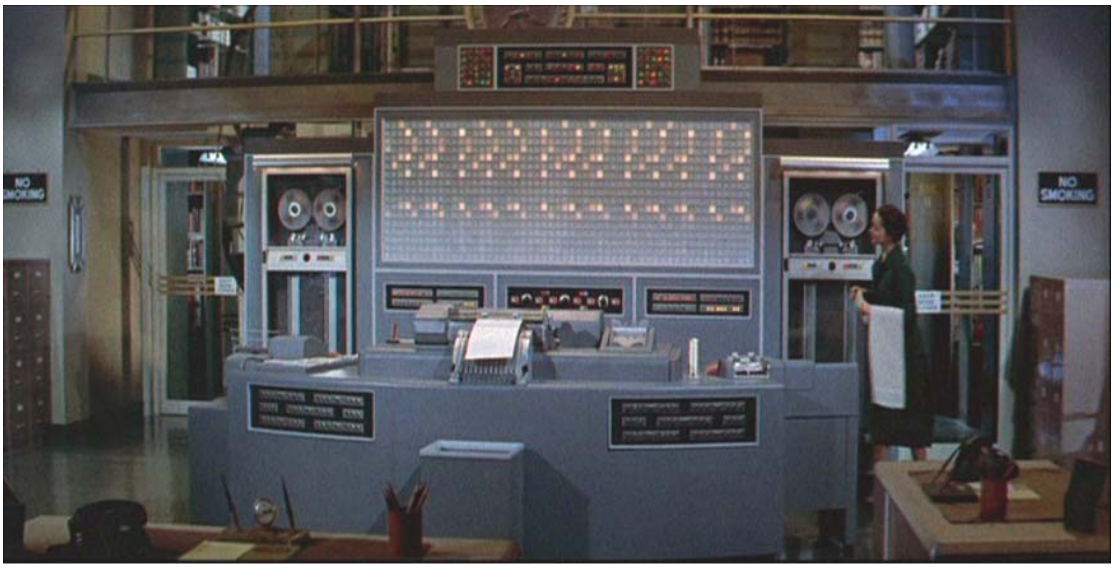

Figure 3: EMERAC – a fictional computer in the Hollywood film *Desk Set* (1957) (DVD)

Once computers were part of the public's awareness of technology, they became central to many science fiction films. Perhaps one of the most famous fictional computers in the science fiction genre is Hal – the artificial intelligence controlling the spaceship 'Discovery' in Stanley Kubrick's and Arthur C. Clarke's 1968 film *2001: A Space Odyssey*. The portrayal of the HAL 9000 computer is another example of technological extrapolation that missed a social innovation. At the time Kubrick and Clarke worked on the screenplay for the film, computers were large, room-sized mainframes. Hal, even though massively more powerful than computers of the day, takes the same form of an individual, large machine – large enough for the ship's captain to enter and disable the computer when it malfunctions (Figure 4). Kubrick, and certainly the scientist Clarke, would have been aware of the electronic engineer Gordon Moore's widely promoted prediction of the exponential increase of computing power (known later as 'Moore's Law'), which was first published in 1965.[4] This originally predicted that the power of a computer would double every year for the next ten years (he later changed this to a doubling every 2 years, which has held true now for over 40 years). Extrapolating forward and applying this theory to the powerful capabilities of the computer 33 years in the future, therefore, was in some respects straightforward, including the advent of artificial intelligence and voice control (which are a reality, although not nearly as successful as predicted). However, predicting the future designed form of the computer is another matter entirely. The use of centralised computers accessed by numerous people proved not to meet the needs of users, and the corollary of increasing the number of transistors on a single silicon chip (as in Moore's Law) is the reduction in size of the transistor, allowing smaller (as well as more powerful) computers to be built. Yet even people closely involved in the industry did not foresee the transformation of computing technology usage from a small number of large machines to an enormous number of individual, personal computers.[5]

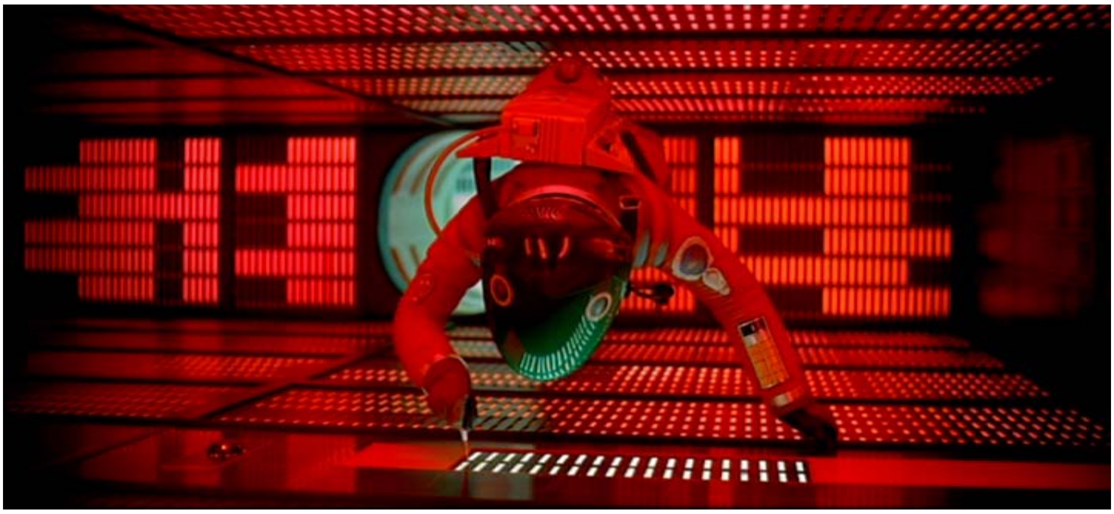

Figure 4: Inside Hal's Memory in the film 2001: A Space Odyssey (1968) (DVD)

[4] G Moore, 'Cramming more components onto integrated circuits', *Electronics*, 38(8): 19 April 1965.
[5] A number of well known predictions from the industry point to this fact – "I think there is a world market for maybe 5 computers" (IBM Chairman Thomas Watson, 1943); "Computers in the future may weigh no more than 1.5 tons" (Popular Mechanics, 1949); "There is no reason anyone would want a computer in the home" (Kenneth Olsen, Digital Equipment Corporation, 1977). See C Wurster, *Computers. An Illustrated History*, Köln, Taschen, 2002, passim.

Popular culture and our relationship with technology

The representation of computers in print, film and popular culture has clearly affected the relationship between people and the technology they use – as representation reflects and amplifies, so it informs and reinforces existing attitudes. Science historians William Aspray and Donald Beaver studied the representation of computers in advertising material between 1950 and 1980 to analyse the popular understanding and perceptions of computing technology and found numerous examples where computers were portrayed as monsters:

> By the late 1960s …. the areas in which computer technology provides corporate competitive advantage – organization, communication and control – are those increasingly identified as the roots of dehumanizing and alienating human technology.[6]

Computer corporations used adverts at the time to 'present computer technology as the solution, not the cause, of a wide range of social ills.'[7] Outside of corporate advertising, computers have been seen to present a number of dangers to society and mankind that have been reflected in different ways in a variety of films. These issues have included job security; the loss of control over technology; the possibility of unintentional nuclear holocaust; the vulnerability of economic and financial computer systems; and the loss of personal liberty and identity, amongst others.

The technological revolution heralded by the appearance of the computer was a case of history repeating itself. In a similar way to the mechanisation of manual labour processes in the industrial revolution, the introduction of the computer into the office from the 1950s onwards was a portent of the loss of employment and social upheaval. Although few might have understood how these mysterious machines actually worked, their ability to outperform their human counterparts presented a clear threat to people's livelihoods and the established orders of the workplace. An early example of this fear was represented in the aforementioned *Desk Set* (1957), which revolved around the introduction of an 'electronic brain' into the research department of a broadcasting company, where its ability to retrieve facts and figures at lightning speed is taken by the researchers in the department as making their roles redundant. This leads to a pitched battle between the workers and the computer experts, where the limitations of the machine become reassuringly apparent.

The realisation that more, and more crucial aspects of the nation's defences were becoming reliant on impersonal and autonomous computer systems raised a number of concerns over the reliability and security of such systems, our ability to retain control over them, and the significant potential for the misuse of such vast power. Films that reflected these particular concerns cast the computer as central to the plot. In *Billion Dollar Brain* (Ken Russell, 1967) the secret agent Harry Palmer (played by Michael Caine) thwarts a plan by a billionaire oil baron to use a supercomputer to initiate a third World War. *Colossus: The Forbin Project* (Joseph Sargent, 1970) was based on a 1966 novel which predicted artificially intelligent supercomputers overseeing the nuclear defences of the USA and the USSR joining forces and using the weapons to control society; whereas *Wargames* (John Badham, 1983) depicted a nuclear war being narrowly diverted when a schoolchild accidentally hacked into the national defence computer system and, believing it to be the system of a computer games company, engages in a simulated war game against the computer (Figure 5). A similar concern over man's ability to fully control advanced technology is shown in *2001: A Space Odyssey* when the HAL 9000 computer kills crew members of the spaceship because they intend to disconnect it.

The susceptibility of financial computer systems to infiltration and the potential economic consequences of unauthorised use remains an ongoing concern, which has been addressed in numerous films including *Hackers* (Iain Softley, 1995), *Firewall* (Richard Loncraine, 2006), and *Diehard 4.0* (Len Wiseman, 2007). Reflecting the growing ubiquitous nature of computers and the lack of interest in their physical form (as discussed in *The (In)Difference Engine*), as the form of the desktop computer stabilised and computing technology became a well-

[6] W Aspray, & D Beaver, Marketing the Monster: Advertising Computer Technology, *Annals of the History of Computing*, 8(2), 1986, 139.
[7] Ibid.

understood phenomenon, the representation of computers themselves ceased to be central to the plots of films. The fears of the public imagination have become bound up instead with the completely intangible phenomenon of the Internet and the possibilities and dangers inherent in wide access to and misuse of personal information. Films such as *The Net* (Irwin Winkler, 1995) and *Enemy of the State* (Tony Scott, 1998) showed the debilitating effects of computer experts being able to remove all traces of a person's identity from computer databases and monitor their every move through computer controlled surveillance.

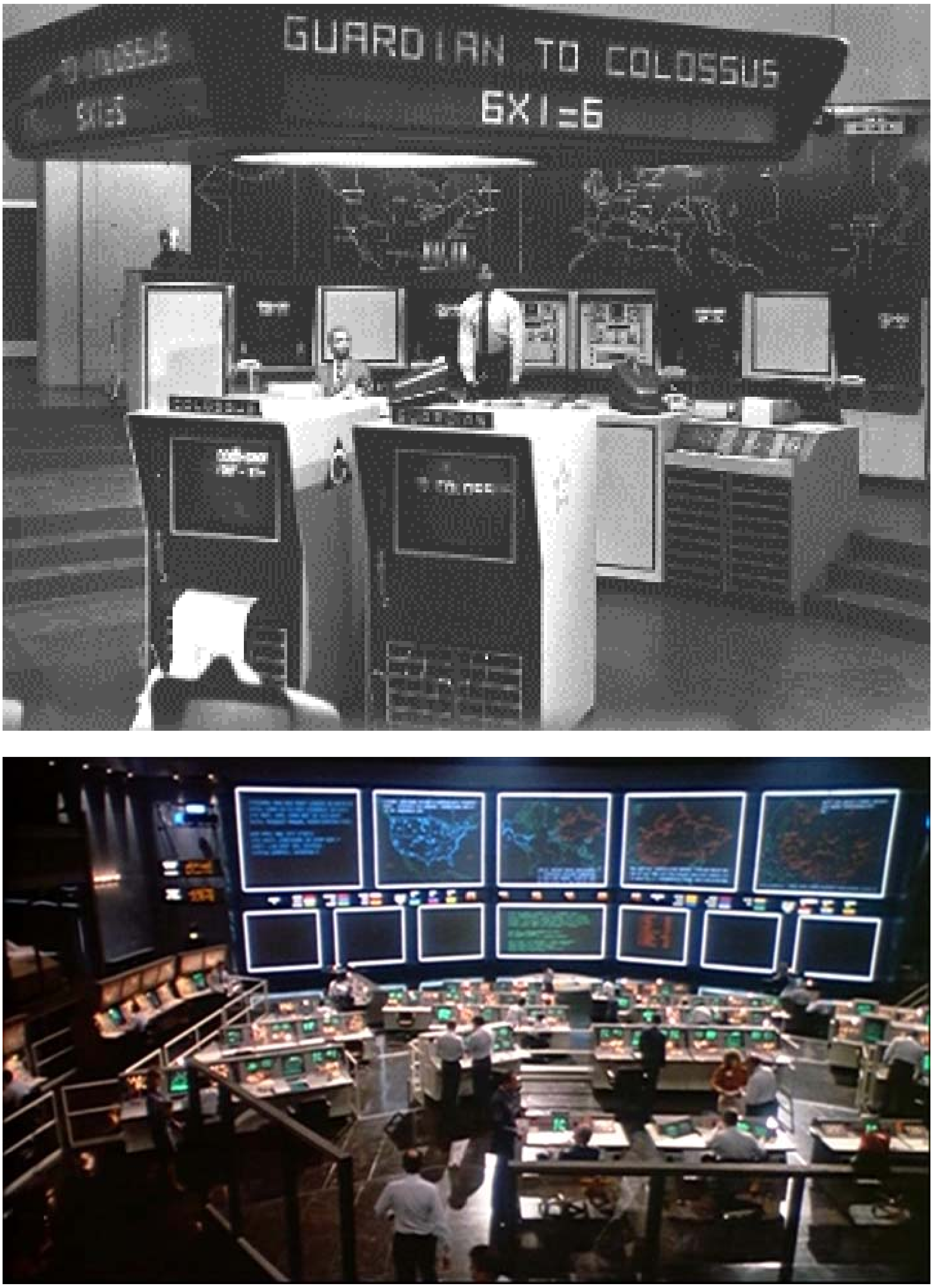

Figure 5: Supercomputers threatening loss of control over nuclear defences:
Top: Colossus: The Forbin Project (1970), Bottom: Wargames (1983) (DVD)

Popular culture and the designed form of the computer

In the published articles submitted, various aspects have been identified as the most relevant sources of stylistic influences that are posited to have inspired the design of the computer in some way. These include film and popular culture, especially science fiction, and the zeitgeist of the space race from the late 1950s into the 1970s. These aspects of popular culture had elements of the unknown and an air of uncertainty to them, and it has long been recognised that uncertainty is a breeding ground for diversity and new design. For example, in the 1920's and 1930's, especially across America, a number of buildings began to appear which had new, unfamiliar functions - power stations, petrol forecourts, and most notably cinemas. These were examples of architecture with no precedent, no history of their own. Alastair Duncan, in his book, *Art Deco* (1988) took the view that this uncertainty was one of the reasons these buildings adopted the new, *avant-garde* styles of Art Deco and Moderne. A future world of cultural eclecticism connoted by these styles seemed appropriate to architects and designers struggling for tangible points of reference. Similarly, the people designing computers had no real understanding of what these machines would be used to do (other than calculate) and so had little in the way of historical precedents on which to base designs:

> The first generation of computers wasn't really designed at all… [T]hey had no particular identity of their own, partly because the jobs they were supposed to be doing still had to be invented.[8]

It should be borne in mind that the earliest computers were not serially produced products, but installations - complex assemblages of components wired into purpose-built cabinetry. 'Programming' these machines involved scientists rewiring components into new configurations to solve particular mathematical problems (Figure 6). As computers became more complex, and had to be operated by people other than those who designed and built them, there arose a need for a way to manage important operations centrally. These control centres were essentially primitive user interfaces, and took the form of consoles – purpose built desks with vertical or sloping panels covered in arrays of control knobs, switches and indicator lights, where the relationships between different controls could be made clear.

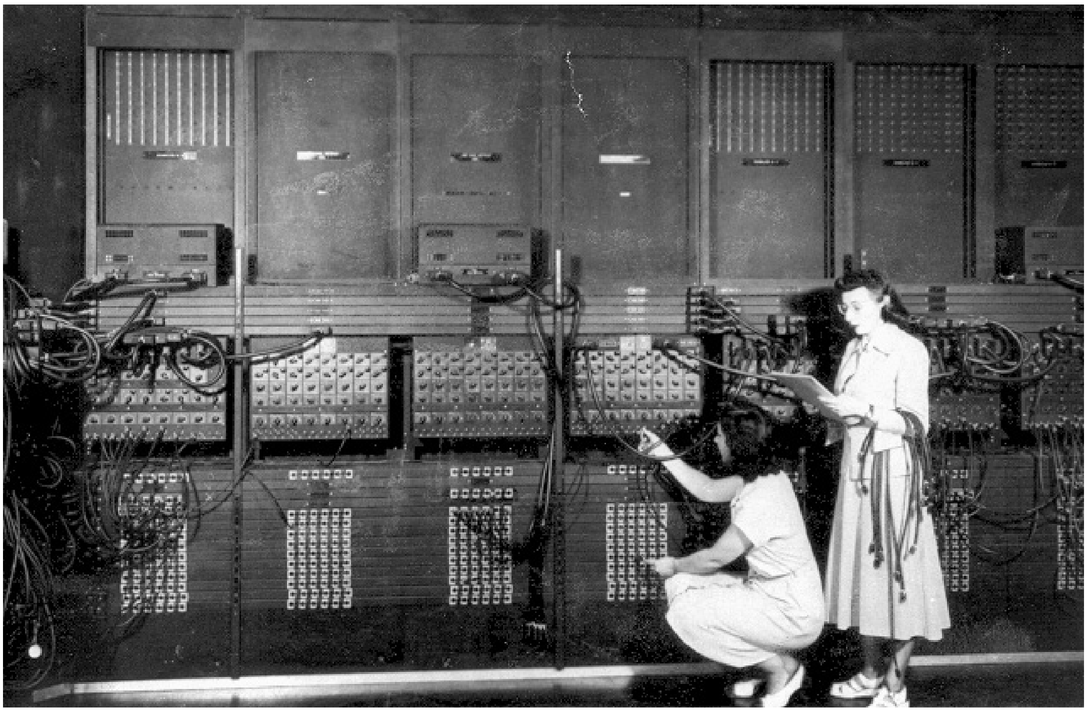

Figure 6: The 1946 ENIAC being reprogrammed by rewiring (www.computermuseum.li)

[8] G Sowden, 'Are you thinking comfortably?', *Design*, April 1983: p. 48.

Figure 7: One of the earliest purpose-built computer consoles: The 1948 IBM SSEC (Selective Sequence Electronic Calculator) (CHM)

Some of the earliest computer consoles appeared on government and military computers in the late 1940s/ early 1950s (Figure 7), and on early business machines in the 1950s and 60s. Even if viewers did not fully understand the functions or capabilities of computers, the console operating a room of electronic cabinetry would have been recognisable to the public as a computer interface at this point. Large consoles were seen in television documentary reportage on the space race, and started to appear in popular film and television in the late 1950s and early 1960s – in the bunkers of the master criminals in James Bond and *Man from U.N.C.L.E.* movies, and as mentioned, in the films *Desk Set* and *Billion Dollar Brain*. Even Hal, the futuristic, sentient supercomputer of *2001: A Space Odyssey,* despite its ship-wide invisible presence and verbal communication abilities, was given a control console not dissimilar to those of real world mainframe computers of the day (Figure 8).

Figure 8: Consoles in popular culture in the 1960s: The supercomputer in *Billion Dollar Brain*, with numerous consoles, 1967; and the control console of Hal in the film 2001: A Space Odyssey, 1968 (DVD)

As stated earlier, John Clute noted that science fiction largely failed to predict the invention of computers prior to them appearing as real objects. When they did appear in popular culture they looked familiarly like existing consoles (perhaps in order to be understood as such by viewers). Therefore, it is problematic to suggest that film and/or popular culture influenced the design of early computer consoles, although a number of authors have suggested this. As in the quote on page 62 of *The (In)Difference Engine*:

> There was a time when console units were only a science fiction illustrator's standby. If a spaceship interior in *Amazing* Stories or a Dan Dare strip looked too bleak, an illustrator would deck it out with vast arrays of glowing lights and dials. Futurists tended to see Earthbound business being conducted from winking, omnipotent consoles too. The console became a cipher for the technological prowess of the corporation to come.[9]

Which might suggest that computer consoles appeared in Dan Dare before they did in actuality, which is patently untrue – even though illustrated science fiction magazines such as *Amazing Stories* started in 1926, Dan Dare first appeared in the *Eagle* in 1950, while prototype computers such as the 1948 IBM SSEC had purpose-built consoles and the first series-produced consoles were made for early business machines in 1951. It also intimates that the scientists building computers were futurists, taking their cue from *Amazing Stories* rather than academic journals, which is entirely possible but not proven.

[9] J Woodhuysen, 'Complex Consoles are Coming', *Design*, January 1980, p. 34.

Suggesting that the design of computer consoles was influenced by the likes of Dan Dare points to some confusion or misinterpretation of what exactly was being portrayed in such imagery. Although it would be difficult to prove the point absolutely, the consoles appearing in early science fiction illustrations, with their screens, dials, lights and levers, were far more likely to have been extrapolations of existing developments in *instrumentation* rather than futuristic predictions of computing. Representations of fictional complex control panels in the 1960s such as those in popular TV programmes such as *Thunderbirds* and *Batman* are ambiguous in their function to say the least (Figure 9), and examples in science fiction illustrations, especially before the advent of computers, clearly would have had a different point of reference. Man's ability to travel further and further afield by ship, submarine and in particular the aeroplane after the start of the 20th century likely fuelled the imaginations of science fiction writers and illustrators contemplating travelling between the stars, and the instrument-crowded cockpits, bridges and helms of these vehicles would have provided a fertile starting point for projecting forward and expanding such controls to fill the flight decks of interplanetary spacecraft (Figure 10). The question, therefore, is did the designers of early computer consoles base their designs on futuristic vehicle control panels? This seems unlikely.

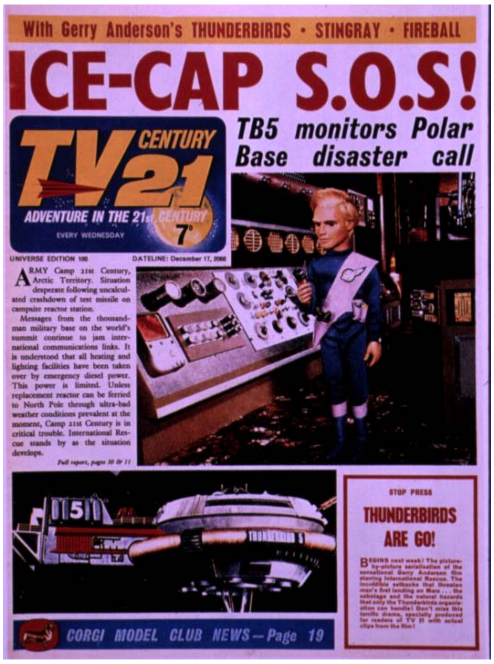

Figure 9: Consoles in popular culture in the 1960s: The control panel of the space station Thunderbird 5 in *TV21* comic, 1968[10]; The Batcave in the *Batman* TV Series, 1966[11].

[10] From R Sabin, *Comics, Comix and Graphic Novels: a history of comic art*, London, Phaidon, 1996, p. 52.
[11] From D Shipman, *A Pictorial History of Science Fiction Films*, Twickenham, Wattle Books, 1982, p. 101.

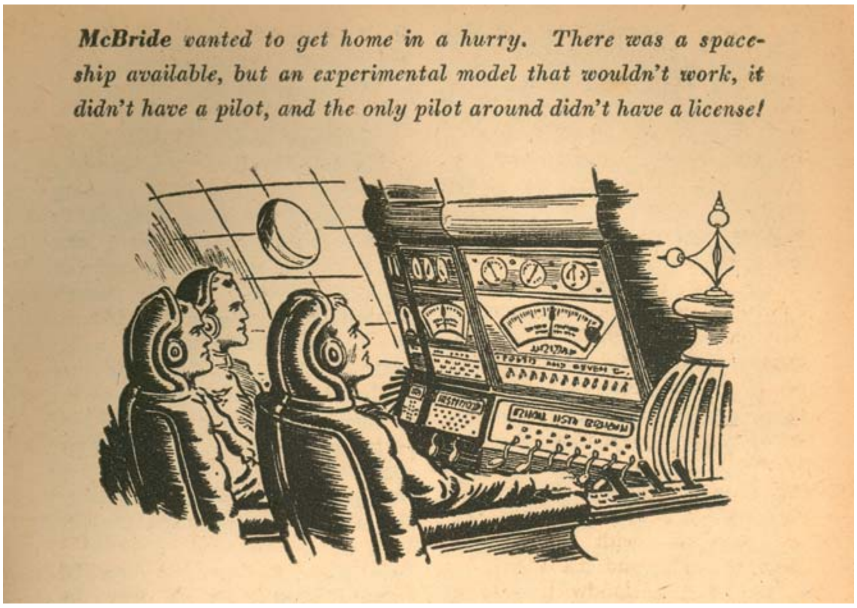

Figure 10: Illustration by Orban for *Astounding Science Fiction* , May 1944 (University of Liverpool)

While the influence of Dan Dare (or similar stories) on early computer console design is at best questionable, the case for the influence of science fiction on the designed form of the computer terminal in later years becomes far more convincing. There is an easy alliance to be seen between the computer's role as forward-looking technology and the futuristic fantasy of science fiction. Mario Bellini's TCV 250 computer terminal for Olivetti in 1966 (Figure 11) was stated in a retrospective exhibition catalogue to have 'a science fiction aspect',[12] and by the 1970s, a science fiction (or at the very least a 'space race' influence) can be seen in the designs of computer terminals such as the Lear Siegler ADM-2 with its 'docking' keyboard and the NCR Criterion (Figure 12) – which looks as if could have come straight from the flight deck of the Starship Enterprise in *Star Trek*. The texts accompanying these images in the brochures, heavily concerned as they were with the future expandability and upgradeability of expensive hardware, points to another justification for such forward-looking, futuristic styling, as do the mythological and futuristic, science-fiction inspired names given to different models of computers at this time (as discussed in *The (In)Difference Engine*).

Figure 11: Mario Bellini's TCV 250 computer terminal for Olivetti in 1966[13]

[12] C McCarty, *Mario Bellini, Designer*, New York, Museum of Modern Art, 1987, p. 21.
[13] Ibid.

Figure 12: The Lear Seigler ADM-2 (1975) and the NCR Criterion (1976). Examples of the influence of space-race and science fiction imagery on the design of computer terminals. (NAHC)

By the time of the emergence of personal computers in the early 1980s, the link between computers and science fiction was even more firmly established.

> Designers approached the first personal computers with the science fiction models of Buck Rogers and 2001 fixed firmly in their minds. Those images – visions of what a computer would look like if it existed-inspired the shape the machine took when it finally became a reality.[14]

Notwithstanding the previously discussed argument over what the technology shown in such science fiction films before the advent of the computer actually was[15], the design of home computers in particular, such as the 1977 Commodore PET 2001 and the 1980 Sinclair ZX80, were indeed presented in angular, futuristic looking cases reflecting 'space-age technology' (Figure 13 and Figure 14), as was the 1979 Texas Instruments 994/A (which betrayed another 'space-race' connection in using software programmes supplied in solid-state, plug-in 'Command Modules').[16]

Figure 13: The Commodore 2001 PET, 1977 (www.365questions.org)

[14] P Palton, 'The Magic Box', *Connoisseur*, January 1986, 55.
[15] Or indeed which version of 'Buck Rogers' is being referred to (as the comic strips/ films and TV programmes were produced from 1926 to 1981, with understandably very different visual environments).
[16] The influence of this type of imagery on design was, of course, not restricted to computer products, and can be seen in myriad products of the period, especially technological ones. It was, however, perhaps particularly pertinent to the design of computers.

Figure 14: Top: the Sinclair ZX80, 1980; Bottom: the Texas Instruments TI994/A, 1979 (computermuseum.50megs.com)

Futuristic Fantasy - Conclusion

The representation of computers in popular culture has always been diverse. The computer itself, and computing technology as a whole has been presented in film in particular as a potential threat. A threat to individuals, with respect to employment and work prospects as well as threatening a loss of personal identity, and to society as a whole through the potential for technology to be appropriated or to develop beyond human control. A threat to the economy, our security and even the planet. At the same time, the computer has been presented, especially by manufacturers, as enabling far greater efficiencies and levels of achievement at work, and in science fiction, as a saviour, enabling mankind to fulfil his potential. Consequently, our relationship with computing technology has been complex and varied. Computers have consistently been seen as agents of change, both good and bad.

With respect to the effect of this representation on the design of computers, as with any form of future predictions, popular culture struggled to foresee the future configuration of technology usage, and so it cannot be convincingly argued that it had a significant impact on the form the computer took on its first appearance in the marketplace. However, this is not to say that there is no relationship per se between the representation of computing in popular culture and the designed form of computing technology.

Before they became commonplace and commodified as everyday items of office equipment in the 1980s, computers represented an exciting (and sometimes frightening) future, which was reflected in their representation in the media, but also in their physical form. Computing technology, and computers themselves, embodied hopes as well as fears, possibilities as well as threats. Their status as constantly improving, cutting-edge developments at a time of rapidly changing technological advances in many walks of life perhaps explains the adoption of ‘space-race’ and science fiction imagery as appropriate points of reference for the styling of computer products in the 1960s and 1970s.

Published Articles

Computer Memories: The History of Computer Form

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COMPUTER MEMORIES: THE HISTORY OF COMPUTER FORM

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Abstract: This paper looks at the computer as a truly global form. The similar beige boxes found in offices across the world, are analysed from the perspective of design history rather than that of the history of science and technology. Through the exploration of an archive of computer manufacturer's catalogues and concurrent design texts, this paper examines the changes that have occurred in the production and consumption of the computer in the context of the workplace, from its inception as a room-sized mainframe operated through a console of flashing lights, to the personal computer as a 'universal' form, reproduced by many manufacturers. It shows how the computer in the past has been as diverse as any other product, and asks how and why it now appears as a standardised, sanitised object. In doing so our relationship with the office computer, past and present is explored, revealing a complex history of vicissitude.

