From Punch Cards to Brain-Computer Interfaces:

75 years of Human-Computer Interaction and its Impact on Society

***Elisabetta Mori** reflects on the history of Human-Computer Interaction and its impact on society, with a special focus on the United Kingdom. This article is one of many educational materials produced by the Archives of IT, thanks to the support of the Worshipful Company of Information Technologists, to foster curiosity in the general public about how computers, software, networks and technology changed society, highlighting the UK's contributions in the field.*

The April 1981 Byte magazine cover showed an illustration of what today we could identify as a "smart watch" or a "wearable computer". It showed a miniaturised version of a computer fitted into the shape of a metal watch in the fashion of the time, with all the desktop computer interface elements: a tiny phosphor video screen, a tiny keyboard (where it would be impossible to type) and a very small floppy disk. The month's theme was about possible "Future Computers?". Although the magazine advised "keep in mind the proximity of April 1", the illustration by artist Robert Tinney is interesting because it shows the miniaturisation of computers, increasingly becoming a personal and wearable object, and essential to our everyday life.

Future Computers? Cover of Byte Magazine, April 1981.

Today we live in a world where computers are intimately integrated into society and influence many aspects of it. Interacting with computers and other technological devices is something we do every day in multiple ways; often we can't function in society without being digitally connected.

When and how did computers enter our everyday life? How did our relationship with computers evolve over the years? These are some of the questions I asked a number of UK professionals who spent their lives researching the field.

In this article I start by exploring the beginnings of Human-Computer Interaction, focusing in particular on the rise of the discipline in the UK and on its UK pioneers; I then look at how HCI has changed in both direction and significance in the light of the WWW and more recent technologies, evolving in from touch-based interaction to voice user interfaces. I reflect on

the impact of HCI on society and how it can put people at advantage or at disadvantage; in particular I also focus on the theme of computers and healthcare and the Internet of Medical Things, leading up to the brand-new experiments around Brain Computer Interfaces.

What is Human-Computer Interaction?

"**Human-Computer Interaction (HCI)** pertains to all the aspects related to how we interact with computers; it relates to both the understanding of how we use digital devices and how to design this interaction in a way that it is better for us", says **Alan Dix,** Professor of HCI at Swansea University.

"HCI involves every aspect of people using computers: from the fine scale of pressing a key, moving a mouse, touching a screen, to the economic, societal and political impact of this, in a world where computers are an intimate part of society and influence every aspect of it. In a certain way to understand the relationship between humans and computers we should start by looking at the evolution of computers themselves."

[1940s-1960s] Mainframe Computers: Bulky Installations Operated by Specialists

After World War 2 electronic **mainframe computers** required big rooms filled with bulky racks, and they were built with thermionic valves first, and transistors later. The computer installation was made of several pieces of equipment and needed a team of engineers and operators to make it function and keep it working.

There was no display screen as we are used to today and interaction was made through buttons, switches, and keyboards, where command-line input required operators to enter text commands in order to interact with the computer. These interfaces were highly specialised and required extensive training to use them effectively. The computer room was huge and a private, almost sacred, place where operators and engineers operated, maintained and supervised the computer installation; computers typically took a long time to start and worked continuously day and night. They also broke down very frequently and they were not as reliable as they are today. Despite their bulk, their memory and storage were small.

Freddie Williams and Tom Kilburn shown programming the **Manchester Mark 1** Computer in the late 1940s. Courtesy of the University of Manchester.

Human-Computer Interaction at the time meant that programmers would probably never enter the computer room. They wrote their programs on paper, often preparing flowcharts using coding sheets and stencils; these programs (and data) would later be punched by a clerk on a paper tape or cards; these were then fed to a computer by specialised pieces of equipment. Printouts and other outputs were picked up later in the day or even later in the week. These machines had different kinds of users: the machine operators, the maintenance engineers, the programmers, and the end users themselves, who were the clients who actually benefited from the calculations and data processing.