FORM AS HISTORY

This paper addresses various criticisms of the history of computing. William Aspray noted that three professions had written about the history of computers: computer professionals; historians of technology and science; and journalists. Computer professionals had constructed a one-dimensional account of technical history. Technology and science historians had employed the methodology of the social shaping of technology to computing, but had less technical knowledge than computer professionals. The analysis of journalists had added little to scholarship, but the personal dimension of computing evident in their work had at least been popularly disseminated. "After all, as historians we are ultimately interested in computing as human enterprise."[1]

This focus on the computer as a technological artefact has, as argued, limited its historical analysis to a narrow technical rather than social perspective. This paper is instead a study within the history of design – a piece of social and cultural history whose subject happens to be a technological artefact. It is not the technology *per se* which is the primary source of interest, but the presentation of that technology to its end user in a designed form.

The history of design explores cultural aspects of design meaning – design produced and consumed as a social process. The social world provides the conditions within which design operates and which design reflects. "If circumstances do not *coerce* form, they are certainly often *manifest* in form."[2] The position here is that through form, objects themselves convey meaning. Their study is a study of *representations* – the semiotic analysis of culture, in which objects or images are interpreted as cultural icons. Designed artefacts, then, are a valid source of evidence for the writing of history. Their value lies in the status of meaning transferred to them by their consumers – an 'anthropology of consumption'.[3]

"COMPUTERS ALL LOOK THE SAME"

At the present time there is a clear perception of the appearance of all computers as identical and consequently boring. Discussions with users of computers entails repetitive rhetoric. "They all look the same", "They're so boring to look at", "They're just grey boxes". But what exactly is it that these people are referring to, the signified of the word 'computer' as signifier?[4]

I believe they are usually referring to the computer as it appears in the office – a series of beige boxes. A processor with a slot for a floppy disc in the front; a monitor; a keyboard; and a mouse. This is the 'Universal Desktop Office Computer' – the 'clone' – an identical, characterless copy of a bland original.

These boxes are the work of designers. The role of designers, one imagines, is to be creative and imaginative. The level of imagination shown over the last decade would appear to be nil. Any manufacturer's latest computer looks remarkably like its last – extra ribs on the case moulding, oval rather than square power buttons, slightly larger or smaller radii along this or that edge.

Computers enable people to do remarkable things: layout and print pages of text and charts; manipulate raw data into meaningful statistics. Through the internet, people across the world exchange ideas and news. The computer bears the mark of an incredibly exciting machine. Why then is its design so nondescript? Instead of instilling awe in people as it promises the Earth, the design of the computer instils only boredom. In this respect, the computer is a missed opportunity, an unfilled possibility, an unfulfilled promise.

This paper will show that there is no reason for this situation to exist. The tracing of the development of the electronic computer as a cultural object will demonstrate that in the past, the computer took a multitude of forms.

The gathering of archival information for such an analysis is problematic. Much ephemera has been lost, and the past focus of computer history has not been their designed form. The National Archive for the History of Computing at the University of Manchester carries an extensive collection of trade catalogues, showing the forms of the computers themselves, and to some extent their context. It must be noted, however, that catalogues are *not* documentary evidence, but *representations*. The photographs show staged sets and models, not real workers in offices. This does not affect the analysis of the form of the computer, as its design is accurately conveyed (although any image of a product is, in effect, a translation placing the form over the function[5]), yet where analysis is attempted of the context this fact becomes important. We are not shown images of reality in catalogues, but a construct of the manufacturer's imagination. Even so, catalogues are a form of advertisement, and their analysis remains valid. Although the information they held quickly dated, it is precisely this ephemerality which makes catalogues such a fascinating record of the computer's development.

This paper focuses on computers in the office rather than the home as there is a marked difference in their development. Haddon has stated "In contrast to its current main image as office equipment that can be used in the home, the early home micro was promoted for less tangible uses."[6] The home computer developed from the hobbyist, as opposed to the office computer's origins in large electronics corporations. The two different trajectories collided with the introduction of the Apple II in 1977. Studying the computer as an object within the workplace deliberately distinguishes between the relationships people have with personal objects and those they use at work, and allows us to consider its position within the corporate hierarchy. This is important – as the authors of *The Meaning of Things* have said: "The tools of one's trade, perhaps more than any other set of objects, help to define who we are as individuals. Karl Marx was right: Humans create their existence primarily through productive efforts".[7]

The number of manufacturers involved means that the range of images collated are representative rather than comprehensive. Consequently, findings from this archival research should be treated as indicative rather than conclusive. The dates associated with the images are a guideline, as the forms of computers presented may not contain the earliest or last example of their kind. Brochures for example may have appeared in advance of a product's launch. Others may have continued to be produced after the brochures ceased. This analysis, then, should be seen as diachronic – examining changes from one form of computer to another, and synchronic only in examining the number of different forms present at any particular time.

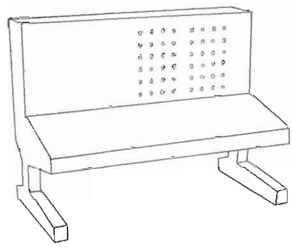
THE DEVELOPMENT OF THE FORM OF THE OFFICE COMPUTER

In order to assess the variety of forms of past computers, a large number of images collated from the National Archive and other sources were arranged into groups, each having a distinct arrangement of the computer's main component parts. Each form is accompanied by a line drawing representing this arrangement, and a small table allowing direct comparison. The selected images shown are indicative of those in each group produced. This approach allows the focus to remain on the design of the computer, transcending the vagaries of less important stylistic influences. Where the input terminal was remote from the computer processor, it is the design of the terminal which has been considered. I would argue that from the operator's point of view, the input terminal *is* the computer itself.

Form A

The earliest computer interfaces, appearing around 1945, were true consoles. Large desks within a room lined with the other components of the computer. The processing and storage units, power supplies and test equipment were housed in bespoke, yet anonymous, boxes. The function of these other components was esoteric, not necessarily understood by the operators. Banks of lights and dials displayed the machine's condition as instructions were given by flicking switches, pushing buttons, and by inserting punched cards, paper tape or typing commands.

Example	IBM Ramac 305, 1955
Earliest Appearance	1948
Latest Appearance	1974
Form Type	Remote Console
Keyboard/Controls	In Console
Monitor	n/a
Processor	Remote
Storage	Remote



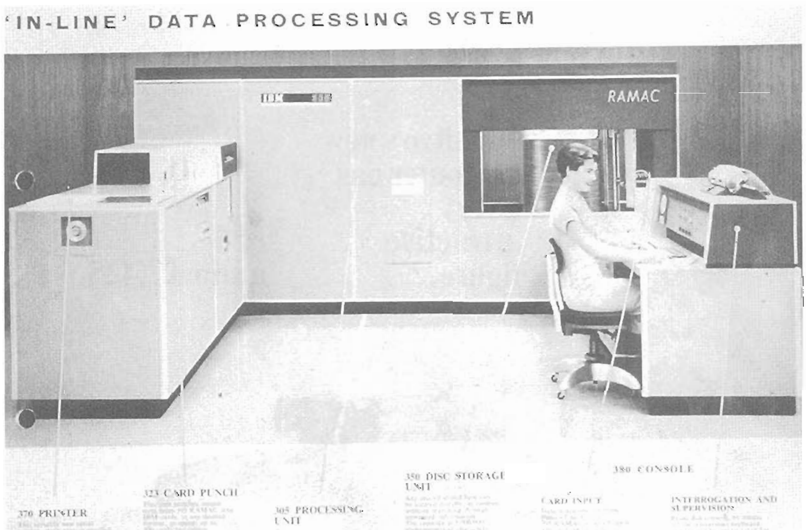


Fig. 1 IBM Ramac 305, 1955 (courtesy of IBM UK Ltd.).

The rhetoric used with this imagery of the console or 'control desk' is interesting. For example, the brochure for IBM's Ramac 305 (Fig. 1) stated that the console was for "interrogation and supervision". Words which suggest that the computer at this point was not seen as a fully willing servant or even as being under complete control, but rather as an alien intelligence to be probed and examined.

Form B

By the mid-1950s smaller computers appeared in which a less powerful processing unit formed part of the operator's desk itself. The

Example	Muldivo Digiputer 1968
Earliest Appearance	1955
Latest Appearance	1974
Form Type	Self-Contained Desk
Keyboard/Controls	Separate
Monitor	n/a
Processor	In Desk
Storage	In Desk/Remote

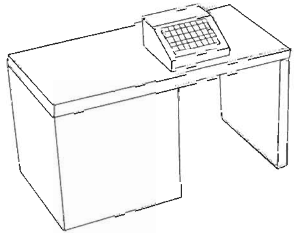


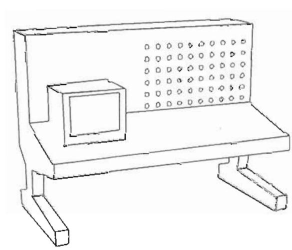
Fig. 2 Muldivo Digiputer, 1968.

pedestal unit contained the electronics, with input and output being through a specially arranged typewriter. The appropriation of the semiology of the office desk and prominent use of the typewriter form placed these computers firmly in the domain of female operatives.

The typewriter has been associated with women ever since they were first employed in offices specifically to operate them.[8] Women were computer operators and programmers "at a time when those activities were considered mundane, ... tedious and repetitive".[9] This relationship between typewriter and computer perpetuated the undervaluation of women's skills as non-technical, as technical competence confers "potential or actual power ... central to the sexual and class politics of technological work".[10]

Form C

Example	ICL 2900, 1974
Earliest Appearance	1964
Latest Appearance	1979
Form Type	Console with Monitor
Keyboard/Controls	In Console
Monitor	In Console
Processor	Remote
Storage	Remote



The commercialisation of the monitor in the mid 1960s meant computers could realistically have visual displays. Monitors in the operating consoles of larger computers gave vastly improved feedback. Instructions in written form rather than in punched tape may have made computers less esoteric, enhancing the feeling of mastery over the machine.

Specially-built consoles denoted expense and dedicated function, and connoted high technology and control. From power station control rooms, to space flight's mission control, and the bunkers of master criminals in James Bond films, consoles with monitors appeared as the epitome of the remote regulation of distant, large and complex processes.

Fig. 3 ICL 2900, 1974.

Form D

Miniaturisation removed the need for a full console, and by the late 1960s a monitor on top of a keyboard plinth formed a remote computer access terminal. These were still concerned with control: the 'Telefile 40/3' was "designed for ... inventory and production control reports, order processing, time-sharing, data collection and distribution". The same format of components continued until the late 1970s, but by 1977 became an intelligent terminal. The plinth contained its own memory, tape storage, and in some cases a printer.

Example	Sanders 720, 1968
Earliest Appearance	1968
Latest Appearance	1979
Form Type	Remote Desktop
Keyboard/Controls	In Processor
Monitor	Separate
Processor	In Keyboard/Remote
Storage	Remote/In Processor

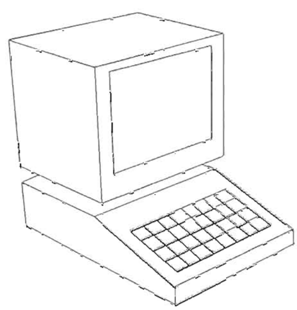
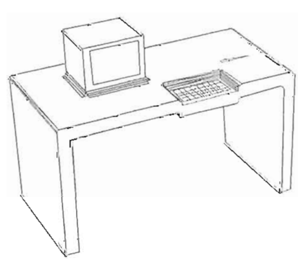


Fig. 4 Sanders 720 display system, 1968.

This form of the computer was also taken by one of the earliest home computers which found a place in business – the Apple II. This particular computer is seen as important by many historians due to the highly influential spreadsheet programme 'VisiCalc' which was instrumental in its move into the manager's office.[11] The partnership of VisiCalc and the Apple II was not only a "breakthrough as a financial tool but its users experienced for the first time the psychological freedom of having a machine of one's own, on one's desk".[12]

Form E

Example	NCR Criterion, 1976
Earliest Appearance	1969
Latest Appearance	1978
Form Type	Remote Console
Keyboard/Controls	In Desk
Monitor	In Desk
Processor	Remote
Storage	Remote/In Desk



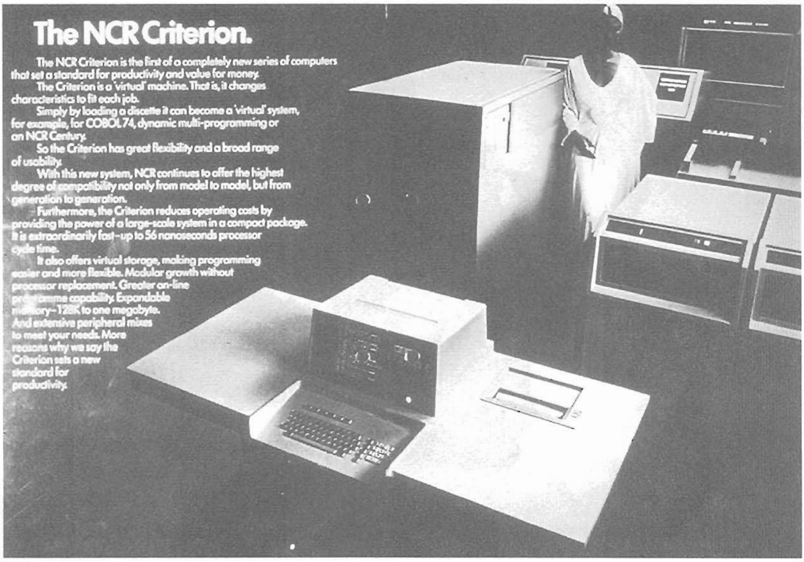


Fig. 5 NCR Criterion, 1976 (courtesy of NCR Ltd.).

The console, meanwhile, developed into a smaller, integrated desk. By 1969 these consisted of a monitor, keyboard and tape or 'discette' storage moulded into one piece of furniture. Combination into a single form seems to have given the computer interface a sense of expense and permanence compared to an arrangement of individual components. NCR's Criterion brochure (Fig. 5) stated that it can "change characteristics to fit each job", had "great flexibility" and "a degree of compatibility not only from model to model, but from generation to generation". This shows a lack of foresight of the speed with which computers would change, or else it is a statement of longevity hoping to counteract the design obsolescence seen by the manufacturer in its own product.

Form F

Around 1972 the monitor and plinth developed into a unit in which the keyboard appeared to visually 'dock' into the monitor. This two-part form was possibly inspired by 'space race' images of modules docking to rockets, although apart from the 'space age' styling of early examples (e.g. Fig. 6, Lear Siegler's 'ADM-2' – "the second generation of the American Dream Machine"!) there is no clear evidence for this.

Example	Lear Seigler ADM-2, 1975
Earliest Appearance	1972
Latest Appearance	1982
Form Type	Remote Desktop
Keyboard/Controls	Visually with Monitor
Monitor	Visually with Keyboard
Processor	Remote
Storage	Remote

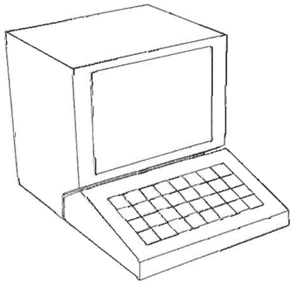


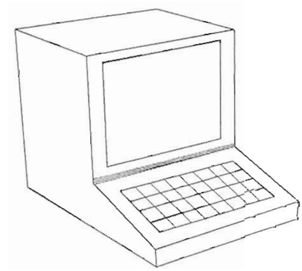
Fig. 6 Lear Siegler ADM-2, 1975.

These units were identified in their brochures as 'display stations', 'display consoles', 'data display terminals', 'data screens' or 'visual display systems'. By taking the role of the 'mother ship' into which the keyboard docked, the monitor gained higher status, displaying clearly the level of control held by its user.

Form G

Also around 1972 the monitor and keyboard appeared as a single unit. As a remote terminal, this form was the complete integration of

Example	ICL Key-Edit 1000, 1973
Earliest Appearance	1972
Latest Appearance	1980
Form Type	Remote Desktop
Keyboard/Controls	In Monitor
Monitor	In Keyboard
Processor	Remote
Storage	Remote



typewriter input and monitor display. The increased importance of the keyboard resulting from this amalgamation is reflected in the names given to many of the terminals: 'data system', 'Data Entry', 'Datapoint', 'Key Edit' and 'Key Entry System'. Here, the computer is clearly presented in its own literature as being for the production of work.

Between 1973 and 1977, the combined monitor and keyboard appeared in many brochures as little more than a futuristic typewriter. Consequently, the association with female operatives is once again evident. A 1977 'Keyboard Training' brochure from Kenrick and Jefferson showed rooms full of such computers and their operators, stating: "Consider the data preparation area of a computer project. This is almost certainly staffed by young, and frequently inexperienced girls". This is a reoccurring image – the female operator (there are no images of a number of men using office computers together), made insignificant by identical repetition – a mere cog in the machine, slavishly inputting data for analysis by the computer.

The computer as a method of control, however, was still in evidence at this time, and with the same combined form. The brochure for Racal's 'Redac Executive' stated the computer's functions as including forecasting of costs and sales, providing current financial status, true costs of overheads per department and evaluating cash flow to enable confident investment decisions: "Individual video display units are provided for the managing director, production director/manager, financial director/chief accountant, and marketing director/manager. These units are located in the individual's own office, and are always ready for immediate use".

It would appear that when combined as one unit, the keyboard element was associated with manual input and production, where the visual display of information remained associated with control.

Fig. 7 ICL Key-Edit 1000, 1973.

Form H

1974 saw an increase in the variety of computer forms available from 7 to 12 distinctly different types. The combined monitor and keyboard gained storage capability. Tape recorders were built into the top of the unit and later, diskette drives were placed next to the monitor

Example	ICL Datacapture, 1977
Earliest Appearance	1974
Latest Appearance	1977
Form Type	Remote Desktop
Keyboard/Controls	In Monitor
Monitor	In Keyboard
Processor	Remote
Storage	In Monitor

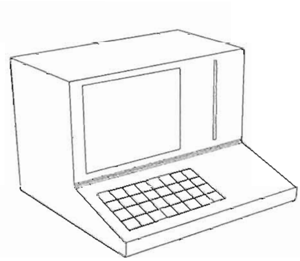
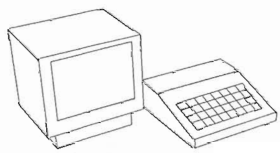


Fig. 8 ICL Datacapture, 1977.

screen. The addition of storage meant easier archival abilities, which may be why this form tends to be depicted as an efficient secretarial aid, rather than a managerial tool or a general workforce object.

Form I

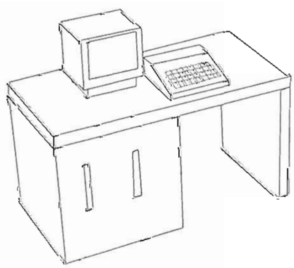
Example	Data General Eclipse, 1978
Earliest Appearance	1974
Latest Appearance	1986
Form Type	Remote Desktop
Keyboard/Controls	Separate
Monitor	Separate
Processor	Remote
Storage	Remote



The remote monitor and keyboard also appeared at this point to separate into two distinct components, bringing the ambiguity of the computer to light again. The 'Harris 1675' was described as a 'key entry station' and a 'data terminal'. The Data General's 'Eclipse S/130' literature presented a room filled with terminals for 'remote job entry'. Others were described as an 'information display system', a 'display station' or for 'processing information'. 'Informer' terminals were available in walnut finish for management "Data inquiry" and white plastic for workforce "Data entry". Generally, units seen in multiples tended to be aimed at use by a workforce, where single or isolated versions were aimed at management of one level or another.

Form J

Example	ICL DRS20, 1981
Earliest Appearance	1974
Latest Appearance	1983
Form Type	Self-Contained Desk
Keyboard/Controls	Separate
Monitor	Separate
Processor	In Desk/Remote
Storage	In Desk



The separate remote keyboard and monitor format also appeared on an office desk containing a storage device – originally magnetic tape reels, then cassettes and finally diskettes. The semiology of a functional desk closely associated this form with the production of work. One brochure stated "DataVet keystations are designed to reduce the keying workload and motivate the operators, the tangible

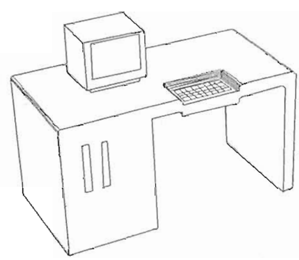
Fig. 9 ICL DRS20 system, 1981.

end product – a cassette – helps each operator to feel involved and of value".

Later versions of this form contained a mini-computer in the pedestal of the desk. These were sold on their smaller size being friendlier than a mainframe. The 'AddoSystem M10' brochure declared "Enter the Mini… Exit the Expert" and stated "Datasaab systems don't need the special air-conditioned environments that big brother demanded". ICL's 'DRS20' (Fig. 9) was part of its 'Distributed Resource Systems' – "a pioneer of networked computing… providing appropriate computing at every level of an organisation in a controlled way". While these systems provided computing throughout the workforce, the level of access was still decided elsewhere.

Form K

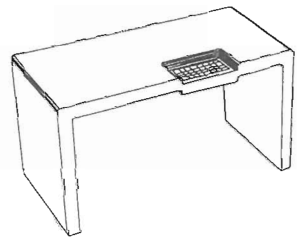
Example	IBM 6/440, 1977
Earliest Appearance	1974
Latest Appearance	1978
Form Type	Self-Contained Desk
Keyboard/Controls	In Desk
Monitor	Separate/In Desk
Processor	In Desk/Remote
Storage	In Desk



In an almost identical form, the keyboard was integrated into the surface of the desk itself. The ideology was of 'intelligent' or 'networked' terminals as a helpful resource. Nixdorf's 'Intelligent Data Entry and Terminal System 8820' targeted medium-sized companies: "As a company grows, so does its problem of collecting data and communicating it… every new person added to the staff makes an impact on the amount of information that must be recorded and communicated". The separation of the keyboard from the monitor and its integration into the desk maintained the importance of manual input – IBM's 'System/32' was described as "a compact operator-oriented unit with keyboard data entry, plus internal disk storage and processing capacity".

Form L

Example	Kienzle 2000, 1975
Earliest Appearance	1974
Latest Appearance	1977
Form Type	Remote Desk
Keyboard/Controls	In Desk
Monitor	n/a
Processor	Remote
Storage	Remote



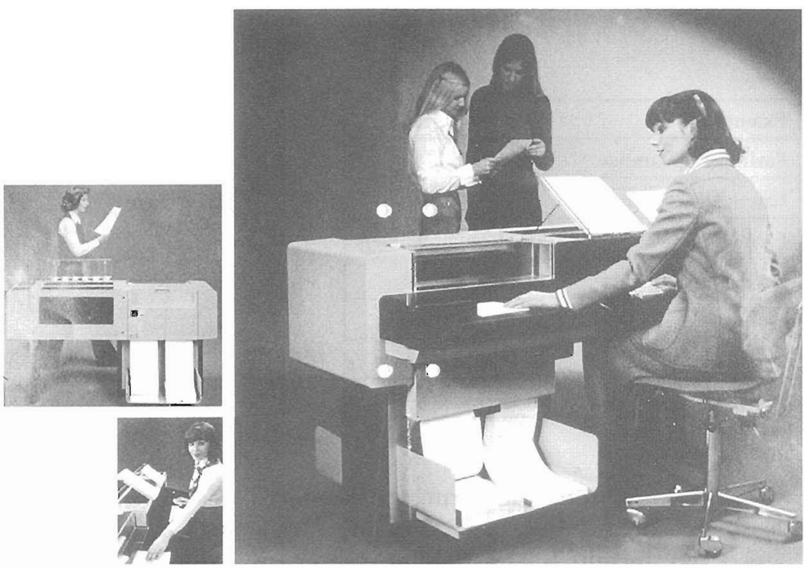
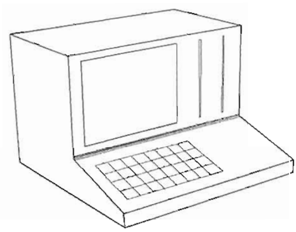


Fig. 10 Kienzle 2000 Invoicing/Accounting Computer, 1975.

A remote terminal forming a desk with a built-in keyboard also appeared in 1974 without a monitor. As might be expected with no instant visual feedback, the manual inputting of data was the raison d'être of these machines – the input of accounting data for later processing as in Kienzle's '2000 Invoicing/Accounting Computer' (Fig. 10) or NCR's 'Distributive Document Processing System'.

Form M

Example	IBM 5100 Portable, 1976
Earliest Appearance	1975
Latest Appearance	1981
Form Type	Self-Contained Desktop
Keyboard/Controls	In Monitor
Monitor	In Keyboard
Processor	In Monitor/Remote
Storage	In Monitor



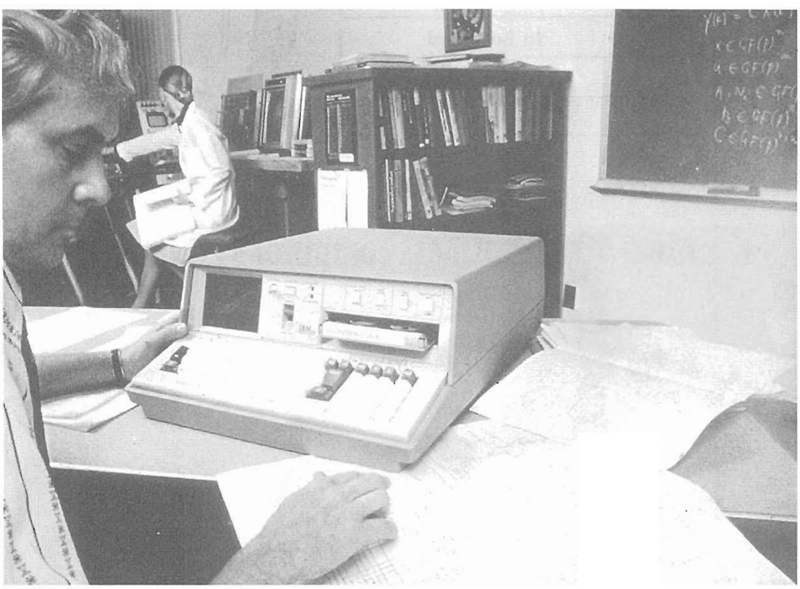
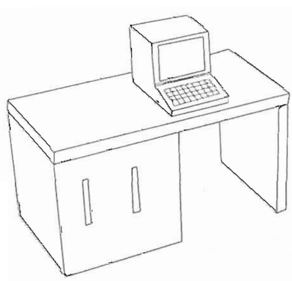


Fig. 11 IBM 5100 portable computer, 1976 (courtesy of IBM UK Ltd.).

Around 1975 a major change began to take place. The computer processor became small enough to fit inside a combined monitor/keyboard/storage unit. The high cost of computing power at this stage restricted its use to specialist applications in engineering or scientific research. IBM's 5100 portable computer heralded "portable power for specialists everywhere" (Fig. 11). Later, self-contained desktop computers appeared for management use, especially in accounts. Hewlett-Packard's 'Graphics Terminal' and IBM's 'Datamaster small business system' presented the ability to draw charts on screen as a major selling point.

Form N

Example	Mael 4000, 1977
Earliest Appearance	1976
Latest Appearance	1977
Form Type	Self-Contained Desk
Keyboard/Controls	In Monitor
Monitor	In Keyboard
Processor	In Desk/Remote
Storage	In Desk



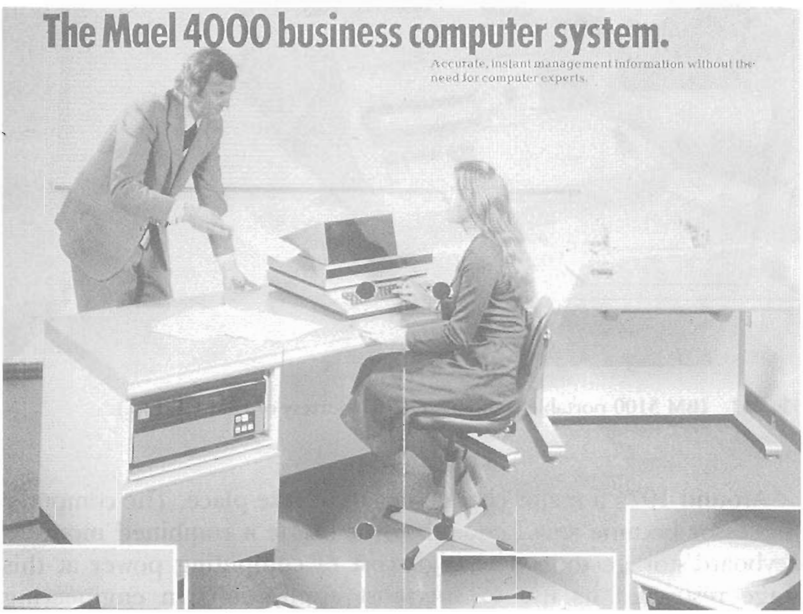
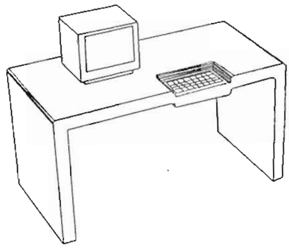


Fig. 12 Mael 4000 business computer system, 1977.

For general applications, the processor remained part of the desk, and the keyboard and monitor again fused into a single component. Labelled a 'data entry terminal' or 'video data terminal', these were aimed clearly at less experienced business users. General Automation Inc.'s 'DM130/2 Business System' "fulfills the information handling requirements of the small to medium sized business". Mael's '4000 Business Computer System' gave "accurate, instant management information without the need for computer experts" (Fig. 12).

Form O

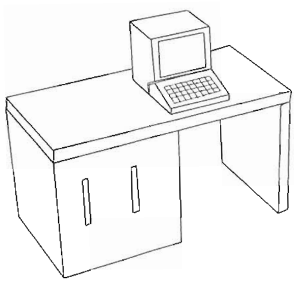
Example	Burroughs B3831, 1976
Earliest Appearance	1976
Latest Appearance	1976
Form Type	Remote Desk
Keyboard/Controls	In Desk
Monitor	Separate
Processor	Remote
Storage	Remote



Desks with keyboards moulded into the surface continued as remote terminals for mainframes, bearing separate monitors. Described as 'keyboard-display terminals' or a 'console display/keyboard', it was a short-lived, ambiguous form of computer, sold as suitable for "both business and engineering/scientific computations".

Form P

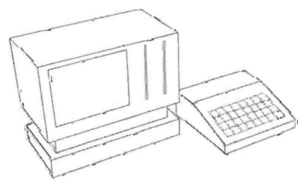
Example	Honeywell 6/36, 1977
Earliest Appearance	1977
Latest Appearance	1977
Form Type	Self-Contained Desk
Keyboard/Controls	Visually with Monitor
Monitor	Visually with Keyboard
Processor	In Desk/Remote
Storage	In Desk



One of the final forms of the computer as a self-contained desk saw the monitor and keyboard unit visually 'docking' together. These appear to have been presented as both a workforce tool of production and a management tool of control. The stand alone Hewlett-Packard 'HP1000' was capable of dedicated computation tasks, controlling automation, and data base management all "in an attractive deskcomputer work center". When networked and appearing in multiples, the form is presented by Honeywell as the latest in efficient production: "Level 6 Office Packaging incorporates attractive desk-styled cabinetry for optimum operator interface between documents, keyboard and CRT" – described as "work-enhancing physical characteristics".

Form Q

Example	ICL DRS20/20, 1982
Earliest Appearance	1982
Latest Appearance	1983
Form Type	Self-Contained Desktop
Keyboard/Controls	Separate
Monitor	Separate
Processor	Separate/Remote
Storage	In Monitor



The stand alone desktop computer also began to separate into individual components. The ICL 'DRS20 Model 20' placed monitor and disc drive into one unit on top of a cast plinth and used a separate keyboard (Fig. 13). This move from workstations and combined units to individual components was a matter of flexibility for the manufacturer rather than the user. The industrial designer responsible for this product, Richard Satherley, stated "The vision of the computer being a desk of course evaporated – manufacturers had to make the decision whether they were making desks and furniture, or supplying computers... no one wants to spend all their money putting them into big boxes that are purpose designed".[13]

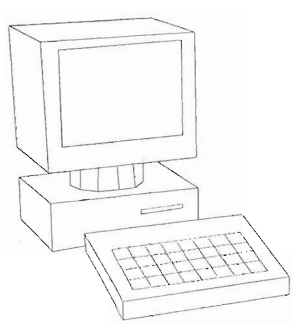
Design magazine discussed the status of these computers: "There was a clear mandate to establish the 2200 as an executive model. Nexos appreciated that word processors should not be considered as simply up-market electronic typewriters, but as the first step, from the customer's point of view, towards an integrated office

Fig. 13 ICL DRS20 Model 20 desktop computer, 1982.

system .... So, Satherley was instructed, make the product distinctive in its own right, and attractive to the executive as well as to the executive secretary".[14] Satherley denied that this distinction between the end users had affected his design for this computer. Although the manufacturer targeted the executive closely, his view was "Executives don't use them".[15] The intentions of marketing departments and the aspirations of designers do not always go hand in hand.

Form R

Example	ICL PC Model 30, 1982
Earliest Appearance	1982
Latest Appearance	1987
Form Type	Self-Contained Desktop
Keyboard/Controls	Separate
Monitor	Separate
Processor	Separate
Storage	In Processor



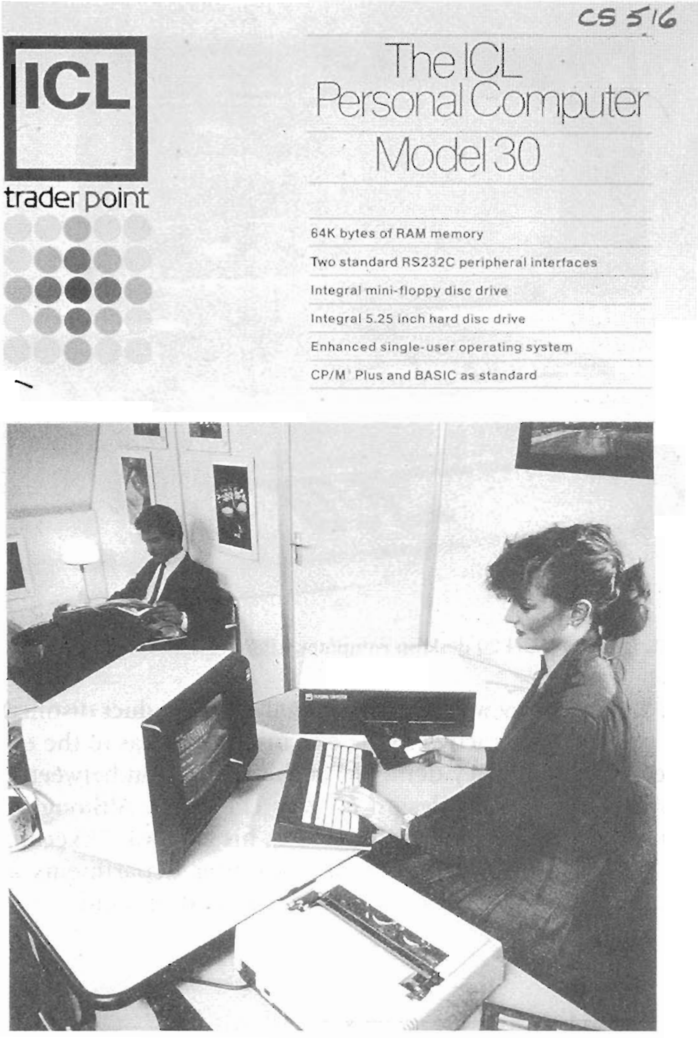
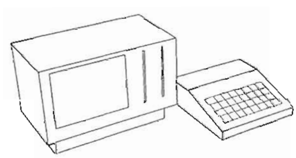


Fig. 14 ICL Personal Computer Model 30, 1982.

The computer became a desktop processing unit with built in disc drive, separate monitor and separate keyboard from late 1981, when it first became commonly known as a 'personal computer'. Initially, images showed these computers being used by individual (female) secretaries for the fast-growing application of word processing (as in ICL's 'DRS 8801 Wordskil'), and even IBM's 'System/36' terminals of the same format were described as 'team computers' as they could link into a larger network. It is not until the late 1980s that the 'personal computer' is portrayed on a desk belonging to a (male) manager.

Form S

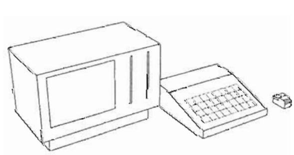
Example	Philips 3003, 1983
Earliest Appearance	1983
Latest Appearance	1984
Form Type	Self-Contained Desktop
Keyboard/Controls	Separate
Monitor	In Processor
Processor	In Monitor
Storage	In Processor



The concept of the computer remaining in a single horizontal desktop unit with only a separate keyboard appeared in 1983 with Philips' '3003 Electronic Word Processor' and Tandy's 'Model 4P'. The Philips computer was a close contender for the 1983 design award in *ID Magazine*, where placing the components in one shell was seen as "rational design",[16] but the placing of the unit on a stalk was seen as aesthetically unsound.

Form T

Example	Apple Lisa, 1983
Earliest Appearance	1983
Latest Appearance	1984
Form Type	Self-Contained Desktop
Keyboard/Controls	Separate & Mouse
Monitor	In Processor
Processor	In Monitor
Storage	In Processor

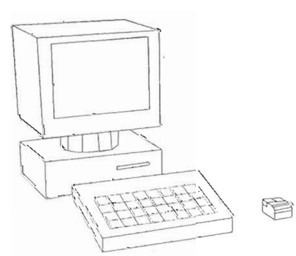


The same horizontal form, with the highly significant addition of the mouse, appeared with 1983s 'Apple Lisa'. As a method of interaction with the revolutionary Graphical User Interface (GUI) developed by Xerox, the mouse changed the way in which people related to the computer completely. The mouse and the GUI moved *all* the attention the computer received to the screen. This particular model was unsuccessful due to its high price and low performance. Its 1984 replacement – the 'Apple Macintosh' – turned the combined monitor, processor and drive vertically, reducing the desk space required and producing one of the most famous individual computers ever created.

If anything, the 'Apple Macintosh' was (and remains) an idiosyncratic vision of the computer. Small, friendly and loved by its owners (one developed such an attachment to his Mac "that he almost wanted to caress, hug and sleep with it"[17]) its greatest drawback was its lack of flexibility. The uniting of monitor, processor and disc drive removed the possibility of easy expansion, tying permanently the ever increasing power and shrinking cost of the processor to the comparatively static technology and high cost of the monitor.

Form U

Example	Torch XXX
Earliest Appearance	1985
Latest Appearance	Current
Form Type	Self-Contained Desktop
Keyboard/Controls	Separate & Mouse
Monitor	Separate
Processor	Separate
Storage	In Processor



The vision of the computer as separate processor, monitor and keyboard remained the most versatile. This, with the addition of the mouse, became the accepted form from 1985 as company after company produced IBM clones. This to date marks the end point of the development of the office computer. Since this form's appearance thirteen years ago, there has been no change in the basic

Fig. 15 Torch XXX, 1985.

arrangement of parts, and an astonishing lack of stylistic development. It is no wonder that journalists make such statements as "Look around your workplace and you barely notice them. So ubiquitous are the white boxes that process data on our PCs that we rarely question how else they might look."[18] This is truly the face of the 'Universal Desktop Office Computer'.

ANALYSIS

It is clear that the uses and perceptions of the office computer have been as varied as the different forms the machine itself has taken: a

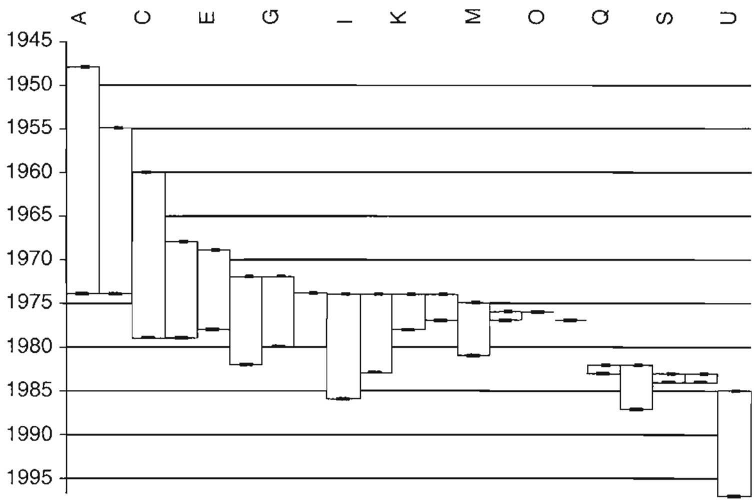


Fig. 16 Duration of different forms of computers.

new and frightening creation, a familiar piece of office equipment, an object for repetitive work, a marker of status. By placing the various forms presented above and the duration of their existence into a column chart a picture of the development of the form of the computer emerges (Fig. 16). Starting in the late 1940s as a single concept – a central console within a room of identical cabinets – a number of different forms gradually appear. This continues until 1976 and 1977 when a peak of thirteen different forms are in existence. This variety becomes eroded as various forms of computer disappear, eventually leaving only the 'Universal Desktop Office Computer'.

The number of different forms in existence at one time is seen in Figure 17. The 'variety of form' line shows the speed at which this divergence and convergence of form occurred. It took the office computer over twenty years to diversify into thirteen different forms, yet only ten more before the final form appears. Figure 17 relates this variety to other factors. A number of analysts have presented charts of quantitative data on relevant aspects of technical and economic computer history.[19] By combining data from a selection of these charts it has been possible to obtain a portrayal of the cost of computing power and total sales of computers.[20] The cost of computing power is shown in Millions of Dollars/Millions of

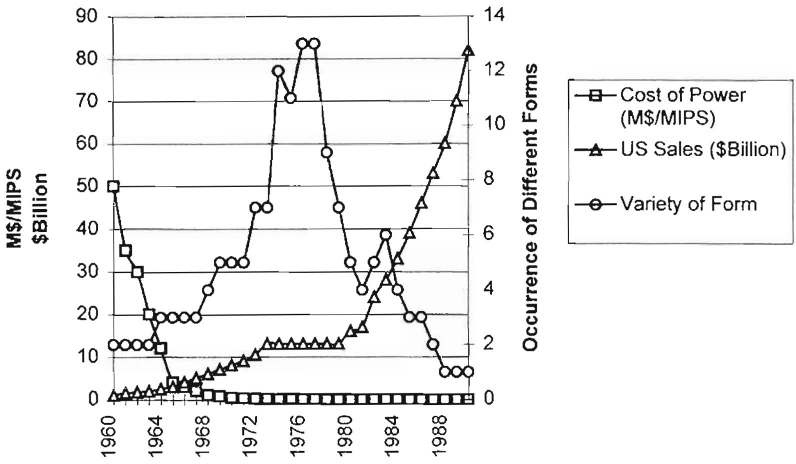


Fig. 17 Sales/Cost of Power/Variety.

Instructions Per Second. The value of sales appears on the same axis measured in Billions of Dollars.

This chart may represent a 'natural' phenomenon in the product life cycle of technological products. To the left, the cost of technology is high and the amount of sales low, as a small number of companies satisfy an emerging market. To the right, the cost of the technology is negligible and the amount of sales high as the computer becomes a commodity item. Both of these are arguably circumstances where aesthetic design is given low priority. The central part of the chart depicts a situation where the cost of technology is relatively low and sales are increasing. A large number of competitors developing a growing market for new products is a situation likely to produce a wide variety of forms.

CONCLUSIONS

It is impossible to deny that technological developments were to some extent responsible for the growing diversity of form in the late 1960s and early 1970s. Radical changes in casing materials occurred as computers moved from being built to order to being mass produced. As a significant investment, the computer was originally sold as being flexible, adaptable, and upgradeable for future needs. This was reflected in its design as an impressive, dominating presence, and its construction in quality materials. Changes in the cost of producing electronic components, and vast increases in computing power have also been associated with changes in computer usage as it moved from the role of a calculator to information processor. The high price of early circuitry negated the cost spent on its inclusion in a piece of office furniture. Through this design approach the computer attained an air of permanence and value at odds with its likely obsolescence.

In part, a greater variety of form resulted from the introduction of overt styling and design to deliberately encourage replacing rather than upgrading computers. Capitalism relies on the constant consumption of new products, and historically this has been enhanced by aesthetic developments in which the desire for the new is fuelled by advertising and brochures of the kind analysed in this paper. However, this occurred before the rate of technological change was fully realised. Manufacturers as well as purchasers now realise office computers are outdated some time before the end of their productive life. The inherent technical redundancy of the computer may have removed the perceived requirement for a visual, stylistic obsolescence.

The role of the office computer clearly affected its design. While it is true that the design of the computer as a typewriter or an office desk framed it as a tool of production, and that images of computers on executive desks framed them as bestowing authority, there was no linear development from one to the other. Computers have always been used for both repetitive work and managerial control. The change in design approach occurred between 1975 and 1985. The forms of computers used for distinct functions were often very different, and reflected the status of the user. Today, exactly the same form is used throughout the corporate hierarchy. The 'Universal Desktop Office Computer' has no obvious semantic it can claim as its own. Status is no longer defined by the form of the computer itself, only by the way in which the technology is employed.

The successful introduction of the IBM 'Personal Computer' in 1981 set a technical and semiotic precedent difficult for rival companies to overcome. Although there is no reason why technical compatibility should be carried over into stylistic similarity, it is understandable. Just as the introduction of a new format of software would threaten to isolate its users from the overwhelming majority of PC compatible equipment already available, a radically different form of computer would run the risk of being perceived as incompatible even if it were not. The similarity of form of today's office computers to many represents a stability they are not willing to upset – pointing to the concept of 'rhetorical closure':

> Closure in technology involves the stabilization of an artifact and the 'disappearance' of problems. To close a technological 'controversy', one need not *solve* the problems in the common sense of that word. The key point is whether the relevant social groups *see* the problem as being solved.[21]

In the case of the office computer, the fear of constant change has been removed by stabilising its design into the position of a 'given'. Appearing as unchanging and predictable, beneath the surface progress continues. New technology is no longer accompanied by new forms. Instead, development is focused on processing speed. More powerful software appears constantly, making the previous version and to an extent the hardware which ran it obsolete. The new, necessarily improved machine provides a continuity in that paradoxically, it is identical to its predecessor. The sense of closure created by this stability locates the office computer, fixing a transient object into one on which meaning can be conferred.

Notes

1. W. Aspray, "The History of Computing within the History of Information Technology" *History and Technology* (1994), 11: 7–19 on p. 10.
2. C. Dilnot, "The State of Design History. Part II: Problems and Possibilities" *Design Issues* (1984), 1, No. 2: 3–20 on p. 10.
3. 'Towards an anthropology of consumption' is the subtitle of M. Douglas and B. Isherwood, *The World of Goods* (Harmonsworth: Penguin, 1980).
4. F. Saussure, *Course in General Linguistics* (London: Collins, 1974), explains that "a linguistic sign unites, not a thing and a name, but a concept and a sound-image" – that is the sign 'computer' is a whole, consisting of the acoustic word 'computer' (the signifier) which when spoken invokes a mental perception of a computer (the signified).
5. R. Barthes, *Mythologies* (London: Paladin, 1973), pp. 95–97, reveals clearly in his analysis of the Citroën DS that the representation of an object even when shown as if in a real situation, is in fact presenting it as something precious, isolated from its natural environment.
6. L. Haddon, "The Home Computer: the making of a consumer electronic" *Science as Culture* (1988), 2: 7–51 on p. 7.
7. M. Csikszentmihalyi and E. Rochberg-Halton, *The Meaning of Things* (Cambridge: Cambridge University Press, 1981), p. 92.
8. V. Guiliano, "The Mechanization of Office Work" in T. Forester (Ed.), *The Information Technology Revolution* (Oxford: Basil Blackwell, 1985), p. 299.

9. G. Kirkup, "The Social Construction of Computers: Hammers or Harpsichords?" in G. Kirkup and L. Keller (Ed.), *Inventing Women: Science, Technology and Gender* (Open University Polity Press, 1992), p. 269.
10. J. Webster, "From the Word Processor to the Micro: Gender Issues in the Development of Information Technology in the Office" in E. Green, J. Owen and D. Pain (Ed.), *Gendered by Design?* (Taylor & Francis Ltd., 1993), p. 118.
11. See for example, M. Campbell-Kelly and W. Aspray, *Computer: a History of the Information Machine* (New York: Basic Books, 1996); S. Levy, Insanely Great (London: Penguin, 1994) and R. Cringely, *Accidental Empires* (London: Viking Books, 1992).
12. Campbell-Kelly and Aspray, *op. cit.*, p. 251.
13. Richard Satherley, interviewed at his London office, July 1st 1997.
14. J. Lott and M. Blakstad, "The Rock-and-Roll Word Processor" *Design* (1981), January: 36–39 on p. 36.
15. R. Satherley, as above.
16. R. Gersin, "Equipment & Instrumentation" *ID Magazine* (1983) Sept/Oct: 26–40 on p. 27.
17. Takashi Ashitomi "Macintosh 128K" *Axis* (1997) July: 122–123 on p. 123.
18. Not Credited, "Reinventing the box" *Blueprint* (1997) July/August, p. 20.
19. See M. Phister Jr., *Data processing technology and economics* (Digital Press, 1979); T. Forester, *The Microelectronics Revolution* (Oxford: Basil Blackwell, 1980) and *The Information Technology Revolution* (Oxford: Basil Blackwell, 1985).
20. It should be noted that both sets of data contain their own problems in terms of ratifying the changing value of money over time and the changing definition of the word computer, as described by the various authors of the data themselves.
21. T. Pinch and W. Bijker, "The Social Construction of Technology" in W. Bijker, T. Pinch and T. Hughes (Ed.), *The Social Structure of Technological Systems* (Cambridge, MA: MIT Press, 1985), p. 44.

The (In)Difference Engine: Explaining the Disappearance of Diversity in the Design of the Personal Computer

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The (In)Difference Engine

Explaining the Disappearance of Diversity in the Design of the Personal Computer

Paul Atkinson

At the time of writing there is a clear perception of all office computers as being more or less identical. Discussion with users entails repetitive rhetoric as they describe a landscape of boring beige boxes. The office PC is indeed a 'clone'—an identical, characterless copy of a bland original.

Through the exploration of an archive of computer manufacturers' catalogues, this article shows how previous innovative forms of the computer, informed by cultural references as diverse as science fiction, accepted gender roles and the discourse of status as displayed through objects, have been systematically replaced by the adoption of a 'universal' design conveyed only by the nondescript, self-referential world of office equipment.

The acceptance of this lack of innovation in the design of such a truly global, mass-produced, multi-purpose technological artefact has had an enormous effect on the conception, perception and consumption of the computer, and possibly of information technology itself. The very anonymity of the PC has created an attitude of indifference at odds with its potential.

Keywords: computers, consumption, gender politics, product design, science fiction, social construction of technology

In 1833, Charles Babbage displayed his calculating machine, the Difference Engine, to an amazed public. One witness wrote: 'visitors gazed at the working of the beautiful instrument with a sort of expression, and dare I say the same sort of feeling, that some savages are said to have shown on first seeing a looking glass or hearing a gun.'[1] That the same sense of wonder and awe no longer accompanies the computer is understandable, but that it should routinely be regarded as uninspiring requires further explanation.

Taking the signified of the signifier 'computer' to be the personal computer as it presently appears in the office and home—a beige rectangular box containing a processing unit, a beige box form monitor, a separate beige keyboard and beige mouse—one encounters a rhetoric of repetition and ennui. Users are heard over and again to state: 'They all look the same', 'They're so boring to look at', 'They're just grey boxes.'[2] In *The Aesthetics of Computing*, David Gelernter refers to computers as 'graceless, lumpy objects . . . an electronic Model T, an awkward shape that is cheap to build and enshrines permanently the first thing that came to mind. And they all look the same, their sheer sameness ought to make us suspicious.'[3] Despite being the subject of strong corporate competition, marketing drives and advertising campaigns, the computer remains an anonymous form, identified only with itself, not its producer. The computer industry confirms its own sterility by adopting the term 'clone' to describe multitudinous, identical, characterless copies of a bland original.[4]

Why is such anonymity acceptable? One argument, put forward by the computer historian Robert Cringely, is that 'The operating system is the identity of the computer, the personality of the computer. Because we use the operating system . . . the underlying computer becomes less important. What's the name on it? IBM, Compaq, Dell, Gateway, Acorn—who cares?'[5] I believe this to be over-simplistic. The sterility of design in such a large area of production has far more complex origins.

This article is concerned with the design development of the office computer and not the home computer. This is an important distinction, as the two have distinctly different histories. The office computer, having roots in the military and large international corporations, has been subject to a series of defining precedents and the continuity of pre-existing work practices that affected its design and acceptance.[6] The home computer, resulting as it did from the activities of individual hobbyists and small garage-based companies, was by way of contrast a completely new, self-referential technological product[7]. It was not until the appearance of the spreadsheet application VisiCalc in 1979, written for the Apple II computer, that these two strands of history really began to interact, and the office and home computer became to all intents and purposes the same object. Because of this distinction between the two, peripheral objects such as the joysticks associated with extending the standardized computer for use as a games machine in the home are excluded from this discussion. Also excluded is the laptop computer and later developments such as personal digital assistants (PDAs). These, due to their portable nature, cannot be described purely in terms of being an office computer, and in any case are objects that carry a host of unique hierarchical, status and role-setting meanings.

The pictorial and textual evidence used in this paper has been gathered from the National Archive for the History of Computing at the University of Manchester,[8] in particular, their Trade Catalogue and Machine Literature Collection, which consists of an extensive range of manufacturers brochures targeted at business users, from the late 1940s to the early 1980s. Taking a sample of over 250 brochures selected for depicting the widest possible variety of computers, the images therein were sorted into groups of computers sharing similar arrangements of component parts, disregarding the date of the computer's design. This provided a framework of twenty-one distinct forms of the office computer that had appeared on a number of occasions (one-off or unique designs were not included in this count). This gathering of heterogeneous examples revealed the sheer diversity of computer designs over the last fifty years. It is a history of variety that seems to have been largely forgotten.

By organizing the constituent computers within each of these groups into a chronological order, a tentative measure of the earliest and latest appearance of each of these forms could be made. (Tentative in so far as no random sample, no matter how large, from an archive —which in itself does not claim to be comprehensive—can positively identify the exact earliest or latest appearance of any particular form of computer. The scope of this subject area—the sheer volume of manufacturers and products produced—means that any findings from this type of archival research have to remain indicative rather than conclusive.) The diachronic analysis of this material exposed the rapid diversification of the office computer or computer interface from a single initial form as a console controlling a remote mainframe [1], into an object which could appear in forms as diverse as office desks, integrated workstations, advanced typewriters, and even extended telephones, before more rapidly converging into a single, accepted shape as a series of beige boxes—referred to in this paper as the 'Universal Desktop Office Computer'. This, to date, would seem to mark an endpoint of the development of the office computer, as for the last fourteen years there has been little or no discernible change in its basic design [2–3].[9]

The detailed exploration of this development as a complex, interwoven story determined by a multiplicity of factors is the subject of a previous article.[10] Here, I wish to explore the bearing of styling influences and cultural references on the design of the computer, arguing that it is these changing influences and references that have contributed to the level of innovation in previous designs, and to the indifference with which we treat the computer today.

Cultural references and office equipment design

Firstly, I wish to explore the role of stylistic influences on the design of the computer in the workplace. While the brochures under consideration show staged office sets, their use in analysing the form of

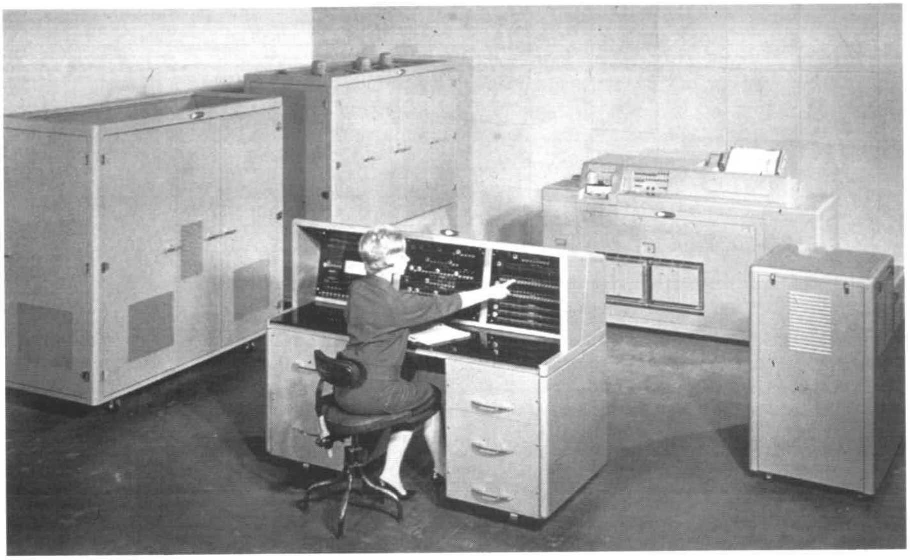

Fig 1. The ICT Type 1202 Electronic Computer, 1960, presented the computer interface as a remote desk-based console—the initial form associated with computers from the late 1940s which continued into the 1970s

the computers remains valid as those forms are accurately displayed (even taking into account that any image of an object can be said to elevate the form over the function).

Clearly, some computer terminals reflected aspects of the 1970s space-race in their appearance and usage at a time when the computer room connoted 'mission control', and parts of terminals 'docked' together like rockets into space stations. The events of July 1969, when the world's attention focused on the first moon walks, meant that the conquering of space became a fundamental part of the *zeitgeist*—yet it was not only the reality of space-age technology that was reflected in the design of the computer, but the

Fig 2. The Torch XXX, 1985, was an early version of the 'Universal Desktop Office Computer', copying the format of the products of larger corporations, a single casing containing a processor with a separate monitor, keyboard and mouse

Fig 3. The latest Compaq Deskpro has exactly the same arrangement of component parts as the Torch XXX, showing how little the basic design of the office computer has changed over the last 14 years

fabricated world of science fiction. The designer George Sowden wrote: 'The first generation of computers wasn't really designed at all . . . [T]hey had no particular identity of their own, partly because the jobs they were supposed to be doing still had to be invented.'[11]

Designers had no historical semiotic reference with which to associate electronic computing, and the imagery of exciting, futuristic technology found in science fiction must have seemed an obvious parallel to the fledgeling machinery [4]. The consoles appearing with the first computers, with angled surfaces, straight edges and vertical backboards covered in control switches and indicator lights, bear more than a passing resemblance to those envisioned by science-fiction artists. In *Design* magazine, James Woudhuysen wrote:

> There was a time when console units were only a science-fiction illustrator's standby. If a spaceship interior in *Amazing Stories* or a Dan Dare strip in *Eagle* looked too bleak, an experienced illustrator would deck it out with vast arrays of glowing lights and dials and seat an intent-looking operator by them. Futurists tended to see Earth-bound business being conducted from winking, omnipotent consoles too. The console became a cipher for the technological prowess of the corporation to come.[12]

It would appear that there was some truth in the saying apparently used by NASA managers in their bids for project funding when they proclaimed: 'There's no bucks without Buck Rogers.'