Picture of **LEO I** Computer, 1950s. Courtesy of the Modern Records Centre, Warwick University, and the LEO Computers Society, UK.

Early computers were originally used for scientific and military purposes but from the 1950s onwards mainframe computers began to be used for business applications as well. This led to a huge revolution in the workplace. It is interesting to note that it was the British tea shop company Lyons who pioneered the use of computers in business with its **LEO Computers**. The Lyons Electronic Office (as the acronym LEO stood for) was used for financial administration, stock control and logistics. As an example, Lyons could use a LEO Computer to determine how much ice-cream should be produced on a certain day, given a certain weather forecast, which of course would also be performed on a LEO Computer by the Met Office.

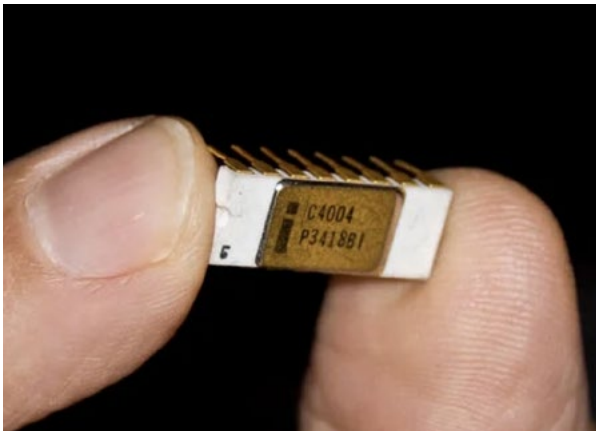
☛ Read the interviews about LEO Computers: **Peter Hermon** **Frank Land**

[1970s-1980s] The Computer Becomes Personal

The advent of personal computing in the 1970s and 1980s was deeply influential in the development of Human-Computer Interaction as a field of study. As computers evolved and became smaller and cheaper, the number and kinds of people who used them expanded dramatically too. Computers began to be commonly used at home, not just for work but also for leisure and entertainment, as video games became popular. The users of mainframe computers were a small part of the population; in some sense they were an elite. The advent of microcomputers first, and PCs later, was a big shift because such machines became something that could be operated by a single person and did not need a team of engineers to operate.

Several key developments helped pave the way for the emergence of PCs as we know them today. First, in the 1960s and 1970s, **minicomputers** were developed. These were smaller and less expensive than mainframe computers and were designed for use by smaller businesses and organisations. This allowed more people to access computing power.

Second, the development of the **microprocessor** in the 1970s was a game-changer. This allowed for the creation of small, powerful, and affordable computers that could be used by individuals in their offices, homes and schools.



Intel 4004 microprocessor.

Third, the development of the **Graphical User Interface (GUI)** in the 1970s and 1980s made personal computers more user-friendly and accessible to a wider audience. When the GUI appeared it allowed users to interact with their computers using visual elements such as icons, windows, and menus, rather than relying on text-based commands.

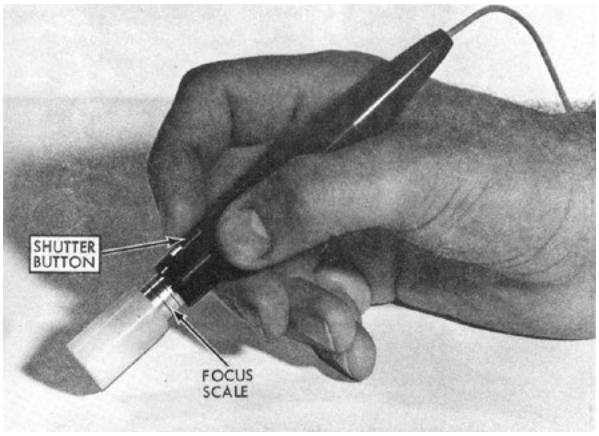
What is a Graphical User Interface?