The console is presented in many other places as the epitome of futuristic technology. As an example, an article in the August 1978 issue of *Wireless World* presented 'the "consumerole", an information console that could be in use in the home or at work by the end of the century' and made a credible attempt at the 'windows'-type display common today. The consoles predicted by science-fiction illustrators and futurologists were imagined as the integration of discrete components into one high-tech object, a design solution that appeared in many consoles, workstations and terminals actually produced by manufacturers. Mario Bellini's 1966 TCV 250 for Olivetti [5] was described in an exhibition catalogue as 'a floating landscape', using a continuous surface to unify separate components. According to the author, 'The terminal also has a science fiction aspect and conveys much of the experimental mood of the 1960s.'[13]

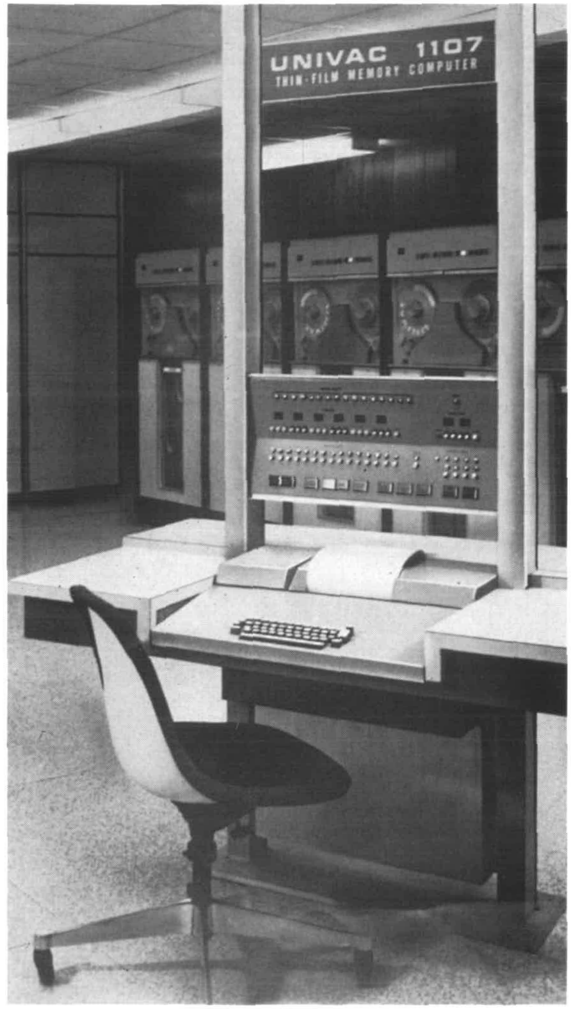

Fig 4. Sperry-Rand Univac 1107, 1961. The science-fiction aspect of early computers was reflected in futuristic looking consoles with panels of control switches and indicator lights on a vertical backboard

This trend towards integration of components seen in computer consoles has to be seen in context as part of a general design trend. Bernard Busch, discussing the design of the 1970s cited enormous changes in technology as an underlying influence: 'One response to these changes was the increasing number of technological design utopias dreamed up in the seventies, drafts for a world in which what had once been science fiction would become reality.'[14] The accompanying images show integrated workplaces—typewriters, phones and intercoms moulded into one desk—suggesting that integration would be

Fig 5. The 'floating landscape' of Mario Bellini's 1966 TCV 250 Terminal for Olivetti explored the integration of components as a metaphor for advanced technology

seen across all office furniture, not only computers. In fact, the integration of various technologies into unified forms was predicted for the home as well as the office. Examples such as Joe Columbo's integrated living spaces may have arisen in part from the freedom designers explored in the plastic possibilities of new materials, or the desire for portraying hygiene by removing sharp lines in expansive, white surfaces. Whatever the reasons, architecture and interior design, furniture and product design all probed the integration of components as a metaphor for advanced technology.

By the end of the 1970s, it appears that the limitations and inflexibility of integration had been realized, and an alternative approach of modularization became prevalent. Domestic consumer products such as lounge furniture, storage units and hi-fi systems allowed the arrangement of the component parts of living space and technology to be built to order. This sort of 'plug and use' approach to technology, explored at least a decade earlier by the architectural group Archigram in their designs for a 'plug-in city', saw the integrated console replaced by a more flexible alternative—the 'multifunction work-station'. An example of this design solution appeared in *Design* in January 1980 [6].[15]

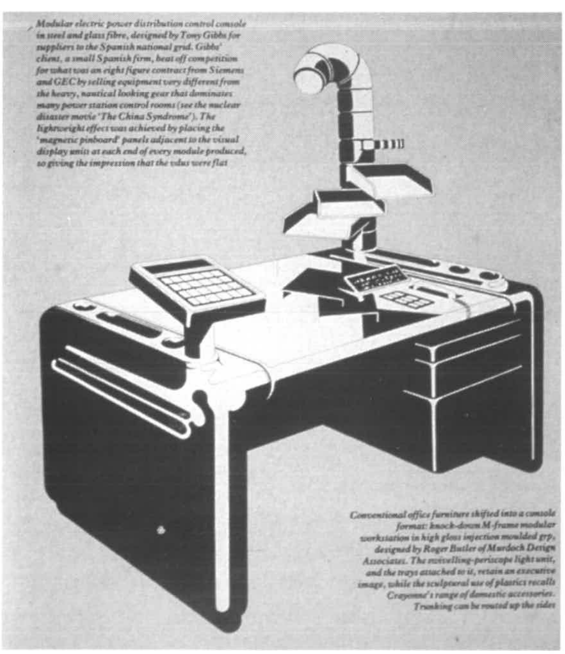

Fig 6. A multi-function modular workstation appearing in *Design* magazine in January 1980, an example of quickly dated technology-based office furniture

A telephone, display screen and computer keyboard are fitted into the desk surface heralding the electronic working practices to come, yet the paper trays and pencil tidy show the designer's acknowledgement that a paperless office for the executive was not just around the corner. Although designs such as this may have been informed by the realization that what was then called 'teleputing'—the convergence of information and computing technologies—would need to occur to meet future business needs, the speed with which such pieces of furniture would date and become technologically obsolete was recognized fairly quickly after. Two years later, Roger Green disparagingly wrote: 'Such devices appear, from time to time, at computer exhibitions, looking as likely candidates for office use as a cinema organ.'[16]

It is not only the physical design of computers that bore the influence of science fiction—the names and model numbers also reflect futuristic pretensions. Companies such as Nexos, Xenotron, Raytheon, Tektronix, Nixdorf and Xerox are names that recall planets from far-flung galaxies, exotically dangerous isotopes, or incomprehensible alien technologies. (For some reason, there is a long-standing tradition of advanced futuristic technology being associated with words having, or suggesting ancient Greek roots—Stanley Kubrick's *2001* was, after all, '*A*

Space Odyssey'). Control Data's 1974 Cyberdata series invoked the far future in the same way that series numbers from various manufacturers—HP 3000, Mael 4000, BTI 5000, and Kienzle 6000—suggested millennial dates in a future history beyond human comprehension. The product which some see as the first ever personal computer, the Altair, was named after the planetary star system visited in the 1956 science-fiction film *Forbidden Planet*. In discussing the shape of early personal computers Phil Palton wrote:

> Designers approached the first personal computers with the science fiction models of Buck Rogers and 2001 fixed firmly in their minds. Those images—visions of what a computer would look like if it existed—inspired the shape the machine took when it finally became a reality.[17]

In fact, certain designers of computer consoles had closer links with science fiction than might be imagined. Phil Palton cited Rob Gemmel (one of the organizers of Apple's 'Snow White' design policy) as having worked beforehand for Lucasfilms, the creator of *Star Wars*, and mentioned one computer hacker referring to a particular computer as 'Darth Vader's lunchbox'.[18] Along similar lines, Roger Wilkes, the designer of custom consoles for the banking industry in the city of London, had previously been involved in the design of control consoles for the TV series *Dr Who* and *Blake's Seven*. An article about his work stated: 'Few people will believe that the props in a children's science fiction programme had a fundamental influence on the working environment of banking in the 1980s.'[19]

All of this is not to try and suggest that science fiction was the only source of styling influence employed by designers of early computers, only that it was a significant factor in the design of *some* of the computers. The concept of the computer as office furniture had been present all along to some extent, particularly in products from larger companies already associated with 'serious' business machinery. An Olivetti prototype of 1964 by Sottsass, and the IBM System/32 of 1975 [7], for example, appear as pieces of hybrid technology, computers looking indistinguishable from large office photocopiers. The exploitation of science fiction in trying to give a physical manifestation to the excitement to be found in the new technology of early office computers may have actually alienated certain people as little in the way of familiarity with previous office equipment could be seen—a barrier perhaps to their acceptance. In these terms the styling of the 'Universal Desktop Office Computer' as an extension of familiar office technology would seem to make sense. In fact, the dominance today of this approach to computer design is more than likely due to the most influential of all office computers in terms of its styling as an advanced

Fig 7. IBM's 1975 System/32 took the aesthetic of the office photocopier, reinforcing the imagery of serious business machinery

typewriter—the IBM PC [8]. Launched late in 1981, its design is nothing if not 'safe'. Phil Palton, in *Connoisseur* wrote:

It is in the tradition of Eliot Noyes-designed typewriters or the mainstream modern architecture of I. M. Pei or Edward Larabee Barnes. The noncommittal 'cream and pebble gray of the IBM PC line is reassuring and adaptable and matches other IBM products . . . there are no tricks or gimmicks in the design.[20]

The IBM PC presented personal computing as little more than an electronic filing cabinet, and it was just about as exciting in its styling. Rather than suggesting a new, stimulating concept of work altogether, it recalled the staid and dusty world of ledgers and manila envelopes. In doing so it found a receptive audience. Rather than connoting radical change, it offered an improved method of carrying on familiar work practices.[21] The IBM PC was even less radical than their own previous computers. Its 'non-committal' colour scheme went against 1970s designs when the company known as 'The Big Blue' used the colours of its corporate identity for its computers—a colour used by other companies including Harris, Case, CMC and Livingston. Others of the period were bright red, including IBM's 'System/3' and NCR's Document Processors. ICL's computers throughout the 1970s and early 1980s appeared in bright orange. Others in yellow, green and brown show the diversity of colour associated with computers at a time when they were of special significance within the workplace, an unusual object meant to stand out from its surroundings. Colour preferences, though,

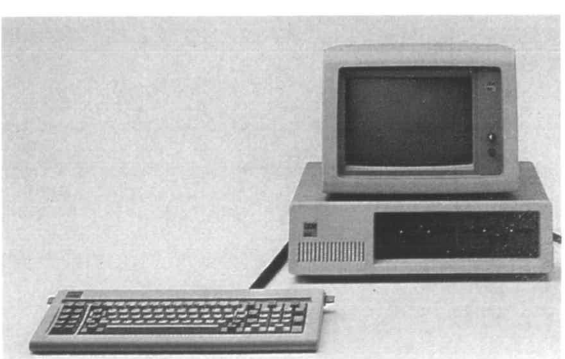

Fig 8. IBM PC, 1981, a formative product in the visual identity of the personal computer

like styling influences, are subject to fashion. In *Design* magazine in 1979, James Woudhuysen reported on Hanover's Technology Fair and commented:

The colour schemes are that all-too-familiar 'seventies ice-lolly orange and freezing light blue. The exceptions are the East Europeans, who go for a garish yellow, and those more progressive Western companies who have followed ITT's lead and opted for an off-white and milk chocolate brown combination—quiet, unpretentious, and successful whatever the size of the gadget.[22]

However, he raised the dangers for design from the over-use of the 'office equipment' approach when he observed that as the major investment in the 1980s was likely to be information products, the design of all other products would be influenced by them, whether or not they contained microchips. There is an interesting distinction that has arisen here in the colours of technologically similar artefacts targeted for use in the home as opposed to an office environment. Throughout the 1970s, for example, almost all hi-fi equipment was finished in a silver colour before converting in the 1980s to a black finish which has become synonymous with the television, video recorder and other domestic entertainment and communication products today. In the office, however, the serious greys and beiges that had always been present to some extent slowly became dominant. As early as 1985, statements were being made about the prevalence of the bland colour scheme as designers tried and failed to change the status quo of computer colour:

The team liked the 'Star Wars' look and felt the white colour could not be bettered. 'Everyone else does grey and beige; nobody wanted an also ran.'[23]

The OPD is finished in ICL's traditional two-tone coffee and cream livery—a significant departure from the single-colour designs proposed by Moggridge.[24]

The colour is not black nor dark grey (which Conran wanted with pale green hinge details) but khaki and beige.[25]

The colour scheme adopted by the IBM PC had a massive influence on later personal computers, just as IBM's 'safe' design approach directed the styling of the whole computer market. It is here that the source of the 'clone' computer can be found. In order to reduce development times and costs the architecture, hardware design and operating system of the IBM PC were left open to use off-the-shelf, non-IBM components.

This lack of design control meant that competitors could easily produce compatible machines with a fraction of IBM's overheads. First-time buyers felt safe buying from a company that was not likely to go out of business, and their rapid sales lead meant that 'it became necessary for IBM's competitors, save Apple, to market PC-compatible machines'.[26] It has also been observed that, as a general rule, the dominance of a small number of large companies in any given industry leads to more stability, but less innovation.

Apple, as evidenced by the futuristic wedge shape of the Apple II, originally embraced the science-fiction mentality wholeheartedly. Like many other small companies, Apple was bred out of the San Francisco school of anarchic young computer hackers. Their most famous moment, though, marks the point of change. The 1984 Apple Macintosh was heralded by an advert directed by *Bladerunner's* Ridley Scott, portraying IBM as 'Big Brother' being smashed by the alternative freedom offered by owning an Apple computer. Industry, however, was not impressed.[27] The Macintosh ethos was 'one person, one computer', and the literature targeted families and people working from home showing a friendly computer 'with the quiet look of a kitchen appliance'.[28] Although Apple were quick to realize its failures, a more powerful version aimed at business users could not alter this perception. In *The Cult of Information*, Roszak recounts Steve Jobs' realization that the future of the microcomputer lay not in the home, but in the office and the school—a realization that represented 'a dramatic change of course in the career of the micro computer'.[29] Since the first Macintosh, Apple have produced computers which, although beautifully styled and detailed, owe more to the format of the IBM PC than their own past success.

The influence of science fiction in the styling of early computers encouraged the open exploration of radically different forms. New technology promised a great deal—it could do anything, and so could look like anything. Computers in this respect held enormous possibilities, and were recognized as agents of potentially great change. The destiny of mankind was seen to be in the hands of a machine,[30] and they were venerated by some as an alternative religion. Michael Shallis's book *The Silicon Idol* puts forward the view that just as religion accepts that God made man in his own image, so society holds technology up as an idol and sees in it a reflection of itself. The technological view holds 'progress' as natural, and as Barthes explained in his essay 'Myth Today', this is exactly how myths operate. Ferranti's naming of its earliest computers after the mythological beings Pegasus, Mercury, Orion and Argos reflects the way they contained measures of hope and promise as well as fear and uncertainty. The positive aspects of this mindset towards the computer as a construct of fantasy contrasts sharply with the negative associations of today's office computer. A world of bland, repetitive clones, featureless designs with no imagination, presents the workplace as a place of boredom, containing no promise except the promise of more of the same.

The influence of gender politics on the design of office equipment

In the second part of this article, I wish to explore the role of status and gender politics of the workplace in influencing the design of the office computer. Again, there is a marked difference between the consumption of essentially the same technology in the context of domestic and working environments, which has affected the status and particularly the gendering of computers in both localities in the past.[31] In a 1986 paper, two computer historians analysed computer magazine adverts to assess how they reflect the perception and popular understanding of the computer by the public. They found that: 'The campaign strategy of presenting novelty within the context of the familiar means that advertising involving the office uses accepted stereotypes and reinforces conventional views of occupational and sexual roles.'[32]

The same phenomenon is clearly seen to occur from the earliest computer manufacturer's brochures. This section examines those catalogues as the representations they are, since the images they contain are in no way documentary evidence of the context in which computing technology has been consumed in the office. Despite this, brochures, like adverts, present a constructed view reflecting the prevailing attitudes of the time in which they were produced, and for this reason they remain a valid subject for analysis.

Significantly, early computers appropriated the semiology of the office desk and typewriter, and the prominent use of these forms framed their operation as a feminine activity. Women were first employed in offices specifically to operate typewriters.[33] In 'From the Word Processor to the Micro', Juliet Webster wrote: 'the processing of text was, of course, "women's work"'[34], and in *Inventing Women: Science, Technology and Gender*, Gill Kirkup noted that women operated and programmed computers 'at a time when those activities were considered mundane . . . tedious and repetitive'[35] (mundane to the extent that one could do one's knitting while operating Ferranti's 1952 Manchester Electronic Computer [9]). Webster's belief is that this relationship between typewriter and computer defined women's skills as non-technical and consequently undervalued; technical competence being seen as central to the 'sexual and class politics of technological work' as it conferred 'potential or actual power'.[36]

Throughout the 1970s, the computer continued to appear as little more than a futuristic typewriter, and the images appear similar to the typing pools of the Edwardian office. Consequently, the association with female operatives remains evident. One 1977 brochure stated: 'Consider the data preparation area of a computer project. This is almost certainly staffed by young, and frequently inexperienced girls.'[37] This is an image that recurs—the operator, always female, reduced in significance by identical repetition—a cog in the machine, under schoolroom supervision, slavishly inputting data.

Brochures that do show images of women working alone at computers are more often than not accompanied with text selling the ease of use of the computer; not as a benefit to the operator, but to the management. 'The operator requires minimal training'[38] and 'if she can type your letters, she can control our computer'[39] are typical quotes from brochures spanning a decade.

This innate sexism is apparent in computer literature throughout the 1970s and early 1980s. Men are portrayed as executives, managers, scientists or engineers, while women are portrayed as operators and assistants. The subordination of women in the context of the computer and the office is reinforced wherever males and females are shown together [10]. Women are portrayed sitting at the computer, carrying out the work while men stand—handing work to the woman, or looking over her shoulder, keeping her under watch. This is in spite of Webster's assertion that in fact women, in relation to office technologies, 'possess much greater competence than their male colleagues and superiors'. Males, she believes, distanced

Fig 9. The Ferranti Manchester Electronic Computer, 1952. The semiology of the office desk and typewriter forms found in early computer interfaces framed their operation as a feminine activity

Fig 10. NCR 8100, 1978. 1970s manufacturers' brochures reinforced the sexual stereotyping of women in the office as computer operators under male supervision

themselves from these technologies 'lest they be seen to be performing a 'low-grade' function'.[40]

Where men are shown using computers on their own, the accompanying text has, as one might expect, a different bias. Here the benefits of the computer are sold explicitly in terms such as 'effective', 'versatile', 'adaptable', 'performance' and 'business efficiency'. Moreover, the uses of control of one kind or another are made clear, whether it is 'production control', 'budget control', 'record control' or 'forecasting'. Images of men working alone on computers do not occur as frequently as images of women working alone, suggesting that although used for control, it was still, somehow, seen as less than 'executive' for men to be seen with an object operated by typing. An article in *Design* magazine in 1981 discussed a new piece of equipment designed specifically for executive use [11]. The MT-02 would, through its design 'express sophisticated engineering',[41] and contained advanced electronics, which meant that the keyboard 'talked' to the monitor via an infra-red transmitter. The styling of the casing, using straight lines, sharp corners and attention to detailing was intended to place the terminal in the same visual category as a finely engineered watch or camera—a very deliberate association with masculine aspects of technology. The author stated:

> Ergonomically optimised for long periods of key bashing by specialist operators, computer terminals aren't usually suited to use by company executives. What's more, rather than building up a desirable space-age corporate commander image, most of them look likely to lower a manager's status to that of the lowly VDU worker with managerial pretensions.[42]

Fig 11. The 1981 QED MT-02 used the appearance of sophisticated engineering to position itself as a masculine, executive object

It may be this attitude that is attempting to be countered in the images in manufacturers' literature, as whenever a man has a computer on his desk, there are other objects present—most notably telephone, paper and a pen [12]. Males in these images appear to retain their importance, and perhaps their masculinity, by showing that they still need to write. They still *need* the desktop, where females require only the computer.

Around 1975, computer processors became small enough to create true, self-contained computers. Initially, the high cost of such technology restricted the use of such computers to specialist applications in

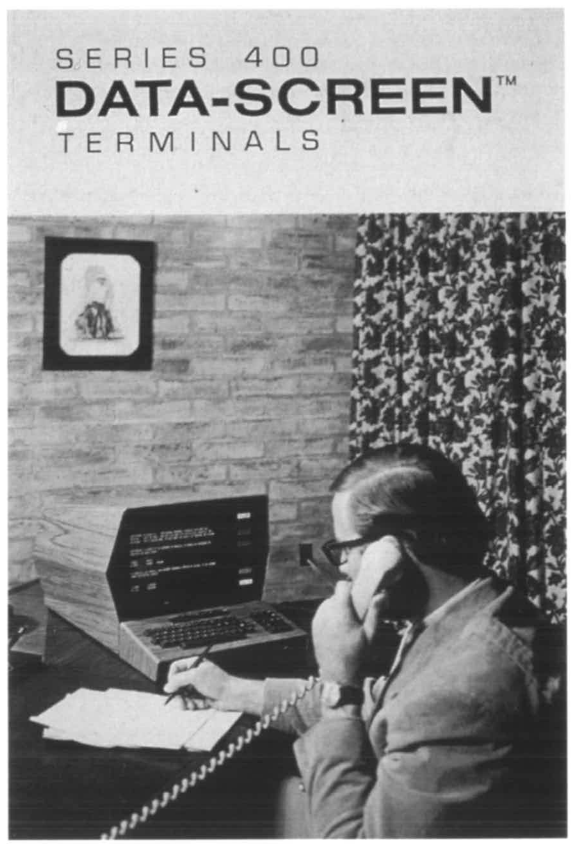

Fig 12. West Hyde Developments Series 400 Data-Screen, 1973. Males using computing technology at this time were usually shown using other equipment to distance them from low-grade typing functions

engineering or scientific research before they appeared for management use at the end of the 1970s. By 1981, desktop processors became known as 'personal computers', and were shown being used by female secretaries for the fast-growing application of word processing. While the images of computers in use in the context of the office do not cease after the 1970s, there are changes in their representation as status symbols that are indicative of wider social changes. The depiction of women as fulfilling menial roles in the office, and males in positions of authority in manufacturer's brochures becomes less clear after 1980, and by the mid- to late 1980s men and women are shown using the computer together as equal members of a team.

The office computer as a status symbol requires some further definition at this point. For an object to work as a status symbol in a traditionally accepted sense there has to be a recognized economic value which works to give it a symbolic value.[43] However, the economic value of the office computer does not represent a personal investment of any kind, merely an investment by the company, and the computer remains diluted as a status symbol. There is also a distinction that has to be made between the perception of objects as status symbols and role-setting objects. Francis Duffy in *The Changing Workplace*[44] noted that objects seen as status symbols by some are seen by others as necessary to fulfil their expected role in a suitable manner. Depending on the position of the observer, what may appear to be a symbol of an act of exclusion can also be seen as merely an indicator of expected behaviour.

The anthropological theories of emulation described in detail by Mary Douglas and Baron Isherwood (1978) and Daniel Miller (1986)[45] rely on reciprocal differentiation—in which there is a constant move to a new position by a superordinate group, providing a new target to be achieved by a subordinate group. In this context the office computer is problematic. The computer's ability to function as a role-setting or status symbol has effectively been removed—not only by the elimination of gendering and sexual stereotyping, but also by the fact that any machine can run any software. Today, a male or female using a computer in an office could be either a secretary using a word-processing package or a financial director using accounting software. It is impossible to distinguish between the two using the indicator of the computer, as it now appears as natural in the office as the office desk. This issue has been resolved by many managers in removing the computer to be operated by a secretary. In doing so, the manager regains a superordinate position by reclaiming the real estate of the desktop to display managerial authority—an example of status being achieved through the absence of a previous status symbol.

It would appear that computers have long been, and still are used for both work production and managerial control. Unlike today, however, computers used for these different functions, particularly from the mid-1970s to the mid-1980s, were designed and marketed in clearly different ways. Computers meant for data input or text production stressed the keyboard element of their design over that of the monitor, deliberately aligning themselves with the typewriter [13]. Where the function of computers

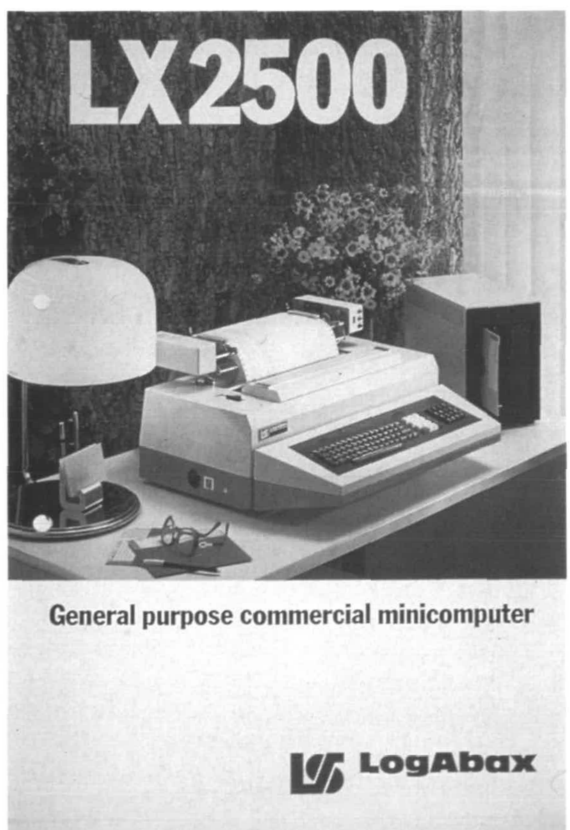

Fig 13. LogAbax LX 2500 minicomputer, 1977. The computer as an object for work production

Fig 14. ICL OPD (One Per Desk), 1984. The computer as an object for managerial control

used for 'low-status' operations was transparently obvious, designs aimed specifically at executives struggled to find a stylistic paradigm. The activities of management and control were perhaps less tangible and lacked semantic reference, resulting in confused objects such as the computer as telephone or intercom [14]. Such a problematic situation engendered exploration, allowing room for failure as well as success.

Conclusion

It can be seen that both stylistic influences and the gendered consumption of technology have played an important role in the development of the computer. There appears to have been a constant tension or dialectic between the precedents of older machinery and the futuristic, or at least forward looking tendencies of the latest technology—a battle seemingly won by an understandable resistance to change. Despite the personal computer being the focus of constant consumption and replacement at a phenomenal rate, the technical nature of their obsolescence has displaced the stylistic obsolescence present in the vast majority of other consumer goods. This has resulted in a cycle of technologically improved products remaining visually static. A potentially ephemeral, fleeting object has become an enduring desktop embellishment.

Within the field of design history, the emotional relationships people are capable of forming with artefacts have been well documented.[46] They are relationships that are not normally seen as being in any way untoward. It may be the anonymity of information technology, the lack of personality in the personal computer, which led to the representation in popular culture of those involved with them as being socially inept.[47] The increasing intrusion of the PC into everyday life is, however, altering this perception. In an attempt to 'reduce the anxieties of computer phobia'[48] society has long made 'a series of cultural assumptions about computers and human bodies'.[49] They have a 'memory', catch a 'virus', and are 'cloned'; indeed some even welcome with a smiling face. As we start to enjoy 'surfing the net' and 'driving the information superhighway', this affinity is being reciprocated. We 'network' with colleagues, 'multi-task' our workload and even refer to intellectual capacity as 'bandwidth'.

It may be worth commenting at this point on the recent launch of the Apple iMac [15]—apparently a complete change in direction in computer design (the cover of the first iMac brochure stated: 'To everyone who thinks computers are too complicated, too costly or too beige'). A quick look inside this brochure confirms that this computer is clearly targeted at family use, presumably a response to the recent massive increase in the domestic use of Internet technology. While it is indeed possible that such a visually radical product may overcome the inertia and affect the design of other personal computers, this is not the first time that such tactics have been tried and, for various reasons, failed.[50] 'New' or suddenly affordable technologies such as flat screen monitors

Fig 15. Apple iMac, 1999. A point of departure for the recently connected histories of office and home computers

(themselves previously launched as long ago as 1972 by Control Data Corporation) may subtly change the PC's appearance, but the precedent of the 'Universal Desktop Office Computer' has so far proved difficult to overcome. Just as the different paths of the home and office computer collided with the appearance of the Apple II, we may here be witnessing a point of departure where the two technologies once again take disparate trajectories.

I would posit that unless a new paradigm is accepted as the underlying representation of computing, an alternative semiology found to describe its function(s), or a more innovative, less universal, more exciting influence than an electronic filing cabinet is used as a reference in the styling of the office computer, in a physical sense it will remain an anonymous form.

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Notes

1 D. L Moore, *Ada, Countess of Lovelace, Byron's Illegitimate Daughter*, John Murray, 1977, p. 44.

2 Paraphrased from interviews with various office staff during research on personalization of the workspace in P. Atkinson, 'Work, rest and play', *Proceedings of the 3rd International Conference of the European Academy of Design, Design Cultures*, Sheffield, March–April 1999, vol. 1, pp. 26–56.

3 D. Gelernter, *The Aesthetics of Computing*, Weidenfeld & Nicholson, 1998, p. 109.

4 The term 'clone' in the context of computers referred originally to computers having operating system compatibility only. Although there is no reason for this technological congruence to carry over into visual congruence as it has, it may be understandable in marketing terms in increasing the chance of acceptance of a cheaper, possibly inferior product. Many corporations today, however, produce personal computers of at least the same quality as 'original' IBM products, yet the sterility of design continues.

5 R. Cringely in *The Money Programme*, BBC, 23 March 1997.

6 See, for example, J. Yates, 'The structuring of early computer use in life insurance', *Journal of Design History*, vol. 12, no. 1, 1999, pp. 5–24, in which the argument is put forward that the acceptance by insurance companies of IBM's success in their early computers was due at least in part by the continuity they offered to their previous tabulating machinery.

7 For a detailed exploration of the development of the home computer, see L. Haddon, 'The home computer: the making of a consumer electronic', *Science as Culture*, vol. 2, 1988, pp. 7–51.

8 The National Archive for the History of Computing was established in 1987 at the Centre for the History of Science, Technology and Medicine of the University of Manchester to preserve rapidly disappearing artefacts and documents relating to the development of the information age. The archive consists of various collections documenting in particular the history of computing in Britain, including Manchester University's association with the development of the first stored program computer and the complete archives of ICL and Ferranti Ltd. The Trade Catalogue and Machine Literature Collection used as the focus for this research consists of approximately 5,000 brochures, mostly from British, European and American manufacturers and covering production from the late 1940s onwards.

9 Although I do not claim that there is no detailed difference between any of the personal computers created by a range of companies between 1985 and today, the fact remains that the basic format and arrangement of components is the same. Small differences do exist between the current products of different companies, and even between one company's range of computers positioned at different price points, but these are so small as to be negligible, and in no way significant enough to carry any kind of signifying function in terms of identity or status.

10 P Atkinson, 'Computer memories: the history of computer form', *History and Technology*, vol. 15, nos. 1/2, 1998, pp. 1–32.

11 G. Sowden, 'Are you thinking comfortably?', *Design*, April 1983, p. 48.

12 J. Woudhuysen, 'Complex consoles are coming', *Design*, January 1980, p. 34.

13 C. McCarty, *Mario Bellini: Designer*, Museum of Modern Art exhibition catalogue, New York, 1987, p. 21.

14 B. Busch in M. Erlhoff (ed.), *Designed in Germany*, Prestel Verlag, 1990, p. 147.

15 Woudhuysen, op. cit., p. 35.

16 R. Green, 'File under future', *Design*, May 1982, p. 47.

17 P. Palton, 'The magic box', *Connoisseur*, January 1986, p. 55.

18 Ibid., pp. 55–6.

19 T. Ostler, 'Sci-fi in the City', *Design*, March 1985, p. 30.

20 P. Palton, op. cit., p. 56.

21 An example of the social construction of technology as a driving force of design development—a process outlined most clearly in W. Bijker, T. Pinch & T. Hughes (eds.), *The Social Structure of Technological Systems*, MIT Press, 1985.

22 J. Woudhuysen, 'Things to come', *Design*, July 1979, p. 42.

23 S. Braidwood, 'Torch: a tin box company no longer', *Design*, November 1985, p. 48.

24 T. Bentley, 'Laid on the line', *Design*, March 1985, p. 34.

25 A. Pipes, 'Designing the terminal', *Design*, February 1985, p. 54.

26 R. Rosenberg, *The Social Impact of Computers*, Academic Press, 1992, p. 257.

27 See S. Levy, *Insanely Great*, Penguin, 1994, and J. Scully, *Odyssey: Pepsi to Apple*, HarperCollins, 1988, for reports of the business world's reaction to the Apple Macintosh.

28 Palton, op. cit., p. 57.

29 T. Roszak, *The Cult of Information*, Paladin, 1986, p. 179.

30 See D. Lyon, 'The roots of the information society idea', in N. Heap *et al.* (eds.), *Information Technology and Society: A Reader*, Sage, 1995, pp. 54–73.

31 See, for example, G. Kirkup, 'The social construction of computers: hammers or harpsichords?' in G. Kirkup & L. S.

Keller (eds.), *Inventing Women: Science, Technology and Gender*, Polity Press in association with the Open University, 1992, and L. Haddon, 'Explaining ICT consumption: the case of the home computer' in R. Silverstone and E. Hirsch (eds.), *Consuming Technologies: Media and Information in Domestic Spaces*, Routledge, 1992, for accounts of the gendering of computing technology in the office (Kirkup) and the home (Haddon).

32 W. Aspray & D. deB. Beaver, 'Marketing the monster: advertising computer technology', *Annals of the History of Computing*, vol. 8, no. 2, 1986, p. 138.

33 V. E. Guiliano, 'The mechanization of office work', in T. Forester (ed.), *The Information Technology Revolution*, Oxford, 1985, p. 299.

34 J. Webster 'From the word processor to the micro: gender issues in the development of information technology in the office', in E. Green, J. Owen & D. Pain (eds.), *Gendered by Design?*, Taylor & Francis, 1993, p. 113.

35 Kirkup, op. cit., p. 269.

36 Webster, op. cit., p. 118

37 Kenrick & Jefferson Ltd., Keyboard Training brochure, 1977.

38 Control Data CRT Display Terminal brochure, 1972.

39 Lomac Adam Computer brochure, 1976.

40 Webster, op. cit., p. 119.

41 T. Lindsay, 'Small screen, big style', Design, May 1981, p. 43.

42 Ibid., p. 43.

43 See Part III of G. McCracken, *Culture and Consumption*, Indiana University Press, 1988, for an explanation of objects as markers of status and consequent superordinate/subordinate relations.

44 F. Duffy, *The Changing Workplace*, Phaidon.

45 M. Douglas & B. Isherwood, *The World of Goods: Towards an Anthropology of Consumption*, Basic Books, 1978; D. Miller, *Material Culture and Mass Consumption*, Basil Blackwell, 1986.

46 See, for example, M. Csikszentmihalyi & E. Rochberg-Halton, *The Meaning of Things*, Cambridge University Press, 1981.

47 D. Lupton 'The embodied computer/user', in M. Featherstone & R. Burrows (eds.), *Cyberspace/Cyberbodies/Cyberpunk*, Sage, 1995, p. 102.

48 Ibid., p. 106.

49 Ibid., p. 99.

50 As mentioned in the introduction, a series of one-off or unique designs were found in the sample collected for this research, but all had disappeared without trace. A similar situation to the present one (at the hands of the same individual associated with the iMac) occurred in the 1980s when Steve Jobs launched the NeXt computer—a black, sinister cube—as a competitor to both Apple and IBM.

Man in a Briefcase: The Social Construction of the Laptop Computer and the Emergence of a Type Form

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Man in a Briefcase:

The Social Construction of the Laptop Computer and the Emergence of a Type Form

Paul Atkinson

Dominant design discourse of the late 1970s and early 1980s presented the introduction of the laptop computer as the result of 'inevitable' progress in a variety of disparate technologies, pulled together to create an unprecedented, revolutionary technological product. While the laptop was *a revolutionary product, such a narrative works to dismiss a series of products which predated the laptop but which had much the same aim, and to deny a social drive for such products, which had been in evidence for a number of years before the technology to achieve them was available. This article shows that the social drive for the development of portable computing came in part from the 'macho mystique' of concealed technology that was a substantial motif in popular culture at that time.*

Using corporate promotional material from the National Archive for the History of Computing at the University of Manchester, and interviews with some of the designers and engineers involved in the creation of early portable computers, this work explores the development of the first real laptop computer, the 'GRiD Compass', in the context of its contemporaries. The consequent trajectory of laptop computer design is then traced to show how it has become a product which has a mixture of associated meanings to a wide range of consumers. In this way, the work explores the role of consumption in the development of digital technology.

Keywords: computers—consumption—gender politics—popular culture—product design—social construction of technology

Introduction

The laptop computer is a piece of technological hardware which holds a particular position in the panoply of technological products of today. Laptops have managed to retain an element of prestige and interest that I have previously argued has long been lost by the desktop computer.[1] Considering that the technology employed is the same, and that the first true laptop computer appeared more or less around the same time as the first desktop personal computer, a comparison of their consequent reception over time reveals a great deal about the perception of portable technology itself.

As will be shown, the arguments about which computer was the first laptop depend on the definition used. The whole notion of discussing 'firsts' in historical terms is fraught with difficulty, especially when the object concerned is a complex one containing a number of different technologies, and is potentially able to appear in more than one form. Judging from the number of dissimilar computers that have been hailed as 'the first laptop' (particularly by their creators)[2] the accolade for designing this particular first would seem to be an important one.

Here, the stance is taken that the term 'laptop' refers to a device which is easily carried while travelling, has its own source of power, a means of storing suitable amounts of data, a full alphanumeric keyboard for input of text, and a screen suitable for displaying a reasonable amount of text and graphics, at a size which is capable of being supported comfortably and easily on a seated person's lap.

By this definition, the 'Compass' computer [**1**], designed in 1980, and manufactured by GRiD Computer Systems Corp. was indeed the first true laptop. This development was presented in the design discourse of the day as the result of the convergence of technological developments in the fields of flat displays, rechargeable batteries, and computing memory; creating a product that was 'ready to happen'.[3] This is where the notion of technological determinism is still evident—Bill Moggridge (responsible for the industrial design of the 'Compass') states:

> ... why was the laptop ready to happen? Why did John Ellenby come up with this concept? I think that it is mostly to do with the convergence of technologies. It would take a man of his vision to understand the possibility, but if you look at the reason it was possible to happen then rather than some other time, it was because all these different technologies were coming together.[4]

However, the pre-history of the laptop shows a stream of developments in which the concept of the laptop's capabilities, if not the actual form, was a clear aim for many. There was a distinct desire for computing technology at a very personal level, even if the exact nature of its use was confused. In the late 1960s, in his doctoral thesis, Alan Kay envisaged the 'Dynabook'.[5] Later, Kay's 'Learning Research Group' at Xerox-PARC saw the development of the 1973 ALTO computer (the precursor to the Apple Macintosh) as 'a step towards the Dynabook', described then as a powerful portable computer in the form of 'a personal dynamic medium the size of a notebook which can be owned by everyone and has the power to handle virtually all of its owners information-related needs'.[6] Kay envisaged these owners as including 'children from age 5 or 6' and 'non computer adults' such as secretaries, librarians, architects, musicians, housewives, doctors and so on'.[7]

Fig 1. The Compass Mk 1 Computer designed for GRiD Systems by IDEO, 1980

The visions of Xerox-PARC researchers appear to have been looking towards a Utopian future where ownership of advanced technology was available to all, and consequently free of any associations of status. The mainstream view of portable technology at this time was, however, loaded with associations of prestige as it was so expensive and uncommon—reflected in the names of products such as 'The Executive Terminal'. Somewhere along the line, it appears that the briefcase—a well established and well understood signifier of executive status—became entwined with a 'macho mystique' of concealed technology, and subsequently with portable computing.

The macho mystique of concealed technology

This 'concealed technology' aspect of the image of the briefcase most likely emerged from its representation as one of the main elements of the secret agent's toolkit in mainstream popular culture of the period. From *James Bond* to *The Saint*, from *The Avengers* to *The Man from UNCLE* and from *Department 'S'* to *Mission: Impossible*, the briefcase was presented in novels, comics, film and television as being likely to hold anything from an assassin's rifle to hidden compartments for alternative identities and false passports—anything but boring paper documents. In these popular texts, the briefcase was presented as having a cachet of 'cool', superiority and an element of danger far beyond its mundane appearance.

It is well documented that far from being sheer escapism, popular television series such as those in the 'action' genre mentioned above played an important role in redefining the self-image of the male and his relationship with technology in both America and Britain:

'The 1960s incarnations of both Bond and Templar [The Saint], therefore, testify to a shift in dominant articulations of masculinity. In an age increasingly pervaded by consumption, advertising and style, 007 and the Saint both became agents for the upwardly mobile jet-set—the two characters breaking with the constraints of traditional masculinity and moving into a mythologized world of hedonism, consumer pleasure and individual autonomy'.[8]

and

'The Avengers was able to respond to and influence developments in various realms of popular culture (notably fashion, pop and the broader image-and-style oriented consumer culture which emerged in the 1960s and 1970s), as well as light-heartedly mediating contemporary social agendas (including gender and class mobility and the relationship between tradition and modernity in an increasingly science- and technology-based society)'.[9]

This 'increasingly science- and technology-based society' was being presented with ever smaller and lighter products, increasing the ability of people to carry technology with them wherever they went. An early example of this trend occurred with the introduction of a miniature radio by Sony in the late 1950s.[10] As products continued to miniaturize with the widespread adoption of the transistor, equipment for tape recording disguised as cigarette cases, microphones and 'bugs' for eavesdropping on the enemy and 'walkie talkies' for communication all made appearances in popular cultural representations of the secret agent's briefcase. The popularity and acceptance of this imagery can be measured by its replication in the production of a number of now collectible children's toys from the era, including, in particular, the 'Bond Briefcase' spy kits of the 1960s [**2**].[11]

The processes of appropriation of this type are explained in some detail by Stuart Ewen, who states that for an image to be appropriated into popular consumer culture it had to fulfil three criteria: it must be 'able to be disembodied, separated from its source … [be] capable of being "economically" mass produced [and] be able to become merchandise, to be promoted and sold'.[12] In this way 'the original cultural commodity's representational aura furbishes these other marketable forms with much of their value'.[13] The James Bond briefcase fitted these criteria and enabled it to become a successful toy in its own right, and perhaps allowed the adult executive briefcase to act as an icon of masculinity and reflect 'the growing accent on espionage within the playboy-adventurer formula that followed the American success of James Bond'.[14]

Fig 2. The 'James Bond Attaché Case' children's toy manufactured by Gilbert/Multiple Products, 1965

Osgerby's 2001 work *Playboys in Paradise* provides further evidence that throughout the 1960s and 1970s, the 'imagined identity' of film and television characters such as Bond 'made significant connections with the material world, offering representations of masculinity through which men could make sense of their place within a profoundly shifting cultural landscape'.[15] This phenomenon is the reason for the title of this article. 'Man in a Briefcase' is a play on the title of the 1967 television series *Man in a Suitcase*. This now cult British TV programme told the story of a government agent who, falsely accused of a crime, is forced to leave the service, travel incognito, and offer his services on a freelance basis. The glamour of the lead character (or at least part of it) came from being constantly on the move, living out of a suitcase as compared with the everyday drudgery of repetitive life at work and at home, and being in part a 'man of mystery', free to arrive and leave whenever he pleases rather than being subject to a hierarchy of establishment control and being tied to an office.

Popular films, as well as reflecting changes in concepts of masculinity, also reflected changing relationships between people and technology. Further evidence that there was an extant desire for portable computers as signifiers of futuristic technology and the associated status that goes with that technology can be seen in science fiction films of the period and the predictions they presented. As an example of this, in May 1966, *Esquire* magazine reported that Stanley Kubrick, then working towards the filming of *2001: A Space Odyssey*, had commissioned a number of major international corporations to produce conceptual designs for technological products of 35 years in the future. The same article shows a concept design produced by the American computer manufacturer Honeywell, showing their vision of what computers were going to look like. Bear in mind that this concept was put forward at a time when computers still filled whole rooms, and personal desktop computers were at least 14 years away. Honeywell's prediction was a computer in a briefcase [**3**]. The accompanying text to the concept design stated:

'Electronics in an attaché case will transform the hallmark of executive life. Designed by Honeywell, the case would allow a government scientist to carry with him a computer, a telephone with computer memory, a TV camera and monitor, and a TV receiver linked to a micro-storage file so a book page or other reference could be displayed at will. There is also a small space for medicines, contact lenses, playing cards. Feasible within three to five years; commercially available in ten to fifteen'.[16]

Fig 3. 'Electronics in an Attaché Case', concept design by Honeywell, 1966

Taking all the above into consideration, that popular culture was presenting audiences of the 1960s and 1970s with a glamorous image of masculinity tied to the notion of the 'playboy adventurer' alongside predictions of an exciting future of mobile technology, it can be argued that the driving force behind the development of the laptop computer was not so much the desire for smaller technological products as status symbols *per se*, but the desire for a product which would allow its owner to be demonstrably free of the ties of everyday office activity; to be a 'Man in a Briefcase'.

False starts and broken promises

Much of the history of computers is presented from a technologically deterministic perspective; as a clearly linear development of new technology allowing the production of smaller, lighter, more powerful products with an accompanying ease of mobility, which in turn affected the behaviour of certain social groups. It is posited here that this linear development is far from the case, and that it was the extant social drive for portable computing described above that was in fact the cause of numerous attempts to create a suitable product, before appropriate technology was actually available. It took a number of years before the reality of portable computing caught up with the promises of the imagery portraying its use. The description which follows of these 'numerous attempts', some of which were concurrent, provides the content for a 'multidirectional' model of technological development described as 'essential to any social constructivist account of technology'[17] by Pinch and Bijker, in which products produced to solve problems are judged and either accepted by the relevant social groups involved, or rejected, leading to the development of alternative products.

Portable terminals

In truth, early attempts at portable computers were no more than dumb terminals, having no computing power of their own, but which could be connected to a telephone by an acoustic coupler and transmit sales figures and orders for travelling sales executives. Portable terminals, however attractive as an image, failed to deliver on the promises of the high-flying executive of the corporate adverts. The lack of any suitable display technology and the need for 'hard copy' information, owing to the absence of any memory, meant that the technical drive behind these items was in fact their printing capability. Silent thermal printers built into the terminals became a high priority, and ousted noisy mechanical Teletype printers.

Two of the many players in this field were the American company Texas Instruments with their 'Silent 700' range, and the British company Transdata with 'The Executive Terminal' of 1972 and 1973 respectively [**4**, **5**]. A mere six years after Honeywell's prediction, the image of portable computing appeared to be set firmly as an executive briefcase.

The identity of the 'Man in a Briefcase'—carrying his office with him (and until the early 1980s it always was a 'him') was a recurring theme of corporate adverts

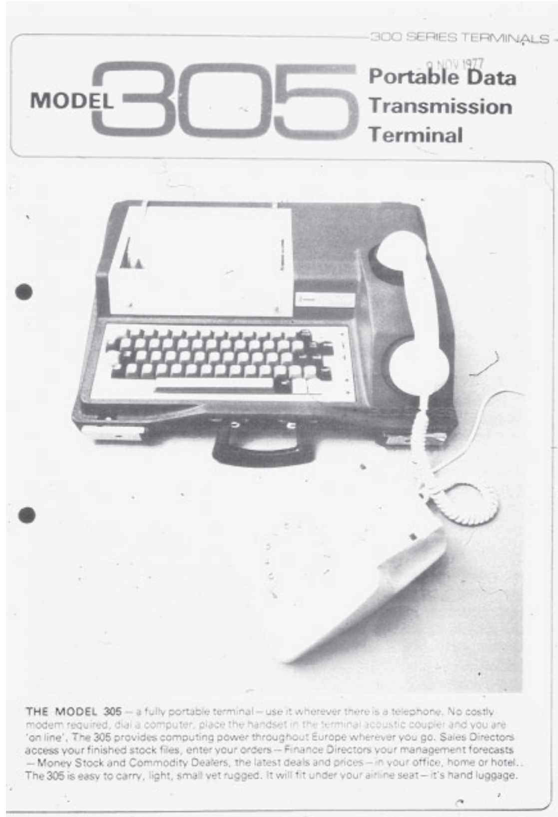

Fig 5. Brochure for the Transdata 'Model 305 Portable Data Transmission Terminal', 1973

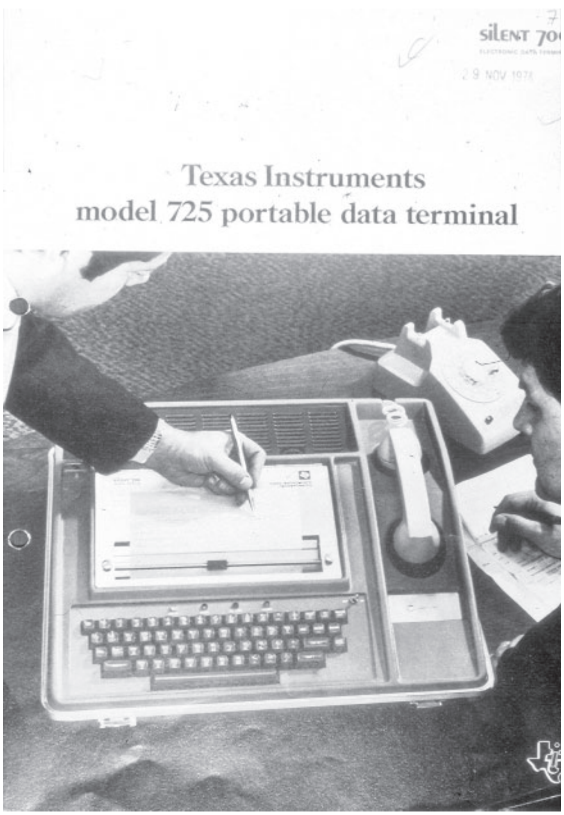

Fig 4. Brochure for the Texas Instruments 'model 725 portable data terminal'. Part of the 'Silent 700' range, 1972

and catalogues promoting portable computing throughout the 1970s. Status can be conveyed in many ways,[18] and although not necessarily expensive and easily available, the mere act of carrying a briefcase can be said to carry associations of authority and importance. There is no real economic value to a briefcase which works to give it a symbolic value, but there is a powerful sense of tradition. The 'James Bond' connotations of seemingly traditional briefcases filled with high-tech electronic gadgetry must have been highly appealing to many executives: people so important they didn't go to work in a car—they aspired instead to travel by private plane and helicopter [**6**, **7**].

The appearance of portable data terminals as new technology is reflected in the nature of the adverts and brochures featuring them, in which associations with existing or known qualities are sought in order to explain the qualities of a product of which the audience is quite possibly unaware. Judith Williamson,

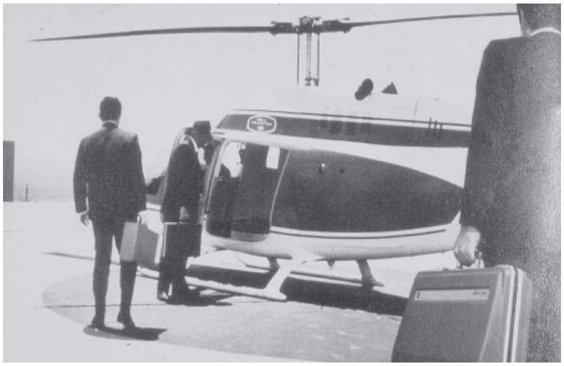

Fig 6. Image from the brochure for the Texas Instruments 'Silent 700' range, 1972

Fig 7. Image from the brochure for the Transdata 'Executive Terminal', 1974

in *Decoding Advertisements*, refers to the products used to make these associations as 'objective correlatives'. In the process of displaying the portable data terminal alongside a private aeroplane a number of qualities are transferred from one to the other—exclusivity, desirability, convenience and reliability. The same occurs when a terminal is shown alongside a helicopter—the freedom of movement, cutting edge technology, and presumably an associated high price.

There is an obvious element of status being displayed here—operating on a variety of levels. When these associations are made it is not just the two aligned objects which are related, but their owners. The same characteristics of power and status are transferred, and the owner is imbued, as Csikzentmihalyi and Rochberg-Halton observed, with the 'distinctive or superior qualities'[19] of the planes and helicopters in which they travel. This process, referred to by Williamson as 'individualism', being analogous to 'totemism', is clearly one of 'differentiation', where the objects act as symbols of the self, which 'stress the unique qualities of the owner, his or her skills and superiority over others'.[20]

The other mode of representation identified by the same authors, and which is being employed here, is one of 'integration', in which the objects serve to 'represent dimensions of similarity between the owner and others'.[21] The mode of transport 'symbolically expresses the integration of the owner with his or her social context'.[22] By owning a portable terminal the owner will be recognized as a member of the executive hierarchy of the workplace. Here, Williamson's use of the word 'totemism' is used to describe the 'formation of groups which cannot be mistaken for the groups of class difference'.[23] The system of social differentiation being created here is laid over the basic class structure of society and is one in which the meanings are 'bought with *products*, not with money'.[24] However, Williamson uses Althusser's notion of 'alreadyness' to explain the subtlety of the process, in that 'you do not simply buy the product in order to *become* a part of the group it represents: you must feel that you already, naturally, belong to agroup and *therefore* you will buy it'.[25] This is where the consumer fits into the process of turning the product from signified into signifier by occupying the space between the two—the receiver of the advert becomes a creator of meaning, because they already feel created by it. This 'natural' belonging is where myth is created, and in effect, it is the receiver that creates the myth. As the sociologist Colin Campbell notes,

'The central insight required is the realization that individuals do not so much seek satisfaction from products, as pleasure from the self-illusory experiences which they construct from their associated meanings. The essential activity of consumption is thus not the actual selection, purchase or use of products, but the imaginative pleasure-seeking to which the product image lends itself'.[26]

It is perhaps understandable that such blatant signification is employed when a new, and unknown, object is the subject of promotional literature: it has no 'meaning' with which the receiver can identify, and so has to 'be given value by a person or object which already has a value to us'.[27] As I will show, as the notion of portable computing became more popular and widely understood, the representation of the laptop changed. As Williamson put it, the 'product merges with the sign, its correlative, originally used to translate it to us, one absorbs the other and the product becomes the sign itself'.[28]

Portable computers

With the development of reasonably priced, durable memory devices during the late 1970s, a significant step forward in portable computing was made possible. The Texas Instruments '765 Portable Memory Terminal' of 1977 was aimed directly at the travelling salesman, and included 20K of a new solid-state technology called 'bubble memory'[29] to enable editing of around four pages of stored data before transmission over the telephone [**8**]. However, although the appearance of even a small amount of computing ability in a portable machine was a considerable advance, the negligible memory and the lack of a display screen meant that truly portable computing was still to be achieved.

'Luggable' computers

'Luggable' or 'transportable' were terms later associated with a series of products for which the term portable was, in hindsight, clearly an overstatement. The appearance of this form of computer reaffirms the point that the drive for portability was more important than the drive for miniaturization. 'Adam Osborne—He Made the Computer Portable' is a chapter in *Portraits in Silicon*, in which Robert Slater describes the development of 'the first commercially successful portable computer'.[30] Developed at the same time as the GRiD laptop, Osborne's specifications for his portable computer included its being small and sturdy enough for travel, easy to make, and cheap. The result, first shipped in June 1981, was certainly all those things, but the fact that it was relatively small didn't mean it was light [**9**].

'Early portable computers were brutes: typical of them was the Osborne 1, a 13 kg machine [in] a box the size of a small suitcase'.[31] Others described it as being 'as portable as a suitcase full of bricks'[32] and Osborne himself estimated 'that at least 80% of its portables never left the office'.[33] According to Slater, critics thought it looked like 'a World War II field radio, with all its dials and wires in the front. Yet it was a computer: it had a detachable keyboard, a 5-inch screen, 64 K of memory, and two built-in disk drives. And one could take it from home to office—and back home again!'[34]

Fig 8. Image from a magazine advert for Texas Instruments 'Silent 765' memory terminal, 1977

Fig 9. Osborne 1 transportable computer, 1981

Although not the first attempt to put a computer in a suitcase (Xerox, for one, had done the same thing earlier), Osborne was the leader in a field of products largely following his exact format—a heavy computer inside a deep vertical case with a removable lid containing a keyboard. The weight was the factor that made all these units fail as a product type, as 'people didn't really drag these sewing machine-sized units around that much'.[35] Even though some of these computers (including the Osborne) were later available with optional battery packs, they were certainly not suitable products for a 'Man in a Briefcase'. The issue of weight and a suitable source of battery power remained a stumbling block for portable computers.

Battery operated portables

When the first computers specifically designed to be battery driven appeared in the early 1980s they were small and light, but they had more in common with large hand-held calculators than with a true laptop computer [**10**]. As such, they also proved to be unsuitable for a 'Man in a Briefcase'. They typically had very small amounts of memory, and small two or three-line LCD displays—hardly suitable for typing in large amounts of information. In fact, by 1983 two of the front runners in this class (the Tandy 100 (also stated as 'World's "first" laptop'[36]) and the Olivetti M-10) were seen as striking because they were able to display eight lines of 40 characters and had 8K of Random Access Memory.[37]

Fig 10. Husky rugged handheld computer, 1981

Laptop computers

Taking the above examples as 'the latest step forward'[38] and considering the size and weight of the 'luggable' computer, the technical innovations embodied in the contemporary 'Compass' computer by GRiD Systems seem all the more impressive. Appearing on the market at exactly the time predicted by Honeywell 15 years earlier, the 'Compass' provided a portable computer which could fulfil the promises of the 'Man in a Briefcase' represented in popular culture.

The GRiD 'Compass' computer was the brainchild of John Ellenby, a British computer scientist who lectured at Edinburgh University and worked as a consultant to Ferranti Ltd on the Argus 700 computer before joining Xerox-PARC in California. Here, he worked on the ALTO computer and the laser printer before setting up his own computer development company, GRiD Systems. While looking to create a product development team, he came across Bill Moggridge who had just decided to start a second office of his successful design consultancy in America. It was John Ellenby's suggestion to locate this office in Silicon Valley because of the huge opportunities, and so Moggridge set up ID Two there in 1979. At the end of the same year Ellenby asked Moggridge's team to help with the industrial design and mechanical engineering of a new product. Back in 1976, Ellenby had spoken to one of the managers who had received the ALTO computer on which he had worked. 'He told me the ALTO was great, but that he had stopped depending on it as he couldn't take it with him to where problems needed solving. I said I could make one the size of a suitcase—he said "no—make it half the size of my briefcase". That's where the aim for the size of the GRiD computer came from'.[39] 'He gave me the belief that there was indeed demand for a powerful, really portable computer'.[40]

In order to raise the venture capital, Moggridge produced a conceptual model 'based on a discussion that John Ellenby and [Moggridge] had about what a small, portable computer could be like and the collection of the technologies that were converging to make it possible'.[41] This unit [**11**] folded in half across the centre in a geometry similar to that of today's laptops (referred to as a 'clamshell' design). A small keyboard next to an off-centre display was to be used

Fig 11. Concept model produced by IDEO for GRiD Systems, 1979/1980

for telephone dialling. When serious development started 'the real restraints of power supplies, printed circuit boards and component availability started to alter the form'.[42]

The most important of these technologies in terms of the appearance of the product was the display. The choice was made of a prototype electro-luminescent display by Sharp that could cope with graphics as well as text. The next technology exploited in design terms was the low-profile keyboard, which manufacturers suddenly reduced in depth by half to only ¾ inch. A slim casing became a realistic possibility. In purely technical terms the latest developments in computer chip design were exploited, as was the use of 'bubble' memory, which was light, compact, stable and had only come onto the market in the previous few years. The GRiD had 256K of bubble memory 'because nobody would ever want more than that'.[43] (This may seem ridiculous now, but Japanese portables that followed the GRiD a number of years later were sold with only 32K as standard). This use of memory ties in with another technological paradigm called 'GRiD Central'. Moggridge explained that 'The concept of 256K being adequate was dependent on the fact that you would have information resident on a centralized server. So you would dial in [using the built-in modem] to upload or download the files that you wanted to store or retrieve'.[44]

Finally, the choice of magnesium as the material for the casing involved a significant amount of technological development. The case material was required to be light, robust, and to conduct large amounts of heat away from the power supply. In the overall scheme of the project, price wasn't too much of an issue, but weight was. Moggridge's team found magnesium being used in chainsaw casings and worked with a St. Louis chainsaw casing manufacturer to develop precise, thin-wall castings which enabled magnesium to become the 'metal of choice for a lot of portable electronic equipment'.[45] This allowed for the creation of a suitably rugged product, as the GRiD was designed to withstand impact forces equivalent to being dropped four feet onto a concrete floor. This was in order to meet the chosen maintenance strategy John Ellenby had planned for the 'Compass' computer, which involved the unit being transported by a courier service.

Moggridge states that, although rugged, 'the design was aimed at trying to make sure it was very prestigious and elegant with the executive in mind'.[46] In his view, Ellenby was aiming at executives because the worldwide market was large, they had sophisticated information processing requirements, and weren't too price sensitive (at $8000, the GRiD was more than double the cost of an equivalent desktop machine). However, the product did fail in that one area—affordability. 'The price was so high, and it was too early for it to be generally acceptable. So it became very much a niche thing'.[47] They sold a number to executives from the 'Fortune 500' companies, but not enough to repay the venture capitalists, and so started to look for other niche markets. The GRiD's rugged design specification meant the unit was very attractive to another target group—the military, and a large number of specifically adapted computers were sold to the American forces; to NASA, for use in the space shuttle; and to the president of the USA for use on 'Airforce One' aeroplanes. The GRiD's iconic status achieved through this exposure was reinforced by MoMA, who placed it in their permanent design collection; *Business Week*, which dubbed it 'the "Porsche" of computers'[48]; and by the American Industrial Design Society, who in 1982 gave the GRiD 'Compass' computer the award for Design Excellence for 'substantially advancing the state of the art of computer design'.[49]

Amongst a confusion of less perfectly conceived alternatives, the 'Compass' must have shone like a beacon, its possibilities lighting the way forward for competitors to follow. The laptop computer John Ellenby uses today 'has the same form, is the same size, and has the same aesthetics'[50] as the original 'Compass'. The durability of this designed form for portable computing, and the rapid demise of the 'luggable' computer and the small battery operated portables, all pay testament to the 'Compass' as an important and successful piece of design in setting a precedent for the visual identity of the laptop computer. It was a form readily accepted by the relevant social group. In following a functional directive to protect the keyboard and screen when not in use, the designers, in adopting the 'clamshell' form, also created an iconic sign in which the shape and the ritual of opening the product reflected that of an actual briefcase.