A GUI is the way we usually interact with our computer or smartphone using visible interface elements displayed on a screen such as pictures and buttons that you can manipulate and click on, instead of typing in text commands. For example, when we open an app on our phone, we usually see a series of pictures or icons that we can tap to do different things; when we use a web browser to browse the internet we click on links and buttons to navigate around: these are GUIs. The point of a GUI is to make it easier for people to use digital technologies by providing a visual, intuitive way to interact with them.

Finally, the **emergence of the personal computer industry** in the 1980s, led by companies such as Apple, IBM, and Microsoft, helped make personal computers more mainstream and affordable. This led to the rapid growth of the PC market, as more and more people began to use computers in their homes and workplaces.

The way we interact today with computers was the result of a series of experimental innovations in the 1960s that eventually made their way into the market. Among these there is Ivan Sutherland's **Sketchpad**, first demonstrated in 1963. Sutherland wanted to make computers more approachable and developed a computer program which enabled users to create and manipulate graphical images using a light pen or stylus on the Lincoln TX-2 computer at the Massachu-

setts Institute of Technology. Sketchpad's innovative use of the light pen allowed users to draw directly on the computer screen.



Ivan Sutherland's **Sketchpad laser pen** CC BY-SA 3.0.

Sketchpad was part of Sutherland's PhD thesis and is considered one of the earliest examples of computer-aided design (CAD) and computer graphics, inspiring many subsequent innovations.

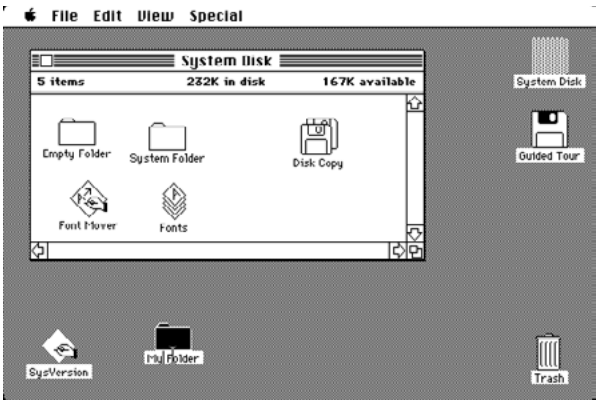
During the same years the **computer mouse** was invented at the Stanford Research Institute in California. Douglas Engelbart was part of a team that was exploring new ways to interact with computers. He came up with the idea of a device that could control the movement of an on-screen cursor. The first mouse prototype was built by Bill English in 1964. Engelbart demonstrated the mouse and many other discoveries such as the hypertext, videoconferencing, and the graphical user interface in a live event in 1968 known as "the mother of all demos".

Alan Kay and the prototype of **Dynabook**, by Marcin Wichary, CC BY 2.0.

Other innovations came from the University of Utah's Computer Science Laboratory where a young **Alan Kay** in his doctoral thesis proposed the concept of what he later called the **Dynabook**: a portable, interactive, and "personal computer for children of all ages". Although the actual Dynabook wasn't fully realised, his ideas strongly influenced the development of tablet computers and portable devices.

Engelbart's electronic office concept and Kay's Dynabook ideas were very influential at **Xerox PARC**, a research facility in Palo Alto, California established in 1970 by the Xerox Corporation. The researchers at PARC, who also included Alan Kay, focused on developing new technologies for personal computing and developed the **Xerox Alto** computer in 1973. The Xerox innovations have become so common that we take them for granted today, like the so-called **What You See Is What You Get**, which is the ability of word processors to duplicate on the screen what the printed page will look like.

The **Xerox Alto Computer** by Maksym Kozlenko CCBY-SA 4.0.



Screenshot of a **Macintosh** desktop, 1984.

The **BBC Micro** at a Computer Festival in Amsterdam, Public Domain.