The vision of John Ellenby, who had realized the potential of flat-display technology for portable computing as early as 1973 while working on early plasma screens, brought together the very latest developments in a number of disparate fields—flat panel displays, non-volatile data storage, miniaturized modems and multi-tasking operating system software; which, while certainly at the cutting-edge, had nevertheless all been previously imagined. Consequently, it is fair to say that had the GRiD 'Compass' laptop computer not been designed in 1980 it would have arrived eventually, although not necessarily in the same form, as Kay's vision of the 'Dynabook' did predict the exploitation of technological advances in miniaturization with some accuracy. However, what the GRiD 'Compass' did achieve, via the input of Moggridge, was to fix the 'clamshell' design as the archetypal product form for laptop computers.[51]

The type of adverts and brochures containing contextual imagery described previously continued well into the 1980s, until such a time that the archetypal form of the laptop created by the GRiD became a 'sign' which could be read and understood by all, and alternative forms had disappeared after rejection by their relevant social group. This is the stage of the social construction of technology that Pinch and Bijker refer to as closure and stabilization, when apparent problems have disappeared and an object's 'final' form can be accepted. Once in this position, the competition between a number of manufacturers led to a proliferation of brochures depicting only the product itself, often devoid of any context at all. The inference is that the object needs to say nothing in terms of selling any associated status, which has become a 'given', and the way is left open to discuss the 'power' of one particular laptop over another [**12**].

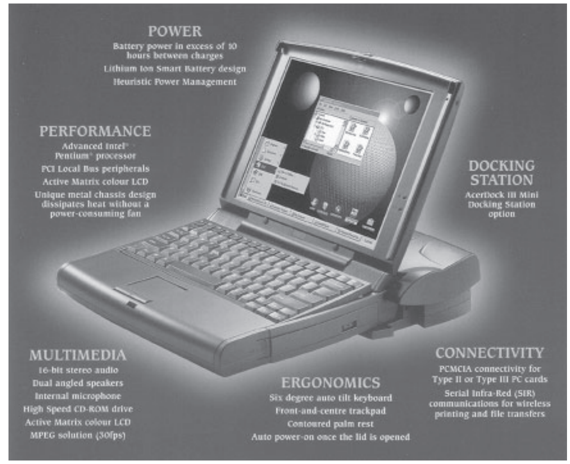

Fig 12. Image from Acernote Portable Computers brochure, 1996

Where these brochures do contain images of laptops being used by people, they are fairly general in nature. While in no way being put forward as a domestic item, they are presented as having limited kudos in terms of business hierarchies [**13**]. Yet there is still an element of status displayed in that anyone given the freedom and responsibility to work outside the controlled environment of the office is perceived not to be in the lower echelons of a corporation. The laptop in this scenario is more often than not a 'role-setting' object as defined by Francis Duffy in *The Changing Workplace*, denoting the level of self-direction of time allowed to an employee, and an object necessary to fulfil their expected role in a suitable manner.

There are various ways in which these images can be perceived, but it is most important to remain aware of what it is that is being interpreted. The images are patently not of reality—they are not documentary evidence of the users of laptops going about their daily business, but a constructed 'reality'—a representation of an imagined or desired reality from the point of view of the manufacturer and/or the advertising agency in charge of product photography. As Hebdige observed, determining meaning through such a network of relationships is complex, as 'there can be no absolute symmetry between the "moments" of design/production and consumption/use, and . . . advertising stands between these two instances—a separate moment of mediation'.[52] While the material remains valid for interpretation within

Fig 13. Image from Toshiba 'Notebook' brochure, 1997

these boundaries, and the results are meaningful in revealing possible perceptions by their audience, they still inevitably fail to expose any 'truths'.

One of the main players in the British portable computing industry in its earliest days was the company Transdata founded in 1970 by John Neale. Transdata's '305' model was promoted as 'The Executive Terminal' but, as discussions with Neale showed, it was actually bought by anybody but executives:

'The advert … was a message into the unknown. With hindsight, it was not company executives who were interested in portable computing; they had little knowledge or experience of computing. It was the protective enclave of the data processing department. An interesting customer for these terminals, because they required no PTT modem and could be outlocated as demand required, were the programmers at ICL on maternity leave, since they could be easily located in employees' homes economically. All other sales came from the Computer Time Sharing companies'.[53]

As discussed, the GRiD also had problems with its target audience. The venture capitalists had said, 'managers at the time did not use computers', but Ellenby believed 'the market was there, only latent. We had to create the demand by taking the equipment out to show to people—mainly mobile sales forces and niche sales people such as pharmaceutical representatives'.[54] Not exactly the imagined user of a high-flying executive.

As the laptop has become a more commonplace, affordable object, the market has, as might be expected, become more diverse. Laptops are now sold not only as portable business machines, but larger versions are sold as 'desktop replacements' where the performance is more important than the portability. 'Rugged', vibration-proof laptops are sold for use in hazardous environments (or, like four wheel drive vehicles, to anybody wanting to project that image), and bright yellow or green 'Alienware' laptops are coveted by VJs (video jockeys) and gamers.

Examining adverts for recent laptop computers shows a series of mixed and confused messages are being delivered and received. Some, such as Dell [**14**] are equivocal or ambiguous. The 'Inspiron' notebooks, being sold with taglines such as 'combining style, power and value' and being 'slim, fast and very attractive', are visually placed in neither a domestic or work setting, but closer reading reveals the same object is meant for both with the amount of memory, choice of software and price defining the lesser product for the home and the superior product for the office. Others align the laptop with work by the choice of name for the product, such as Toshiba's

Fig 14. Newspaper advert for Dell 'Inspiron', 2001

'Satellite Pro' [**15**], which is backed by copy reading 'for mobile business users'.

Packard Bell [**16**], who opted for the design iconography of the iMac for a whole range of home computers, appears to associate their 'Chrom@' laptop with the individual rather than the work or home environment. The tagline 'The creation of a new lifestyle' is followed by copy referring to the 'stunning looks and leading edge technology' representing 'the ultimate sensory experience in mobile computing'. While no doubt powerful enough to cope with the demands of business, the continuing text refers only to 'enjoying top-quality games and DVD movies on your TV screen', placing it firmly in the domestic arena.

An early advert for one of Apple's recent creations, the Titanium Powerbook, is devoid of context altogether, and shows the product in almost complete isolation [**17**]—a few words of text which, combined with the imagery, draw attention to its remarkably

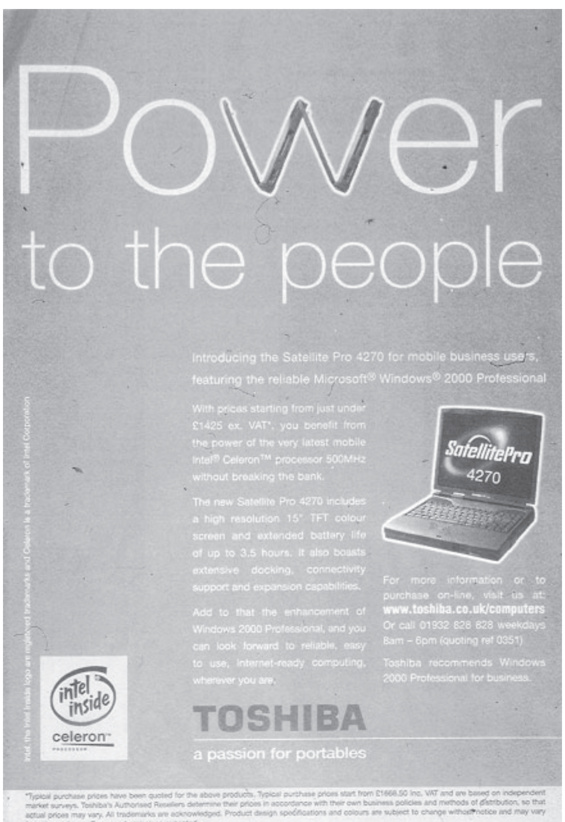

Fig 15. Newspaper advert for Toshiba 'Satellite Pro', 2000

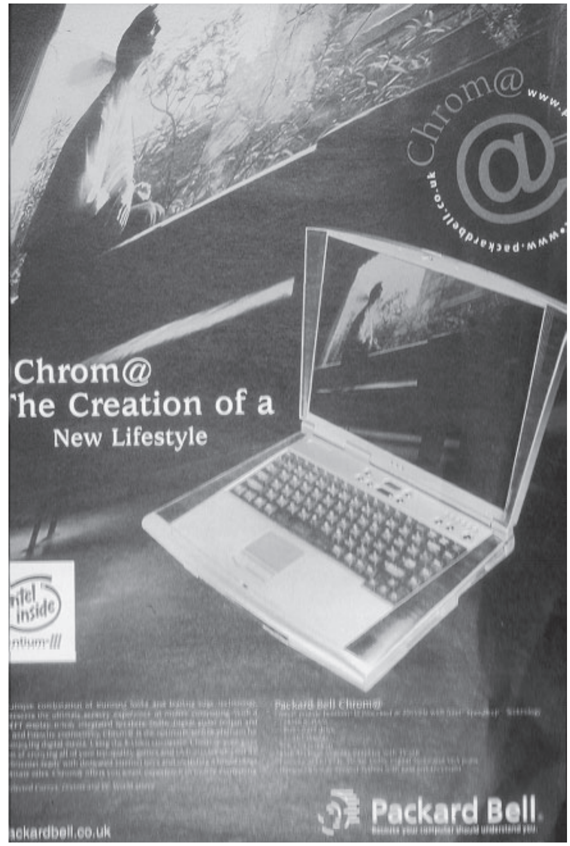

Fig 16. Newspaper advert for Packard Bell 'Chrom@', 2000

thin casing and very large screen which, perhaps as a deliberate reference to their 'arch enemy', bears a colourful picture of *The Road Ahead*, suggesting the title of a book by Microsoft's Bill Gates.

Diverse as all these adverts may be, the basic form of the laptop has arguably remained a masculine technological object. As has been shown, portable computers started as fairly heavy objects, with rugged designs aimed at a male audience. A comparison could be made, though, with other technological artefacts which have not remained as clearly masculine. Mobile phones started with exactly the same target audience as laptops, and yet have successfully lost all their original connotations. This may be due to their having a role which is clearly more 'personal' than 'work', and the fact that interchangeable covers enable them to be more easily personalized. Personal Digital Assistants (PDAs) have an overt business/work function, yet their small size enables them to be carried in jacket

Fig 17. Newspaper advert for Apple 'Titanium Powerbook G4', 2001

pockets or small bags, again stressing the 'personal' aspect. It seems, however, that by and large, the laptop still acts as a simulacrum of a briefcase and as a signifier of the corporate world.

Conclusions

So, it seems that the difference between the so called 'clear' messages being sent out by manufacturers in the design of their literature and in the design of the products themselves, and the actual consumption of the technology in the marketplace was marked, and serves as a reminder that such conclusions about 'reality' cannot reliably be drawn from advertisements.

For example, far from remaining executive in status, by the late 1990s it had become commonplace for service technicians from companies such as British Telecom and British Gas to carry laptops with them to type in and print out test results in the field, and yet no trace of this is evident in the material gathered. Therefore, the apparent 'natural' status of the laptop in brochures from this period also has to be questioned, and this points perhaps to the need for more research to be done in the area of interviewing manufacturers and consumers.

It is unclear exactly where the laptop resides in our culture at the moment. As an inherently mobile piece of technology, it can move freely between the environments and cultures of home and business with ease. While it can still be seen as carrying an amount of executive status, in many respects it carries no more than does an expensive briefcase, and the act of carrying a briefcase is no longer the exclusive domain of the male.

Yet the representation of 'concealed technology' as an element of 'macho' culture persists to this day. The gadgetry designed for James Bond to use in the field is still a major component of the films, and children still play with 'James Bond' briefcases (which now, of course, contain a laptop computer). Other examples in recent popular film texts include the remake of *The Jackal*, starring Bruce Willis, controlling an unfeasibly large weapon by means of a computer in an aluminium briefcase, and a laptop with wireless capability being used by Tom Cruise to transfer laundered money between bank accounts while travelling on a train, as shown in *Mission: Impossible 2*. Also, much has been written about the gendered appropriation of technology in a domestic setting,[55] and as Elaine Lally points out in

At Home with Computers, 'powerful role models for women are less visible than the stereotyped gendered representations of the computer advertising'.[56] Indeed, the popular representation of laptop computer usage appears to remain largely masculine.

It is interesting to note that mainstream advertisements for laptop computers, which have, for a number of years, been devoid of context, are once again showing the product's use *in situ* in order to explain the new features of wireless and Bluetooth capability. Although it in no way affects the form of the laptop, in some respects these features could be seen as destabilizing the laptop from its accepted position, as an important new product function has come into play. Comparing a recent advert from Samsung [**18**] with the Texas Instruments advert from 1977 [**4**], it seems very telling that the perceived user of this latest incarnation of the laptop remains clearly a travelling businessman; and that in many respects little appears to have changed over the last quarter of a century. Although the reality of its use may be very different, the laptop is still represented as the object of choice for a 'Man in a Briefcase'.

Fig 18. Newspaper advert for Samsung X10 Notebook, 2003

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Notes

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1 Atkinson, P. 'The (in)difference engine: explaining the disappearance of diversity in the design of the personal computer', *Journal of Design History*, vol. 13, no. 1, 2000, pp. 59–72.

2 J. Westly, the founder of 'Husky Computers' claims his battery powered 'Husky' (see Fig. 10) to be the first laptop, but it had no alphabetical keyboard input, and was specifically designed as a rugged computer for data collection in adverse environments. See *The Obsolete Computer Museum*: http://www.obsoletecomputermuseum.org> [Accessed 10 February 2001]

3 Interview with Bill Moggridge at the London Offices of IDEO, 15 June 2000. (See also 'The Compass computer: the design challenges behind the innovation' in *Innovation – The Journal of the Industrial Designers Society of America* Winter 1983 pp. 4-8).

4 Ibid.

5 M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, London, Orion Business Books, 2000 p. xiv suggests the date of the first appearance of the 'Dynabook' to be in this thesis in 1969. However, interviews with Alan Kay on websites give the date he conceived it as 1968 (http://www.squeakland.org/school/HTML/essays/dynabook_revisited.htm (accessed 3 March 2005) and http://en.wikipedia.org/wiki/Alan_Kay (accessed 10 March 2005)). However, a Dynabook-type concept was presented to potential clients of Xerox (Wesleyan University, Middletown Connecticut, USA) in 1967 as part of a fully digitized library and student learning system (Tim Putnam, personal communication), before Kay joined Xerox (1970 or, on some sites, 1972).

6 Learning Research Group, 'Personal Dynamic Media' cited in L. Press, 'Before the Altair: the history of personal computing' in *Communications of the ACM*, vol. 36, no. 9, September 1993, p. 31.

7 A. Kay, 'Personal computing' cited in L. Press, (1993) op. cit., p. 29.

8 B. Osgerby, 'So *you're* the famous Simon Templar' in B. Osgerby & A. Gough-Yates (eds.) *Action TV*: *Tough Guys, Smooth Operators and Foxy Chicks*, London, Routledge, 2001, p. 44.

9 M. O'Day, 'Of leather suits and kinky boots' in B. Osgerby & A. Gough-Yates (eds.) *Action TV*: *Tough Guys, Smooth Operators and Foxy Chicks*, London, Routledge, 2001, p. 222.

10 Sony introduced the TR-63 'pocketable' radio in 1957, at a cost equivalent to an average Japanese worker's monthly salary. Unfortunately, it was just larger than a businessman's normal shirt pocket. Sony salesmen were consequently issued with

custom-made shirts with slightly larger pockets. (http://www.sony.net/Fun/SH/1-6/h2.html [accessed 6th January 2005]).

11 The famous Bond attaché case first appeared in the film 'From Russia With Love' (1963) and contained 50 gold sovereigns, 40 rounds of ammunition, a folding rifle with infrared telescopic sight, and a can of tear gas. (http://www.007forever.com/mystique/gadgets003.html [accessed 5 January 2005]) A collector's website describes the children's toy version as being produced by Gilbert/Multiple Products from 1965, and states they are currently valued at $2000. (see http://www.towson.edu/~flynn/toys.html [accessed 5 January 2005]).

12 S. Ewen (1988) cited in M. O'Day, op. cit., p. 229.

13 Ibid., p. 229.

14 B. Osgerby, op. cit., p. 46.

15 B. Osgerby, *Playboys in Paradise: Masculinity, Youth and Leisure-style in Modern America*, Oxford, Berg, 2001, p. 162.

16 Anon, 'In the year 2001, the shape of everyday things …', in *Esquire*, May 1966, p. 116.

17 T. Pinch & W. Bijker 'The social construction of facts and artifacts: or how the sociology of science and the sociology of technology might benefit each other' in W. Bijker, T. Hughes & T. Pinch (eds.) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, MIT Press, 1987, p. 28.

18 See G. McCracken, *Culture and Consumption*, (IUP, Indiana, 1988) Part III, which describes objects as markers of status and hierarchies of relationships.

19 M. Csikszentmihalyi & E. Rochberg-Halton, *The Meaning of Things: Domestic Symbols and the Self*, Cambridge University Press, Cambridge, 1981, p. 29.

20 Ibid., p. 38.

21 Ibid., p. 38.

22 Ibid., p. 39.

23 J. Williamson, *Decoding Advertisements*, Marion Boyars, London, 1978, p. 47.

24 Ibid.

25 Ibid.

26 C. Campbell, *The Romantic Ethic and the Spirit of Modern Consumerism*, Basil Blackwell, Oxford, 1987, p. 89.

27 J. Williamson, op. cit., p. 31.

28 Ibid., p. 35.

29 Bubble Memory stored data in cylindrical magnetic domains, or 'bubbles' in a thin film of magnetic material. The presence of a domain indicated binary 1, the absence, a zero. (http://www.xs4all.nl/~fjkraan/pc5000/bubble.html) 'It was once widely believed that bubble memory would become one of the leading memory technologies, but these promises have not been fulfilled' (http://www.webopedia.com/TERM/b/bubble_memory.html) [both accessed 7 January 2005].

30 R. Slater *Portraits in Silicon*, MIT Press, Massachusetts, 1987, p. 323.

31 M. Aartsen, 'Portable computers, a buyer's guide', in *Design*, March 1984, p. 48.

32 I. Stobie, 'They all laughed, but …', in *Practical Computing*, January 1983, p. 108.

33 M. Aartsen, op. cit., p. 48.

34 R. Slater, op. cit., p. 326.

35 R. Cringely, *Accidental Empires*, Penguin, London, 1996, p. 173.

36 T. Carlson, *The Obsolete Computer Museum*, op. cit.

37 I. Stobie, 'Tandy 100', in *Practical Computing*, August 1983, pp. 96–98; and I. Stobie, 'Olivetti M-10', in *Practical Computing*, December 1983, pp. 88–89.

38 I. Stobie, op. cit., August 1983, p. 98.

39 Interview with John Ellenby conducted over the telephone, 9 February 2001.

40 Interview with John Ellenby conducted by email, response dated 11 February 2001.

41 Interview with Bill Moggridge, op. cit.

42 Ibid.

43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 Ibid.

48 'The Compass computer: the design challenges behind the innovation', op. cit. (see note 3), p. 7.

49 Ibid., p. 4.

50 Interview with John Ellenby conducted over the telephone, op. cit.

51 It is important to note that even though other forms of portable computer have since appeared, such as PDAs and 'tablet' computers, they have complemented rather than replaced the laptop. PDAs have significant amounts of memory, but are usually seen as a detachable peripheral of the computers with which they dock. Tablet computers are laptops with demountable screens, but have yet to prove popular. The flat form and way they are held and used with a stylus could arguably connote a clipboard and hence not appear 'executive' enough.

52 Hebdige, D., *Hiding in the Light: On Images and Things*, Routledge, London, 1988, p. 80.

53 Interview with John Neale conducted by email, response dated 28 January 2001.

54 Interview with John Ellenby conducted over the telephone, op. cit.

55 See, for example, R. Silverstone, & E. Hirsch, *Consuming Technologies: Media and Information in Domestic Spaces*, Routledge, London, 1992, and A. Cawson, I. Miles & L. Haddon, *The Shape of Things to Consume: Delivering Information Technology into the Home*, Avebury, Aldershot, 1995.

56 E. Lally, *At Home with Computers*, Berg, Oxford, 2002, p. 167.

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

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

Paul Atkinson

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.

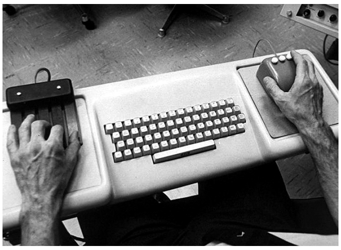


Figure 2
The Augment System Interface, 1968.
Courtesy of the Bootstrap Institute,

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.

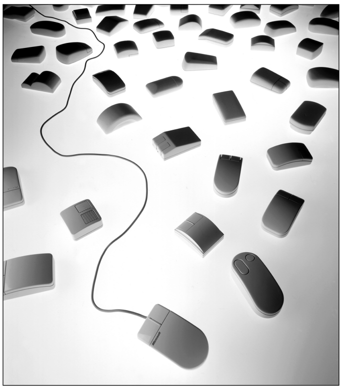


Figure 8.
The third-generation Microsoft mouse with development models, 1987. Photo by Rick English, courtesy of IDEO.

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=OYecfV3ubP8 (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.

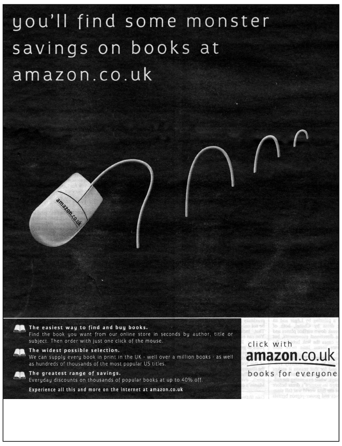


Figure 10
The mouse as the Loch Ness Monster, Amazon.co.uk.ad.1999 (© 1999 Amazon.com. All rights reserved).

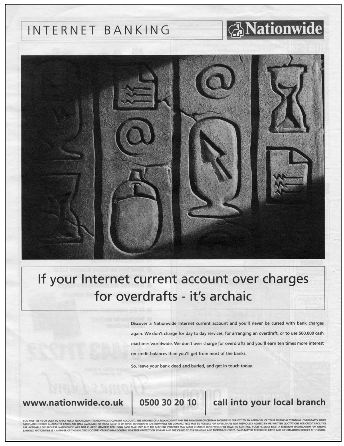


Figure 11
The mouse as a as hieroglyph . Nationwide Building Society ad. 2000. Courtesy of Nationwide Building Society.

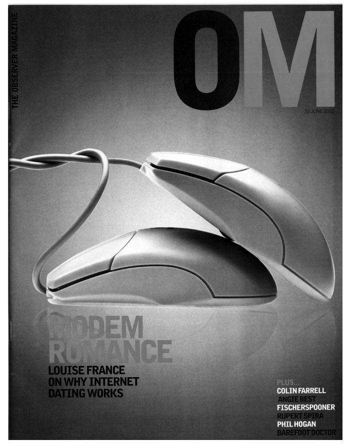
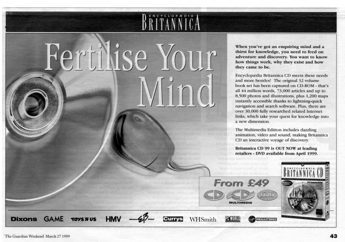
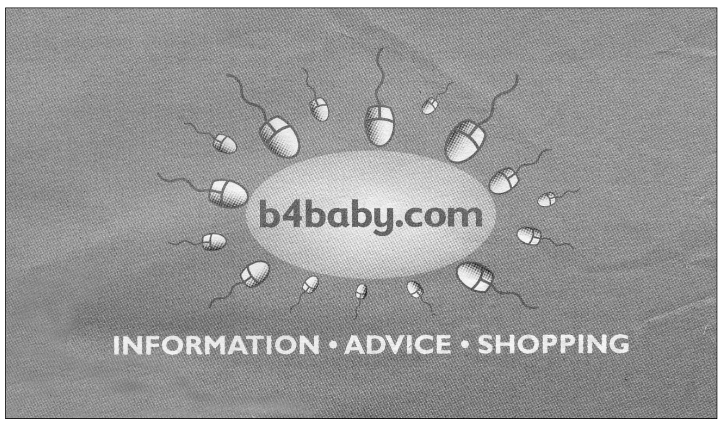


Figure 12
The mouse as a real mouse, cover of *Observer Magazine*, 2002, (© Guardian News & Media, Ltd. 2002).





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

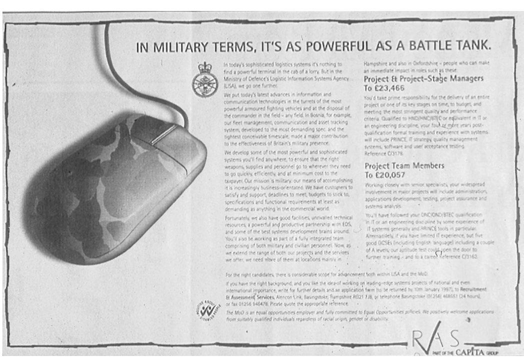
As it has become more commonplace and identifiable as an everyday artifact in its own right, the mouse has taken the form of a wide variety of wildly differing objects, ranging from a tank to an electric light bulb, from the Loch Ness monster (Figure 10) to an alien, and even a fossil, an Egyptian hieroglyph (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).

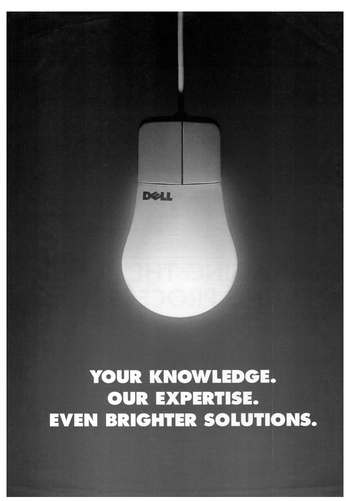
The Mouse as an Abstracted Symbol

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.

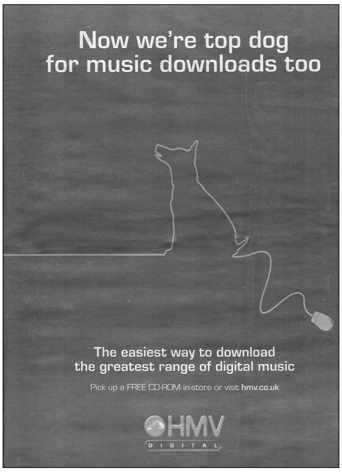


Figure 18
HMV online music sales ad, 2005.
Courtesy of HMV.

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.

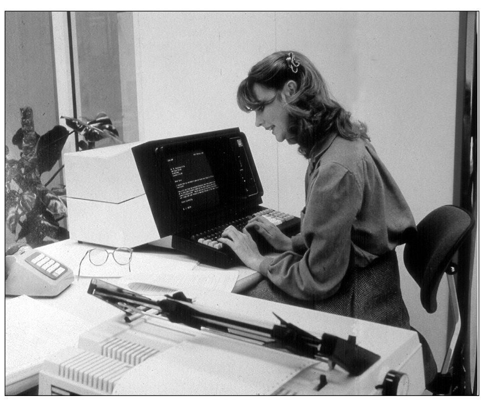


Figure 20
ICL Text 25, 1982. Females shown using computers in the late-1970s and early-1980s were shown carrying out the feminized skill of typing. Image courtesy of the National Archive for the History of Computing, University of Manchester.

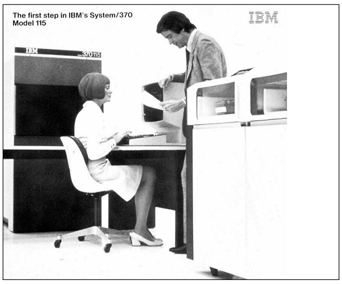


Figure 21
IBM System/370, 1976. Male managers were shown standing next to seated female operators in computer manufacturers' literature. Image courtesy of the National Archive for the History of Computing, University of Manchester.

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.

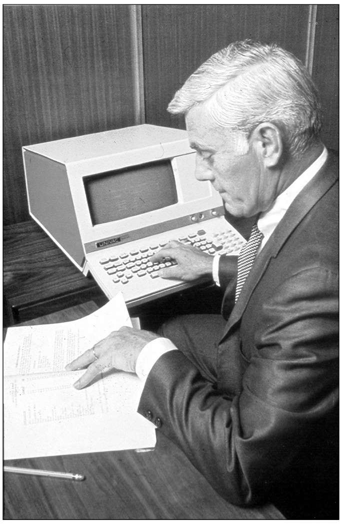
Clearly, there were contemporaneous and significant social changes taking place during this period of the late-1970s and early-1980s, most notably around the awareness of feminist issues and sexual equality, which had a considerable impact on the perception of male and female roles within the office. 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.

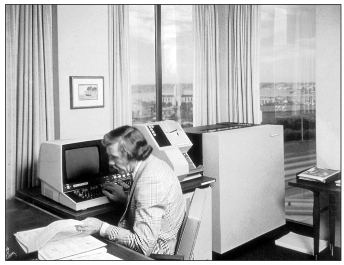
The introduction of the computer mouse into the office changed all that. Suddenly, here was an object that not only changed completely the way in which a computer was operated, but also changed the perception of the computer itself. Using the mouse, there was not the same need to type. Instead, one could 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.

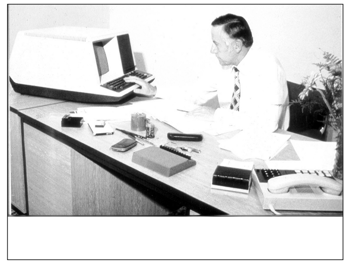
Conclusions

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.

Acknowledgments
I would like to take this opportunity to thank all those who gave their time to help in my research for this project: Dennis Boyle, Paul Bradley, Kate Brinks, Stuart Card, Doug Engelbart, Bill Moggridge, Rickson Sun, Bill Verplank, and Jim Yurchenco. A shorter version of this article was presented at the 2006 Design History Society Conference in Delft, the Netherlands. My thanks also go to all those who contributed feedback, and to the Editorial Board of *Design Issues* for their advice.

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.

A Bitter Pill to Swallow: the Failure of the Tablet Computer

(In Press)

A Bitter Pill to Swallow: The Failure of the Tablet Computer

Paul Atkinson

Tablet computers (or tablet PCs) are a form of mobile personal computer with large, touch-sensitive screens operated using a pen, stylus, or finger; and the ability to recognize a user's handwriting—a process known as "pen computing."

The first of these devices, which appeared at the end of the 1980s, generated a huge amount of interest in the computer industry, and serious amounts of investment money from venture capitalists. Pen computing was seen as the next wave of the silicon revolution, and the tablet computer was seen as a device everyone would want to use. It was reported in 1991 that "Nearly every major maker of computers has some type of pen-based machine in the works."[1]

Yet in the space of just a few years, the tablet computer and the notion of pen computing sank almost without a trace.[2] Following a series of disastrous product launches and the failure of a number of promising start-up companies, the tablet computer was discredited as an unfulfilled promise. It no longer represented the future of mobile computing, but instead was derided as an expensive folly—an irrelevant sideline in the history of the computer.

This article traces the early development of pen computing, the appearance, proliferation, and disappearance of the tablet computer, and explores possible reasons for the demise of this particular class of product.

Product Failures in the History of Computing

This article is concerned with the design, production, and consumption of artifacts, and the numerous factors which can affect their success or failure in the marketplace. For any company bringing a product to market, the amount of time and money invested in the research, design, and development of the product itself and in the market research, promotion, packaging, distribution, and retailing of a product means that an unsuccessful product launch is an extremely serious but unfortunately all too real prospect. The risk perhaps is understandably more common when the artifacts are complex technological products in a fiercely competitive field, and where the technology itself is still relatively young, not yet stable, and in a constant state of flux. Consequently, the historical development of the personal computer is (quite literally) littered with examples of products that have failed in the marketplace.

Occasionally, because of poor manufacture, misdirected marketing or promotion, and software not meeting consumer expectations, some of these products could be said to have "deserved" to fail. However, advances in production technologies and quality control in recent years have reduced manufacturing failures (notwithstanding some very well publicized events such as the poor battery life of earlier "iPods", the cracked screens of the first iPod "Nano", and exploding batteries in some Sony laptops[3]). But despite advances in manufacturing quality, there still are numerous examples of well-designed products (often winning design awards) which were heavily promoted and performed as promised, yet still failed in the marketplace. Obviously, merely solving pragmatic problems is no guarantee of success.

Product Failures and Theories of Technological Change

A great deal has been written from a number of different perspectives about why technological products fail in the marketplace. These include economic and business analyses, marketing critiques, design critiques, and sociological enquiries. This body of work is far too large to describe in any depth here, but concludes that there are multiple reasons in each case for product failure in the marketplace.

In *The Invisible Computer*, Donald A. Norman refers to the notion of "disruptive technologies"—technologies which have the ability to change people's lives and the entire course of the industry.[4] It is Norman's contention that this ability to disrupt inherently produces products to which there initially is a large amount of resistance. Norman also believes that company attitudes, including internal politics, the preference for an existing, tried and tested market over the need to develop a new one, and the need to produce profits quickly rather than investing in new products which may take a number of years to reach maturity means that new technologies are not taken seriously enough.[5]

Norman's argument is that, in order to be accepted in the marketplace, three factors have to be right: the technology, the marketing, and user experience. As an example, he quotes the well-known story of the Xerox "Star" computer designed at Xerox PARC in the early 1980s. The Star was a product well ahead of its time, having the first commercially available graphical user interface (GUI), and a design philosophy of user interaction that set the standard for an entire generation of PCs. Unfortunately, it was a consumer product before the consumer existed. The product had not gone through the process of exposure to the marketplace, which normally occurs when a new technology appears, is accepted by "early adopters" of technology, and then is refined for the mass market. The same thing happened a few years later when Apple introduced the "Lisa"—a larger, more expensive precursor to the Macintosh. In both cases, the technology wasn't quite ready. They both were painfully slow, had limited functionality because no one had written applications for them, and were extremely expensive. Therefore, there was no benefit for "early adopters" of technology in using these products, despite the novelty of the GUI, as the lack of application software meant that they didn't do anything other computers couldn't already do. The fate of the Star and the Lisa would have been shared by the

Macintosh, had it not been saved by the advent of a "killer application," making it indispensable to specific groups of users. This was desktop publishing software and the invention of the laser printer.[6] Norman's view is that the Star and the Lisa both had superb user experiences, but insufficient technology and marketing.[7] Not having all three was the reason for failure.

This underscores the fact that the reasons for failure in the marketplace of any product are more complex than at first might be imagined. We will explore this notion in other theories that address the same issues.

The theory of the social construction of technology takes the view that a complex range of factors are involved in the success of products, and that social factors have precedence in the process. As a counterpoint to a physical reality affecting outcomes (i.e., the technology itself), social constructionists see a web of relationships between people and between institutions that share beliefs and meanings as a collective product of a society, and that these relationships are the basis for subjective interpretations rather than physical or objective facts. The notion of the "truth" of a socially constructed interpretation or piece of knowledge is irrelevant—it remains merely an interpretation.[8] It is an interpretation, though, which has significant agency.

This is in direct contrast to the theory of technological determinism—the view that technology and technological change are independent factors, impacting on society from the outside of that society—and that technology changes as a matter of course, following its own path, and in doing so changes the society on which it impacts. (A good example is the notion of "Moore's Law," which states that the power of a microchip doubles every year as if it were a "natural" phenomenon). There is an element of truth contained within this, in that technological products do affect and can change our lives, but it is simplistic to imagine that other factors are not at play. Put more simply as "interpretive flexibility," the argument of social constructionism is that different groups of people (i.e., different relevant social groups of users) can have differing views and understandings of a technology and its characteristics, and so will have different views on whether or not a particular technology "works" for them. Thus, it is not enough for a manufacturer to speak of a product that "works": it may or may not work, depending on the perspective of the user.[9]

The above arguments on social constructionism perhaps have been most widely promoted by the sociologists Trevor Pinch and Wiebe Bijker,[10] who use examples such as the developmental history of the bicycle to show how a linear, technological history fails to show the reasons for the success or failure of different models, and that a more complex, relational social model is required.

A slightly different view is held by others, such as the historian of technology Thomas Hughes, who sees technological, social, economic, and political factors as parts of an interconnected "system." In this instance, different but interconnected elements of products, the institutions by or in which they are created, and the environments in which they operate or are consumed are seen as a complete, interdependent network. However, a technological system remains a socially constructed one: "Because they are invented and developed by system builders and their associates, the components of technological systems are socially constructed artifacts."[11] There still is a distinction here between the human and nonhuman components of a system: "Inventors, industrial scientists, engineers, managers, financiers, and workers are components of but not artefacts in the system."[12]

By comparison, Actor Network Theory, associated with the sociologists Bruno Latour, John Law, and Michael Callon, breaks down "the distinction between human actors and natural phenomena. Both are treated as elements in "actor networks"."[13] In Actor Network Theory (ANT), all parts of a system or network are equally empowered as actors having an influence on technology—there is no distinction between small or large elements, animate or inanimate, or real or virtual. Technology is conceived of as a growing system or network. The actors (and the relationships between the actors) "shape and support the technical object."[14] An important aspect of the theory is that:

> The actor network is reducible neither to an actor or a network alone nor to a network. Like networks it is composed of a series of heterogeneous elements, animate and inanimate, that have been linked to one another for a certain period of time. The actor network can thus be distinguished from the traditional actors of sociology, a category generally excluding any nonhuman component and whose internal structure should not, on the other hand, be confused with a network linking in some predictable fashion elements that are perfectly well defined and stable, for the entities it is composed of, whether natural or social, could at any moment redefine their identity and mutual relationships in some new way and bring new elements into the network. An actor network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of.[15]

In other words, the role of any particular actor in a network is not fixed, but indeterminate and changeable, being at times dominant or, at other times, insignificant in its agency.

These theories are useful in the analysis of the introduction of complex new technologies, and the tablet computer is an excellent case in point, having a particular level of complexity. As a product, the tablet computer brought together a number of discrete technological advances, each having its own history of development: pen interfaces, handwriting recognition, and touchscreen technology.

The History of Pen Computing: Early Developments in Pen Interfaces

Figure 1. The SAGE Air Defense System of 1961 used a light pen on a radar display screen to register the position of aircraft and missiles. Image courtesy of Computer History Museum.

The principle of using a pen device rather than a keyboard to interact with a computer may appear to be a relatively recent development. As a matter of fact, pens were one of the earliest devices to be used in this way, many years before the invention of the computer mouse. Light pens (or light guns) were used in the experimental "Whirlwind" computer built at MIT between 1946 and 1949, when it became operational, for analyzing aircraft stability for the U.S. Navy. In this system, a light pen pointed at a symbol of an aircraft on a display screen produced identifying text about that aircraft. This machine formed the basis of the later TX-0 machine started in 1953 and the SAGE (Semi-Automatic Ground Environment) air defense system (Figure 1) started in 1958; both developed at MIT's Lincoln Laboratories. In the SAGE system, the light gun was used to convert the "blip" on a cathode ray tube (CRT) showing the location of an aircraft or missile into X-Y coordinates. When a blip appeared, a "light gun" was pointed at that point on the screen, and an internal photocell registered the blip. Since the time taken for the screen display to be refreshed was a known quantity, the time difference between the start of the screen refresh and the light gun registering a blip could be translated into an accurate X-Y position, and a trajectory then could be predicted.

The TX-0 machine was the first in a series of experimental digital computers built at MIT, which included the 1958 TX-2—notably used by Ivan Sutherland in 1963 to develop "Sketchpad"—the first computer drawing software, in which a light pen was used as the principal input/output device, initiating the "direct manipulation" of computer data (Figure 2). The abstract for Ivan Sutherland's Ph.D. thesis describes the use of a pen to interact with a computer:

> The Sketchpad system uses drawing as a novel communication medium for a computer. The system contains input, output, and computation programs which enable it to interpret information drawn directly on a computer display. … A Sketchpad user sketches directly on a computer display with a light pen. The light pen is used both to position parts of the drawing on the display and to point to them to change them. A set of push buttons control the changes to be made such as erase, or move. Except for legends, no written language is used.[16]

Figure 2. Ivan Sutherland's 1963 "Sketchpad" software was the first computer drawing package, and used a light pen as the principal input/output device. Courtesy of Ivan Sutherland.

The Development of Handwriting Recognition

Figure 3. A RAND Tablet being used to interpret handwritten commands. Image courtesy of Computer History Museum.

Concurrent with Sutherland's development of the technology needed to draw items directly on a computer screen, others had been working on methods to enable computer users to directly write commands that could be interpreted by the computer as instructions. An early example of a device which could read stylus movements accurately enough to interpret handwriting was the RAND Tablet (Figure 3). After years of development, a 1964 memorandum booklet titled "The RAND Tablet: A Man-Machine

Graphical Communication Device" prepared by the RAND Corporation for the Advanced Research Projects Agency (ARPA) stated:

> Early in the development of man-machine studies at RAND, it was felt that exploration of man's existent dexterity with a free, pen-like instrument on a horizontal surface, like a pad of paper, would be fruitful. The concept of generating hand-directed, two-dimensional information on a surface not coincident with the display device (versus a "light pen") is not new and has been examined by others in the field. It is felt, however, that the stylus-tablet device developed at RAND is a highly practical instrument, allowing further investigation of new freedoms of expression in direct communications with computers.[17]

An example of an actual RAND Tablet in the archives of the Computer History Museum in Mountain View, California is accompanied by an entry which reads:

> The Rand Corporation produced one of the first devices permitting the input of freehand drawings. Also called the Grafacon, the original Rand Tablet cost $18,000. The attached stylus sensed electrical pulses relayed through a fine grid of conductors housed beneath the drawing surface, fixing its position to within one one-hundredth of an inch. Many experimental systems were developed to recognize handwritten letters or gestures drawn on the tablet, such as Tom Ellis' GRAphic Input Language (GRAIL) method of programming by drawing flowcharts.[18]

Tom Ellis was the author of a number of RAND reports describing the development, beginning with Ivan Sutherland's "Sketchpad" research, of a system in which an operator could write instructional commands for a computer directly on the RAND Tablet:

> One fundamental facility of the man-computer interface is automatic recognition of appropriate symbols. The GRAIL system allows the man to print text and draw flowchart symbols naturally; the system recognizes them accurately in real-time. The recognizable symbol set includes the upper-case English alphabet, the numerals, seventeen special symbols, a scrubbing motion [a hand-drawn squiggle] used as an erasure and six flowchart symbols—circle, rectangle, triangle, trapezoid, ellipse, and lozenge.[19]

Ellis's GRAIL system was the beginning of handwriting recognition technology. Not only that, but since the system also contained text-editing facilities such as "character placement and replacement, character-string insertions, line insertions, character and character-string deletions, and line deletions" it formed the basis of word processing technology without the use of a keyboard.[20]

Touchscreen Technology

Touchscreen technology was first developed by Dr. Samuel Hurst while on leave from the Oak Ridge National Laboratory to teach at the University of Kentucky.[21] His initial idea came in 1969, when he was looking for a way to digitize large sets of strip charts. Hurst and a graduate student (Jim Parks) made a two-dimensional digitizer by using two sheets of electrically conductive paper with a sheet of ordinary paper between as an insulator to create a sensor. By connecting two voltmeters—one to each conductor—a needle prick through the strip chart and the sensor supplied an x-coordinate to one voltmeter and, independently, a y-coordinate to the other. This initial invention became the "Elograph," patented in 1972 (Figures 4 and 5). Returning to Oak Ridge and founding the company "Elographics" in 1971, Hurst went on to lead the development of transparent touchscreens, with the first produced in 1978, and five-wire resistive technology, the most commonly used form of touchscreen technology.[22]

> The first instruments were intended for the scientific market, and it was not a significant product because the "digital online" era had arrived and there was not a need for strip charts. It is amazing, in retrospect, that we survived long enough to take a poor product for the wrong market to an excellent product for a good (consumer) market. In a discussion with our patent agent, Martin Skinner, the idea emerged of a transparent touch screen for use with computers, and we were stimulated by Siemens when they paid some of the development costs for early units, but we did not have the insight to think that the touchscreen market would become so important.[23]

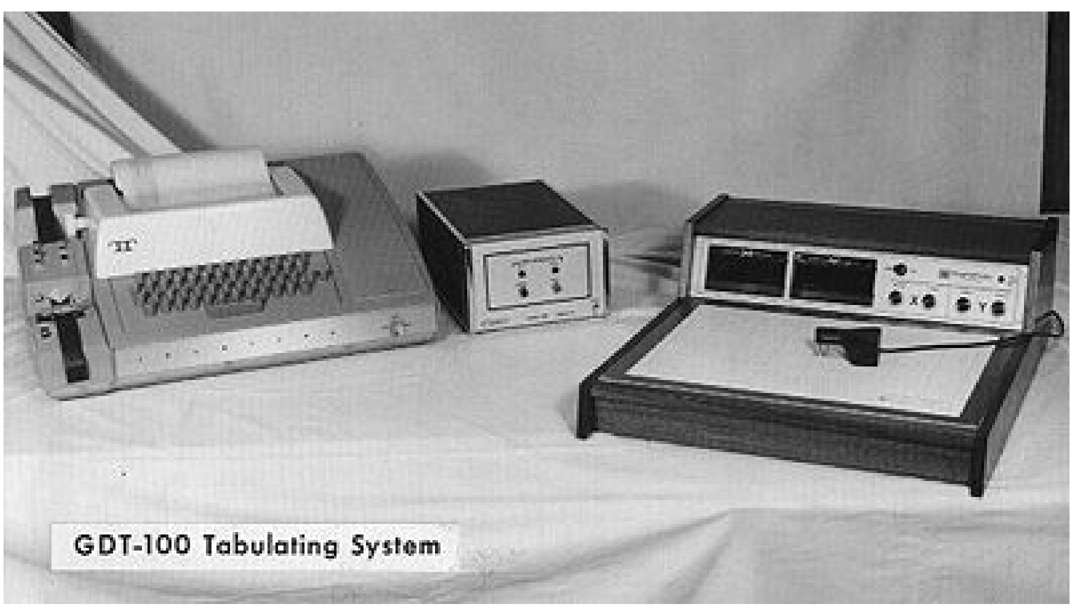


Figure 4. The "Elograph" electronic graphing device, 1971.
Courtesy of Tyco Electronics, Elo TouchSystems.

Figure 5. A later version of the "Elograph" being used to analyze strip chart data, circa 1973. Courtesy of Tyco Electronics, Elo TouchSystems.

Although they had some way to go until they were suitable for use in consumer products, these cutting-edge advances in human/computer interaction meant that, by the end of the 1970s, all of the relevant technologies were in place and thoroughly documented to enable the development of the "tablet computer." It actually took almost a decade until the appearance of the first tablet computer, although this requires some clarification of the definition of the product, as well as the acceptance of various streams of parallel development.

Tablet Computers

Tablet computers as revolutionary new products experienced a rapid rise in popularity and were the center of industry attention for a few years in the early 1990s. Even though their popularity then underwent a massive decline, they did not disappear altogether, and still are manufactured today in limited quantities. Over the years, they have appeared in a number of forms but can grouped into some general categories.

Tablet computers that essentially are a large touchscreen covering a processor unit are referred to as "slates." The input is purely through the screen via a stylus or finger, although external keyboards may be attached. The onboard processor allows a full range of computing capabilities. Where portability is a key concern, wireless versions with no onboard processors (called "thin-client slates") also are available. These utilize applications stored on remote servers. The lack of keyboard input is associated with the main use of these tablets in specialized, "vertical" markets such as the healthcare industry or in sales and insurance field work, where the tendency is for standardized forms to be filled in rather than entering large amounts of text.

"Convertibles" attempt to achieve the best features of tablet computers and laptop computers. The large touchscreens are movable, so that they can either act as a normal laptop with the keyboard in front of the screen, or be arranged so that the screen covers the keyboard completely, only allowing pen input. These have been more successful than slates, yet they remain a compromised product. The keyboard means that they inevitably are thicker and heavier than slates, and the touchscreen capability means they are more expensive than normal laptops. There also is a more expensive subset of convertibles known as "hybrids," which have keyboards that can be completely detached, restoring the thin cross-section of slates. In this instance, the "tablet" part of the computer is the screen and processing unit, and the detachable keyboard can be seen as a peripheral component. The distinction might be an important one because, to be termed a true "tablet computer," the screen input (the "tablet") and processing unit (the computer), it could be argued, have to be contained within the same product rather than being a portable computer which, through an additional component, has screen-based input capability.

So for clarification, the defining characteristics of the tablet PC are taken here as being a self-contained personal computer having a large, touch-sensitive screen and handwriting recognition capabilities to allow input by a stylus. With respect to size, tablet PCs have a screen size large enough to allow significant pen input (usually approaching that of a piece of A4 paper), and require both hands to operate if not rested on a stable surface. Although tablets may have the same organizational capabilities of "personal digital assistants" (PDAs), they have computing capabilities similar to desktop computers. The use of organizing software such as electronic calendars and alarms is not their primary function.

The quote cited earlier in this article—that "Nearly every major maker of computers has some type of pen-based machine in the works."—points to a serious problem for historians of the technology of this period, and requires the inclusion of a caveat. Researching the exact chronology of product releases in the field of portable computing from the late 1970s to early 1990s is fraught with difficulties, and not just because of the sheer amount of competing products that were available. Many products, especially those from smaller start-up companies (which in many cases essentially were one-man bands), were not promoted as widely as those from major manufacturers, and information concerning them is hard to find and even harder to accurately verify. In addition, major manufacturers in desperate competition at a time of rapid technological progress raced to launch short-lived products to such an extent that many of them were outdated as soon as they hit the market—and almost immediately replaced by updated versions. Moreover, in an attempt to gain a head start on competitors, products were routinely announced and promoted sometimes up to a year before their launch, by which time many already had been dropped in favor of a more advanced model, or failed to materialize because of technical, financial, or other problems. These products are known in the industry as "vaporware"—intended products that may have been prototyped but never actually were sold. There also is the issue of parallel development to take into account. Many of the features of these products were first developed in isolation at research institutes and universities, and widely disseminated as actual or theoretical possibilities that then were simultaneously adopted by different companies in their product development. So the issue who was "first" is a complicated one. Finally, many of the accounts of this period, as in this article, include oral histories from the individuals involved at the time. These individuals more often than not were simultaneously involved in numerous projects and, because of the fluidity of the market, often changed employers or started new companies without keeping detailed records. (They are, after all, largely engineers and entrepreneurs—not academics and historians.) It is quite common to discuss the same issues of product chronology and attribution with different people who were involved with the same project, at the same time, and obtain completely different versions of events. As Friedrich von Hayek said:

> The knowledge of the circumstances of which we must make use never exists in concentrated or integrated form, but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess.[24]

For all the above reasons, it is practically impossible to be absolutely certain of all details, so the accuracy of dates and the completeness of chronologies of these products often are questionable. Therefore, the following chronology includes many of the key products, but certainly not all that appeared, especially if there was little difference between competing products launched simultaneously.

Early Products

Historically, the conceptual roots of the portable tablet computer as a discrete product are the same as those for the laptop computer, both arising from original interactive computer concepts proposed by Alan Kay as part of his doctoral thesis,[25] and later developed by the Learning Research Group as the "Dynabook" at the Xerox Palo Alto Research Center (PARC) in the early 1970s (Figure 6).

In 1968, while studying at Utah, Kay conceptualized a computer which brought together his work on interactive computing, the emerging technologies of flat-screen displays and handwriting recognition, and programming developments aimed at children. Kay explains:

> Ed Cheadle and I had been working on a desktop personal computer (the FLEX machine) since early 1967, and in the summer of 1968 I gave a presentation of this machine and software at the first ARPA grad students conference. One of the highlights was a visit to Don Bitzer's lab where the first plasma panel flat screen display was being invented (with Owens

Illinois). We saw a one-inch-square display that could light up a few pixels. Flat-screen displays were not a new idea either in fiction, semi-fiction (like *Popular Science* mag), and in the real technological world. Still, it was galvanizing to actually see the start of one!

We knew the transistor count in the FLEX machine and some of the grad students and I sat around one afternoon estimating when those transistors could be put on the back of a big enough plasma panel. (Moore had announced the first version of his law in 1965.) Our estimate was about ten years. … At the same time, Peter Brodie at Westinghouse was also working on a flat panel using liquid crystals.[26]

Later the same summer, Kay visited researchers working on computers for nonprofessional users, including RAND, where Tom Ellis had developed his GRAIL system, and Seymour Papert (a pioneer in artificial intelligence) at a school in Lexington, where he was using his LOGO programming language developed for children.

This was a transformative experience and on the plane back to Utah I started to think about making a computer for children that could combine some of the LOGO ideas, those of the FLEX machine, and the GRAIL tablet-based system. The ten-years-out problem became a non-problem because I realized there was at least ten years worth of user interface, software, and curriculum development that would have to be done.

When I got to Utah I made a cardboard model of what such a machine would be like. (It was made hollow so we could load it up with lead pellets to see how heavy it could be made before it became a pain, etc.) It had slots on the side for the removable memory and the stylus.[27]

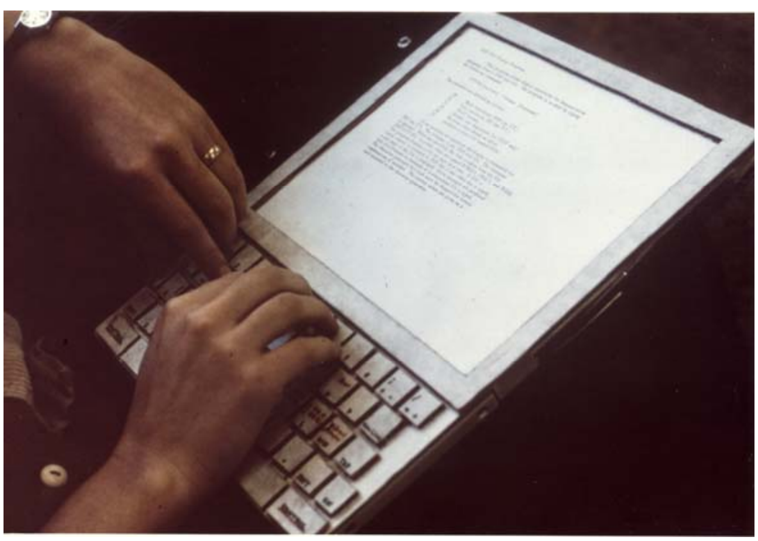


Figure 6. Alan Kay's "Dynabook" concept model, 1968.
Courtesy of Palo Alto Research Center, Inc.

This concept became one of the most radical product proposals of the time. In a paper produced by the Learning Research Group, Alan Kay and Adele Goldberg promoted the concept of the Dynabook as "A Dynamic Medium for Creative Thought":

> Imagine having your own self-contained knowledge manipulator in a portable package the size and shape of an ordinary notebook. Suppose it had enough power to outrace your senses of sight and hearing, enough capacity to store for later retrieval thousands of page-equivalents of reference materials, poems, letters, recipes, records, drawings, animations, musical scores, waveforms, dynamic simulations, and anything else you would like to remember and change. We envision a device as small and portable as possible which could both take in and give out information in quantities approaching that of human sensory systems.[28]

Quite clearly, such a computer was not technically possible at the time (Kay still thinks this is true[29]), and yet his vision of the Dynabook was so powerful that it drove the development of computing technology inexorably towards truly portable computing. Even the name has been inspirational and much emulated. A company called "Dynabook Technologies" was set up in 1987 to develop such a computer, and gained $37 million in financial backing yet never managed to overcome technical problems and went bankrupt in 1990,[30] and Toshiba appropriated the name for its early pen tablets, marketed as "Dynapads."[31]

A number of products have laid claim to being or have been hailed as "the first tablet computer." However, with respect to the definition laid out above, many of these have one or another characteristic missing. Some products had character recognition rather than full handwriting recognition; while others were not self-contained products, but had to be connected either directly by cable or by radio signals to remote processing units or servers. This is an important distinction in design terms because in a unit where the touchscreen is a separate component connected by a cable, it can act as a peripheral input device rather than an intrinsic part of the product form. These factors are important in charting the development of tablet computers as a discrete class of products.

The first to bring together the three technologies of pen interfaces, handwriting recognition, and touchscreens into a consumer product was Dr. Ralph Sklarew. His product, the "Write-Top" (Figure 7), built in 1987 by Linus Technologies, was "arguably the first portable computer with handwriting recognition."[32] It certainly had all the capabilities of a tablet computer, although it was not termed as such at the time. However, even though it was prototyped as a self-contained unit, the production version (designed by Peter H. Muller of Inter4m) "was a two-part design tethered via a cable."[33] It came close to being a self-contained unit since the touchscreen element could be "latched" onto the base unit to create a "grey sandwich." [34]

Sklarew founded Linus Technologies in 1985 with $11 million in venture capital. They demonstrated their first version to a number of interested parties, including GRiD Systems (see below). [35] He and his partners received patents for a "Handwritten keyboardless entry computer system," and sold approximately 1,500 units before closing in 1990.[36]

Figure 7. Linus Technologies Write-Top, 1987.
Courtesy of Inter4m.

Self-contained Tablet Computers

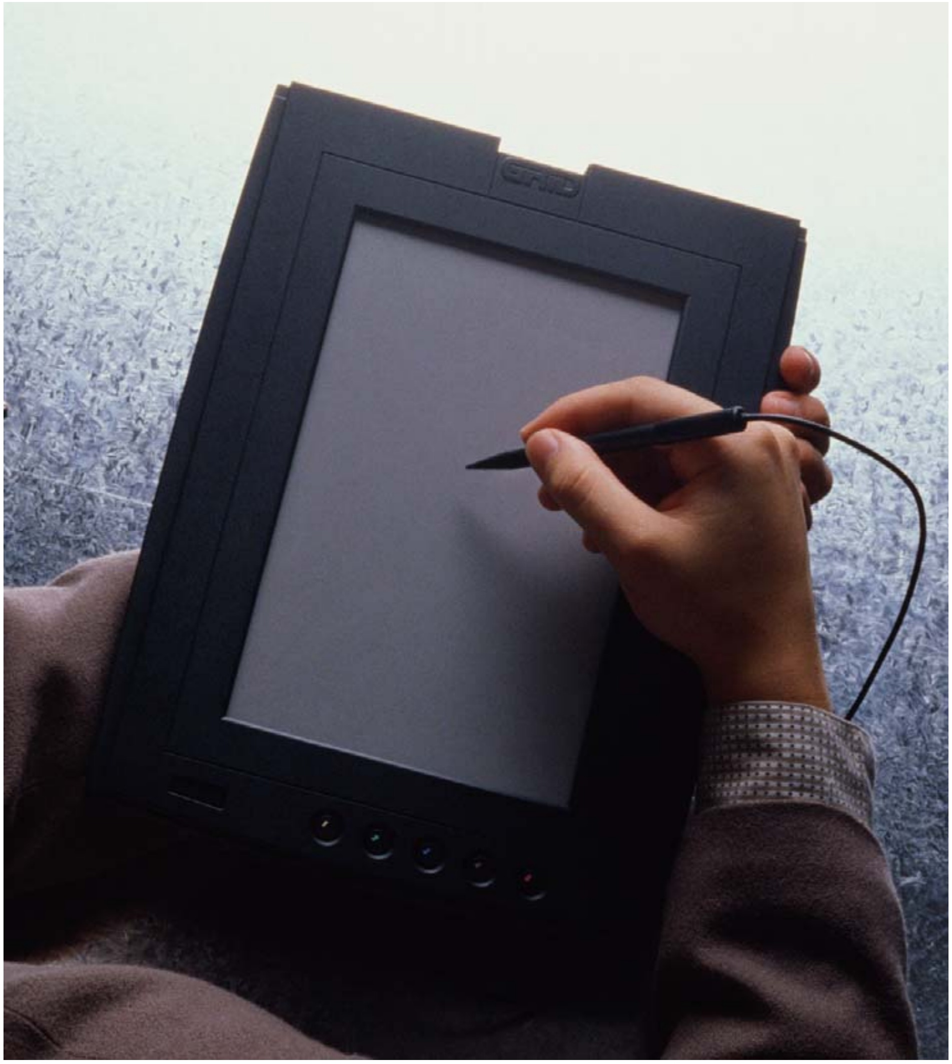


Figure 8. The GRiDPad, 1989.

Courtesy of IDEO.

The first successful attempt at a self-contained tablet computer appeared in the form of the GRiDPad from GRiD Systems, conceived by Jeff Hawkins (Figure 8). GRiD Systems was the company that produced the first true laptop computer, the GRiD Compass, launched in 1982.[37] Hawkins states that he came up with the idea of a tablet computer with a stylus interface in 1987, while studying neuroscience at UC Berkeley during a two-year leave of absence from GRiD. “During a neural networking conference, a company called ‘Nestor’[38] demonstrated their handwriting recognition software which was based on pattern recognition algorithms. I realized that this could best be put to use in a mobile computer.”[39] In the fall of 1987, Hawkins went to an interview with GO Corporation, a promising start-up company, to see if this was the best place to take the idea forward. GO saw itself as a pen-computing business, which worried Hawkins: "There's no such thing as a 'pen-computing' business—you just need a PC with an additional stylus. You don't have 'mouse computing' as a core business. The point is mobile computing, not pen computing."[40] Hawkins believed that GO would fail. Instead, he took the idea with him to GRiD in 1988, and managed the GRiDPad project there; employing IDEO to do the industrial design.[41] The GRiDPad was deliberately targeted at specialist, vertical markets such as the medical profession because this is where Hawkins saw market opportunities. "I never saw pen computers as a replacement for a full PC as GO did. GO was really pushing pens—they lost all sense of reality. They never shipped, whereas the GRiDPad turned over in excess of $30 million in its best year."[42]

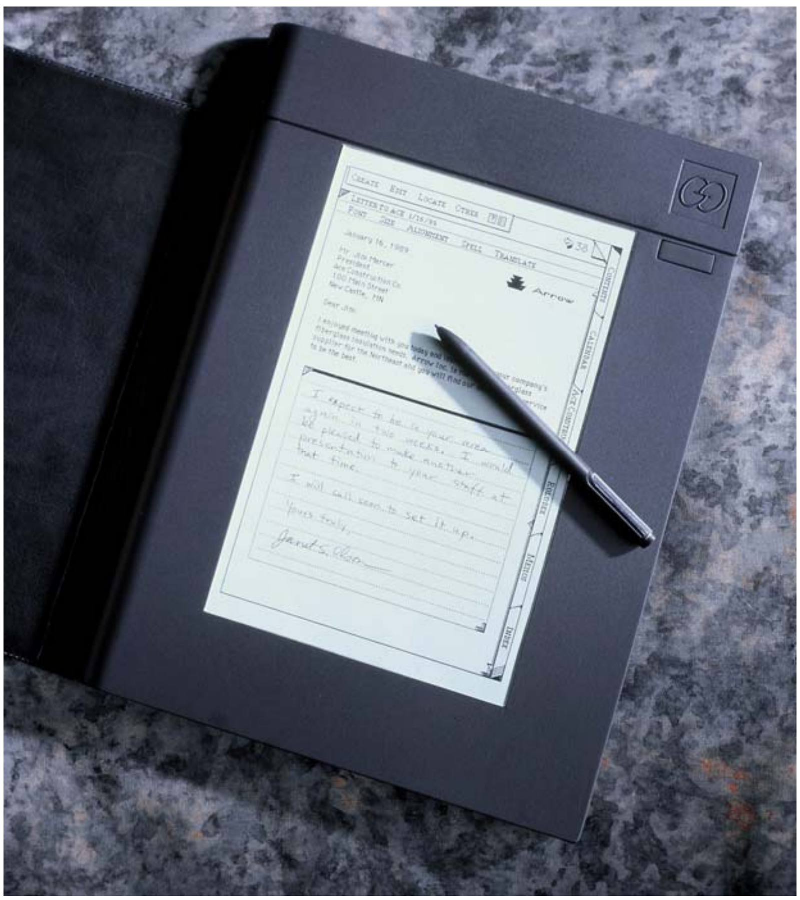


Figure 9. The prototype GO computer, 1991.
Photo by Rick English, courtesy of IDEO.

The GO computer is a significant piece of "vaporware" if only for the sheer size of the endeavor and amount of publicity that accompanied it. The idea for the product arose during a business flight shared by Mitchell Kapor (founder of Lotus Development Corporation) and Jerry Kaplan, when they had the equivalent of a "religious epiphany"[43] that a portable pen-driven computer could solve all the traveling executive's information- handling problems. Kaplan went on to found GO Corporation in August 1987.

The product was developed to the stage of a working but deskbound prototype of connected components by 1988, yet despite having received in total more than $75 million in financial backing and the enthusiastic support of IBM and AT&T, it suffered all kinds of engineering setbacks. A working preproduction version was not assembled until June 1989 [44] (Figure 9). The final product, with industrial design work by Paul Bradley of Matrix Design and mechanical engineering by David Kelly Design (both later to become IDEO) was done in 1991, by which time the company had changed direction to concentrate on their handwriting recognition interface software called "PenPoint." This put them in direct competition with Microsoft, and when Microsoft launched "Windows for Pen Computing," a huge public relations battle ensued.[45] Not surprisingly, GO lost. Kaplan went on to write an autobiography in which he said: "The real question is not why the project died, but why it survived as long as it did."[46] GO was taken over by AT&T in 1994, and eventually shut down.

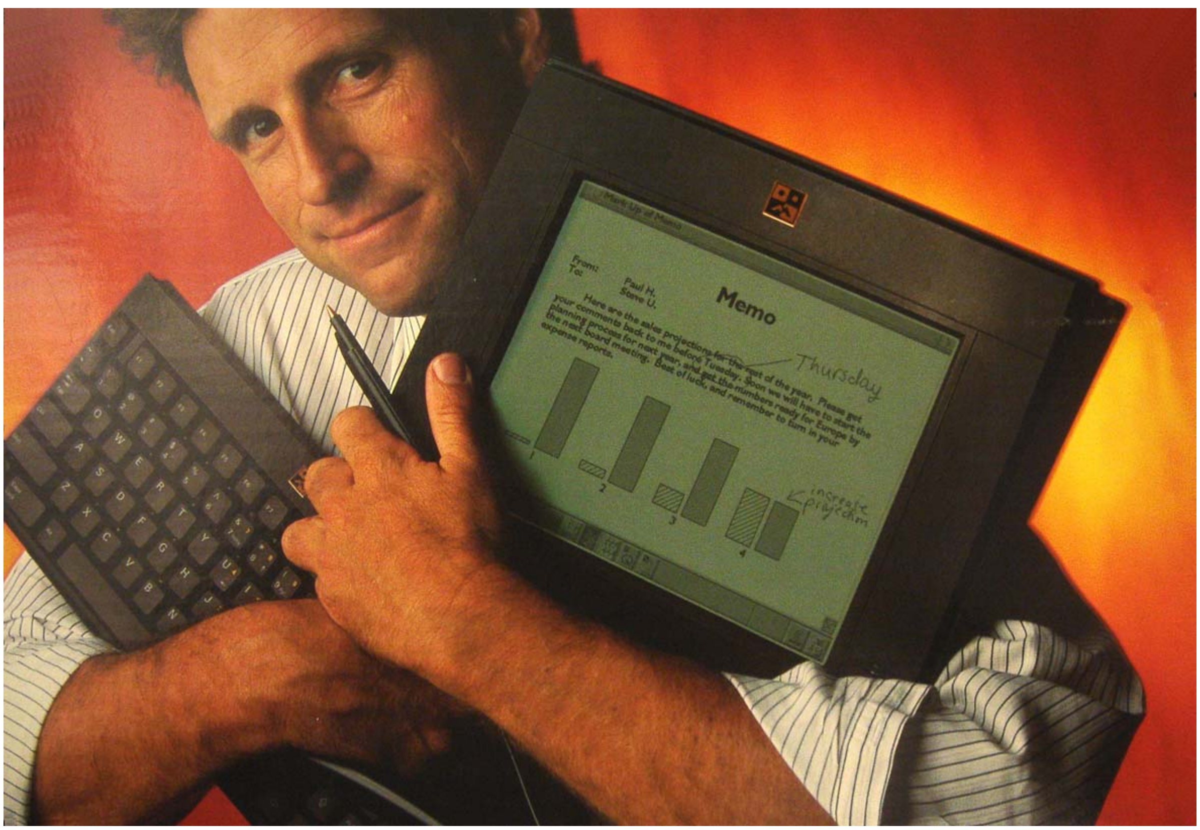


Figure 10. The 1991 Momenta Pentop computer (a contraction of "pen computer" and "desktop") attempted to move the target audience of tablet computers to mobile executives.

GO wasn't the only company that thought the ideal pen-computing operating system was yet to be created. In 1991, the computer magazine *BYTE* ran a review article on yet another new product (Figure 10) aiming to set the standard:

> Many players in the nascent pen-based computing market see the transition from conventional notebooks to pen systems as a chance to bypass the DOS standard and start afresh with more modern technology. Although the era of pen-based systems has barely begun, there are already three competing operating environments. This mad scramble to set new software to norms for pen computers may be a rude shock to users comfortable with the uniformity of DOS.
>
> In the midst of all this uncertainty, a fourth environment has arrived from start-up Momenta. One of the most widely anticipated entrants to the market, Momenta's pen-based laptop sports a new GUI that represents yet another effort to define the look and feel of pen computing.
>
> The Momenta computer is different in other ways, too. The company is aiming it at mobile executives, not at the blue-collar and field workers who have until now been the target audience for pen-based PCs. Perhaps most surprising, Momenta is playing down the role of handwriting recognition in the system, saying that the technology is too immature to substitute for a keyboard in many cases. Instead, Momenta sees the pen, in conjunction with its new GUI, as a more intuitive substitute for a mouse.[47]

The competition was indeed tough. Although it was in many respects a radical product and had many innovative features leading to its appearance on the covers of twenty magazines, Momenta International ceased trading in 1992, less than a year after the Momenta Pentop's launch. In an article reflecting on his career, the company's founder, Kamran Elahian, said "We set out to create a computer that would be incredibly easy to use. I was absolutely convinced that we would revolutionize the PC industry." The same article concluded: "There was just one problem. No one bothered to build a market for pen-based computers. In three years, Momenta burned through $40 million. … For a while at least, Elahian held the Valley's title for burning the most capital in the shortest period of time. Momenta was a monumental flop."[48]

A spinoff from GO, called EO Inc. (also sold to AT&T), had some success with two versions of products called "Personal Communicators" in 1993. These units, with industrial design work by frog design, had a built-in modem to provide phone, fax, and electronic mail capabilities. The smaller-screened version, the EO 440 (Figure 11), sold around 10,000 units, but the company collapsed shortly after launching the larger-screened EO 880.[49] Before it collapsed, the company was working on various future possibilities, including a tablet computer with speech recognition.

Figure 11. The EO 440 Personal Communicator, 1993.

Figure 12. The GRiD Convertible, 1993. Courtesy of IDEO.

After his success with the GRiDPad, Jeff Hawkins tried to develop a product "that offered the best of both the laptop and tablet."[50] The result, with industrial design work by IDEO, was the GRiD Convertible, launched in 1993 (Figure 12). This used a clever mechanism which allowed the screen to slide and pivot to cover the keyboard and convert the laptop into a tablet. "Bill Gates loved it. It failed in the market place. I learned at that time that people didn't really want to write on their display."[51] Hawkins realized that "people wouldn't pay for or compromise the quality of a laptop for a pen interface."[52]

Divergence

Around 1993, the closely related products of tablet computers and Personal Digital Assistants began to move apart. Apple ran a whole series of projects during the late 1980s and early 1990s to develop tablet computers, most of which were cancelled.[53] These included a notebook-sized, slate-type computer concept codenamed "Figaro" between 1987 and 1991 (which evolved into the Newton), the PenMac, the Macintosh Folio, and SketchPad, all in 1992; and the WorkCase and Newton MessageSlate in 1993. Apple felt that a tablet computer might compete with and divert sales from the Macintosh, so the project was rethought as a PDA.[54]

Figure 13. The Apple Newton MessagePad 2000, launched in 1997.
Courtesy Apple Inc.

The Apple Newton MessagePad eventually was unveiled in May 1992 at the Consumer Electronics Show with a large-scale publicity drive claiming to have produced the "future of computing." It was released the following year, unfortunately to weak reviews. After a number of redesigns culminating in the MessagePad 2000 (Figure 13), the technology was placed into the Apple eMate laptop computer in 1997, and then discontinued altogether in 1998. Although it was produced for six years and won numerous design awards, the Newton was never the success Apple hoped for, and the goal of reinventing personal computing was never achieved. Although it was marketed as a PDA rather than a tablet computer, the unit itself was too large to fit into any pocket, was expensive (the final models costing $1,000), and initially suffered from poor handwriting recognition software, which many regard as the main reason for its failure.[55]

The End of the Line?

The Apple Newton would seem to mark the point at which the tablet computer developed into the Personal Digital Assistant. Some manufacturers did continue to produce true tablet computers, but with little success. The original IBM "ThinkPad" in 1993 was a tablet computer, and Sony produced a Pen Tablet PC in 2001, but it was discontinued due to low sales only a year later.[56] Despite this, a number of manufacturers including IBM and HP still produce a variety of models,[57] and Bill Gates openly defends them, predicting they soon will come into their own as products, and ensuring that the latest version of Windows, "Vista," supports pen computing.

The story of the tablet computer to date covers some fifty years from its conception, with real products being produced for twenty years. The sheer amount of money and effort involved in trying to bring the tablet computer to the marketplace is staggering. As a product group, they have swallowed billions of dollars in investment capital and thousand upon thousands of man-hours in R&D, design, and promotion. Sales remain pitifully low, and yet manufacturers and a small number of users still cling to the concept, convinced of its potential. At Microsoft, the tablet PC is most prominently promoted by one man, Bert Keely, who has the title "Architect, Mobile PCs & Tablet Technology." Keely constantly attends research seminars and computer shows, and appears in the news media demonstrating the advantages of pen computing. He admits that tablet technology has a number of flaws and a long way to go,[58] but remains convinced that the future of pen computing will be "astounding."[59]

Conclusions

So why has the tablet computer not been a successful product? In theory, it had it all—a computer that you could use as if it was a pad of paper. As proposed by the theories discussed earlier, there always will be more than one reason for any product failure. Yet many of the factors mentioned in the case study as to why certain individual tablet computers had failed are issues which subsequently have been resolved. Clearly, the technical problems which plagued early products such as slow processor speeds and software reliability have been overcome. The compatibility of software means that applications for such computers are far greater in number and, while still not perfect, issues of functionality such as the reliability and accuracy of handwriting recognition software have been greatly improved. The manufacturers currently involved are not start-up enterprises lacking in financial support or backing; and the products are now part of large ranges of computing equipment from well-known and respected companies, and have received marketing support of a suitably high level. Yet despite the sales predictions and assurances from Bill Gates, and the enthusiastic promotion of people such as Bill Keely, tablet computers still account for less than five percent of the personal computer market.[60]

Social constructionism suggests that a complex range of social factors are the most significant elements to take into account in the success or failure of technological products. Indeed, it would appear from the technical factors that have been resolved that the only possible barriers left to the acceptance of tablet computers are social ones. The concept of "interpretive flexibility" proposes that different groups of people have different views on the extent to which a particular technology "works" for them. However "natural" a form of communication writing may appear to be, perhaps, as Jeff Hawkins believes, people don't want to write on computer screens, and a pen on a large display is not a good user interface for a computer.[61] The feel of pen on paper is a difficult one to surpass.

> Some of the technology still isn't solved. Paper still has qualities screens don't have. Is the stylus active or passive? If it is active, then they are a problem. The screen resolution still isn't good enough, and there is still a parallax issue. Handwriting recognition still isn't good enough: text editing is still complex to use.[62]

According to Stuart Card, a research scientist at Palo Alto Research Center and an expert in human/computer interaction, the problem of pen computing is self-evident, and revolves around the difficulty of overcoming the physical keyboard:

> The reason pen computing doesn't work well is that the software it works with was designed to be used with a mouse and keyboard—the pen input was added later. PenPoint [the operating system developed by GO] was better as it was gesture-based. This means going back to recall rather than recognition [having to learn and remember how to execute a command rather than intuitively interpreting an icon] but that's okay as long as there are a limited number of gestures, say around five to ten, and the gestures are mimetic rather than symbolic. As an example, it's difficult to spreadsheet with a mouse. It could be easier with a pen if the design of the software works. Currently it is just as difficult to use a pen, or more so as you also have to include handwriting recognition errors. Another is writing URLs [Website addresses]. Handwriting recognition software has algorithms to ignore "nonsense" words, but URLs are random series of

letters and no spaces, so that doesn't work. The pen clearly has an advantage if the input is a drawing, but how many people use that? And virtual keyboards are useless for typing—only one key at a time. You will always need a keyboard for bulk text input.[63]

Another factor could involve the complexity of a personal computer, which is clearly accepted if not desired in a desktop PC. This may not be acceptable in such a portable format as the tablet PC. Slow start-up times, large size and weight, and the compromises inevitable in multifunctional products such as a full computer do not cross over well to situations in which the computer is held and carried around by the user, and constantly turned on and off.

It is possible that the semantic associations of tablet computers and the body language employed when using them is an issue. In use, tablets tend to be carried in the cradle of one arm and written upon with the free hand in much the same manner people write on clipboards (indeed, some tablets such as those by "Aqcess" have been designed with detailing to specifically connote physical clipboards). The success of tablet computers in vertical markets suggests that this was not an issue for users carrying out specialized field work with "rugged" products, where the clipboard was and is a commonly used and accepted piece of equipment, but it may possibly have been an issue when attempts were made by companies such as Momenta to overtly move tablets into the executive market.[64]

Factors such as these, which may appear to be small problems, or even insignificant by some, are held by Actor Network Theory to have the potential to be highly significant in the successful take-up of new products. The interesting aspect of ANT, though, is the understanding that the significance of these factors is not seen as fixed, but fluid. At any moment, any factor can move from being a significant actor to an insignificant one, or vice versa, even as the result of forces outside of the network itself. With this level of uncertainty in mind, it must be recognized that the current public attitude toward tablet computers and to pen computing itself theoretically could change at any moment, however unlikely that may seem.[65]

While the tablet computer has failed to capture the public's imagination, the PDA has succeeded—but that's another story. The reasons for the failure of tablet computers, as for any complex technological product, are not straightforward. All or any one of the reasons above; or a combination of small details which together constitute the nature of the experience of using a tablet computer, could be equally responsible. As social construction theory would have it, the acid test of computing equipment is not the technology, but user acceptance. And as Actor Network Theory shows, however small or inconsequential an agent may appear to be in the overall scheme of things, it still can have the ability to make or break any product.

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[34] O. Linderholm, "Linus Write-Top," *Personal Computing World* (October 1988): 131.
[35] R. Sklarew, July 5, 2007 e-mail communication to the author.
[36] Linus Technologies' patents were later acquired by GRiD Systems after they were sold to Tandy. (http://blinkenlights.com/classiccmp/linus/) (Accessed online July 3, 2007).
[37] See P. Atkinson, "Man in a Briefcase: The Social Construction of the Laptop Computer and the Emergence of a Type Form," *Journal of Design History*18:2 (2005): 191–205.
[38] Nestor, founded in 1975 by Nobel Prize winner Dr. Charles Elbaum, built software using neural network technology, which emulates human learning and classification processes.
[39] Interview with Jeff Hawkins at the offices of Numenta, Palo Alto, CA, May 10, 2007.
[40] Ibid.
[41] B. Moggridge, *Designing Interactions* (Cambridge, MA: MIT Press, 2006), 184–185.
[42] Interview with Jeff Hawkins at the offices of Numenta, Palo Alto, CA, May 10, 2007.
[43] Kaplan, *Startup: A Silicon Valley Adventure* (New York: Penguin Books, 1994), 15.

[44] Ibid., 111.
[45] J. Hawkins, January 24, 2007 e-mail communication to the author.
[46] J. Kaplan, cited in D. Kaplan, *The Silicon Boys and Their Valley of Dreams* (London: Harper Collins, 1999), 199.
[47] A. Reinhardt, "Momenta Points to the Future," *BYTE* (November 1991, News column).
[48] B. Breen, "Fresh Start 2002: Starting Over … and Over …," *Fast Company* 54 (December 2001): 77.
[49] C. Baranski, June 22, 2007 e-mail communication to the author.
[50] B. Moggridge, *Designing Interactions*, 189.
[51] Jeff Hawkins, January 24, 2007 e-mail communication to the author.
[52] Interview with Jeff Hawkins at the offices of Numenta, Palo Alto, CA, May 10, 2007.
[53] P. Kunkel, *Apple Design: The Work of the Apple Industrial Design Group* (New York: Graphis, 1997).
[54] The term "Personal Digital Assistant" was coined by John Sculley, CEO of Apple at the Consumer Electronics Show in Las Vegas, Nevada, January 1993. (http://encyclopedia.thefreedictionary.com/) (Accessed online July 4, 2007).
[55] B. Moggridge, *Designing Interactions*, 198.
[56] M. Kanellos, "Sony Phasing Out Pen-tablet PCs" (http://news.com.com/2100-1040-816422.html) (Accessed online January 31, 2007).
[57] *Tablet PC Hardware Models* (www.microsoft.com/windowsxp/tabletpc/evaluation/products.mspx) (Accessed online January 31, 2007).
[58] B. Keely, "Nomadic Computing with PCs" in *Microsoft Research Faculty Summit 2005* (http://research.microsoft.com/workshops/FS2005/) (Accessed online January 18, 2007).
[59] B. Moggridge, *Designing Interactions*, 198.
[60] Gartenberg's optimistic view of the future of tablets isn't shared by all analysts. "Handwriting recognition-based machines will comprise just one percent of the global notebook market in 2005, rising to a mere 2.4 percent by 2009," says Andy Brown, IDC's programming manager for European mobile computers and devices. (C. Everett, "Tablet PCs: Is the Writing on the Wall?," ZDNet UK. (Accessed online July 6, 2007 at: http://news.zdnet.co.uk/emergingtech/0,1000000183,39206429,00.htm).
[61] Jeff Hawkins, January 24, 2007 e-mail communication to the author.
[62] Interview with Jeff Hawkins at the offices of Numenta, Palo Alto, CA, May 10, 2007. ("Parallax" refers to the thickness of the glass screen creating a visible distance between the end of the pen and the electronic ink on the display surface.)
[63] Interview with Stuart Card at Palo Alto Research Center, Palo Alto, CA, May 9, 2007.
[64] Having said that, numerous people interviewed for this article commented on the advantage of tablet computers in meetings, where they can be rested on a surface and written on in a similar fashion to a pad of notepaper. The feeling is that it is far more socially acceptable to quietly write notes in a meeting than to noisily type into a laptop computer using a keyboard. An article by the Associated Press ("Momenta to Show 'Pentop Computer,'" *The New York Times*, October 4, 1991) said: "The Momenta allows users to scribble notes on its screen in situations like meetings, where typing would be inappropriate." Additionally, the screen of the tablet lies

flat, without creating a physical or "psychological" barrier between the user and other attendees.

[65] Many have predicted that touch-screen technology will become standard: "The tablet PC is likely to expand the overall PC market, because a portion of the mobile work force that previously could not use PCs now has a product that can enhance its productivity and capabilities. The tablet PC also may increase the number of multi-PC workers …. Over the long-term, it is likely that the tablet PC may not remain a separate PC product segment. Instead, tablet PC functionality will become a feature of nearly all notebook PCs," eTForecasts, 2002, "Worldwide PC Market" (Accessed online July 6, 2007 at: www.etforecasts.com/products/ES_pcww1203.htm).

Concluding Statement

The design of computers, as indicated in this overview of my published work, is important. The relationship of users to computers has changed dramatically over time, and particularly with respect to the issues of power, gender and status. In addition, the representation of computers in popular culture has contributed to this relationship.

The published articles I have submitted for a PhD by Publication form only a part of the corpus of work that I have published (see *Appendix 1*, p. 71). Nevertheless, it represents a coherent and balanced attempt to interpret and analyse the issues surrounding the history of computer design, and, I believe, has established my original contribution to the subject at a high professional standard.

Although 'complete' in terms of a submission for a PhD by Publication, it is by no means the end of the project. The articles cover the history of the office computer and the development of mobile computing, but not handheld computing to any degree. The histories of the mouse and the pen interface have been explored, but not the development of the trackpad. I have deliberately avoided moving into the territory of the games console, but it is closely enough related to the computer to justify some work in this area. One of the drawbacks of writing the design history of a technological product as fast moving as the computer is that the object of analysis itself is constantly under development. This drawback, though, is also an advantage as new material for investigation is continuously presented. There are a number of international conference papers already underway that explore some of the issues raised in this overview, and plans for a number of journal articles and eventually more than one book. It is an ongoing process with which I will be engaged for some time to come. There are also some related areas yet to be explored or which are worth developing further, either by others or myself.

A fuller exploration of the advertising of computers on a more quantitative basis would be fruitful, which might compare different target markets and audiences as well as different geographical and cultural contexts to provide accurate reference material for the analysis of the consumption of computing technology. Some work has been done in comparing British and American material, but the design history of computers in the Eastern Block and Soviet Union would be a worthwhile, if perhaps difficult topic to study given the availability of (or lack of) primary material. The consumption of computing technology in domestic and business environments is also an area awaiting a thoughtful, in-depth ethnographic survey to give a fuller sociological account of our recent and current relationship with computers. Again, the comparison of different cultural contexts in this respect would be interesting.

I am particularly interested in exploring more of the recent developments in evolutionary theory and their application to the analysis of design production and consumption, and ways in which these could be compared with or used in conjunction with social construction theory and its subsets. There is potential here to create a powerful tool for the analysis of designed objects, which could, for example, provide an interesting account of the persistence of certain design features from one generation of computing to another.

The articles presented here address the lack of writing on the history of the designed form of the computer, and over a number of years I have built an international reputation for innovative work in this area. My articles have been referenced by a number of scholars, and recently I was noted in a keynote speech by a leading American professor of design history to be one of the only design historians exploring recent and current technology.[1] Over the course of writing these articles, the subject of the design history of the computer has grown in popularity and no doubt will continue to do so as the computer becomes an increasingly important product in people's everyday lives (and indeed in people's past lives).

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[1] Victor Margolin, professor emeritus of art and design history at the University of Illinois at Chicago, delivered the Catherine Hoover Voorsanger Keynote Address opening the 17th Annual Symposium on the Decorative Arts and Design on the 3 April 2008, sponsored jointly by Parsons The New School for Design and Cooper-Hewitt, National Design Museum, Smithsonian Institution. Viewed 28 April 2008 <http://www.newschool.edu/eventDetail.aspx?id=13708>

Appendix 1

Other relevant published and disseminated works in the area of the design history of the computer.

Published Conference Papers:

P Atkinson, 'Upwardly Mobile: the role of fashion and image in the development of mobile computing', *Proceedings of the IFFTI 2008 Conference*, Melbourne, Australia, March 2008 ISBN tbc.

P Atkinson, 'Design Disasters in the History of Computing', *Proceedings of the 7th European Academy of Design Conference*, Izmir, Turkey, April 2007 ISBN tbc.

P Atkinson, 'The Best Laid Schemes o' Mice and Men: the evolution of the computer mouse', *Proceedings of the Design History Society Conference*, Delft, Netherlands, Sept 2006 ISBN 978-90-5155-032-0

P Atkinson, 'The Laptop- Design or Desire?', *d3 desire, designum, design*,.*Proceedings of the 4th European Academy of Design Conference*, Aveiro, Portugal, April 2001 pp. 390-395 ISBN 972-789-024-5

P Atkinson, 'The Origin of PCs: perspectives on the history of the office computer', *Proceedings of the 2nd International Conference on Design History & Design Studies*, Havana, Cuba, June 2000 ISBN 959-7182-03-3

Conference Papers:

P Atkinson, 'The Material Culture of the Laptop', *Material and Ideal Research Conference*, Helsinki, Finland, May 2001

P Atkinson, 'The (In)Difference Engine', *Design History Society Conference*, Huddersfield, Sept 1998

Keynote Lectures:

P Atkinson, 'Man in a briefcase: the social construction of the laptop computer', *Digital Design Products Conference*, Design School Kolding, Denmark, Jan 2004

P Atkinson, 'Gifs, Tiffs and Jpegs: Materiality and Museology in a Digital Age', *Symposium on Design, Technology and Cultural History*, Turku, Finland, Sept 2002

External PhD Research Workshops & Lectures:

P Atkinson, 'The design history of computing technology', *University of Turku*, Finland, Sept 2002

P Atkinson, 'The material culture of the office computer', *Manchester Metropolitan University*, Sept 2000

Appendix 2

Letter from the Editorial Board of *Design Issues* confirming the publication of the final article, *A Bitter Pill to Swallow*

Outlook Web Access

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You replied on 03/03/2008 11:36.

From: Dennis Doordan [Dennis.Doordan.1@nd.edu] Sent: Sat 01/03/2008 18:07

To: Paul Atkinson

Cc:

Subject: Design Issues publication information

Attachments:

View As Web Page

1 March 2008

Paul Atkinson

Dear Paul,

Greetings from Notre Dame. I am writing to you on behalf of the editors of Design Issues regarding your manuscript: A Bitter Pill to swallow: the Failure of the tablet Computer. We look forward to seeing your article in print soon. Your piece is scheduled to appear in Design Issues volume 25 number 1.

As you know, Design Issues is published quarterly and is now recognized internationally as one of the leading journals in the field. Thanks to our distribution agreement with MIT Press Journals, the Table of Contents and (depending on whether or not an academic institution subscribes to the service) full texts PDFs of articles are available on-line as soon as the print version of each issue appears. This feature insures world-wide distribution of material in the journal in a timely manner.

Let me know if you have any questions regarding this and again, thank you very much for submitting your work to Design Issues.

Yours truly,

Dennis P. Doordan

Co-Editor, Design Issues

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