Although it was never successful on the market due to its very high price and business focus, the Xerox Alto influenced the development of personal computers for years to come: it had a Graphical User Interface and a mouse built in as early as 1973. Apple engineers used its concepts in their products: the **Lisa** and the **Macintosh**, launched in 1983 and 1984, were inspired by the Alto, and used icons, pull-down menus, and windows to represent files and applications, and were controlled by a mouse. GUIs were designed to be more intuitive and user-friendly than earlier interfaces: relying on visual elements made them easier to use. They are often also referred to as the **WIMP interface**, where WIMP stands for Windows, Icons, Menus, and Pointers. Alternatively, WIMP is an acronym for Windows, Icons, Mice and Pull-down menus.

In the UK several manufacturers of PCs and products emerged during this time. The **BBC Micro**, released in 1981 by Acorn Computers, was initially developed for use in schools as part of the **BBC Computer Literacy Project**. PCs had an impact on education and learning with a growing emphasis on Computer Based Technology and Computer Assisted Learning. The field is important as it is such a widespread area which nowadays impinges upon design, HCI and Artificial Intelligence (intelligent tutors, avatars, assistants). The BBC Micro became popular with home users as well due to its powerful hardware and versatile software.

The **Sinclair ZX Spectrum**, released in 1982 by Sinclair Research, was one of the most popular home computers of the 1980s in the UK. It was affordable and had a large library of games, making it a hit with consumers.

Christopher Curry and the BBC Micro

Clive Sinclair and the Market for Personal Computers

Children playing with an **Amstrad CPC464 computer**. Data and programs were input with the built-in tape reader on the right of the keyboard. The game on screen is Paperboy. Picture by Adrian Pingstone. Public domain.

The **Commodore 64**, released in 1982 in the US, was a hugely popular home computer in the UK and around the world. It had advanced graphics and sound capabilities, and a large library of games and software. The **Amstrad CPC**, released in 1984 by Amstrad, was a popular home computer that featured a built-in cassette player and a high-quality keyboard. It was a direct competitor to the Sinclair ZX Spectrum and the Commodore 64.

The advent of PCs and the democratisation of computing pushed the growth and the establishment of Human-Computer Interaction as a discipline.

☛ Read the interviews: **Clive Sinclair** **Chris Curry** **Herman Hauser** **Steve Furber** **Andy Hopper**

☛ **BBC Computer Literacy Project** on the Archives of IT

[1970s-1980s] Mapping Early HCI Communities in Britain

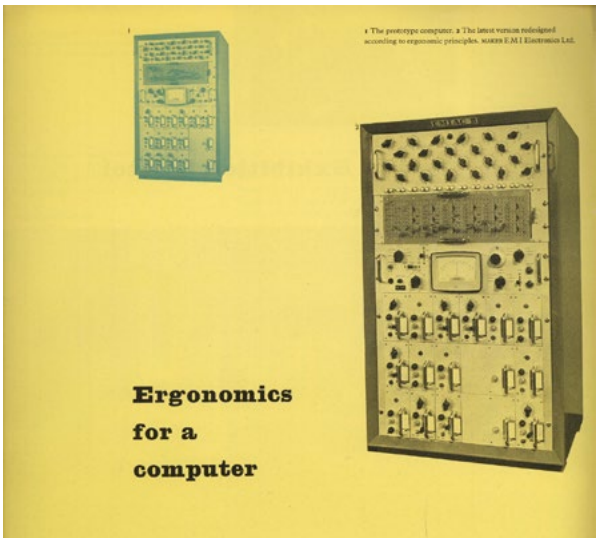


Image cover of the paper **Ergonomics for a Computer** by Brian Shackel, published in 1959.

The establishment of Human-Computer Interaction as modern academic discipline began during the 1970s. Initially, however, what we now call Human-Computer Interaction was referred to as Man-Machine Interaction "if you forgive the sexism of the age", as Professor Dix points out.

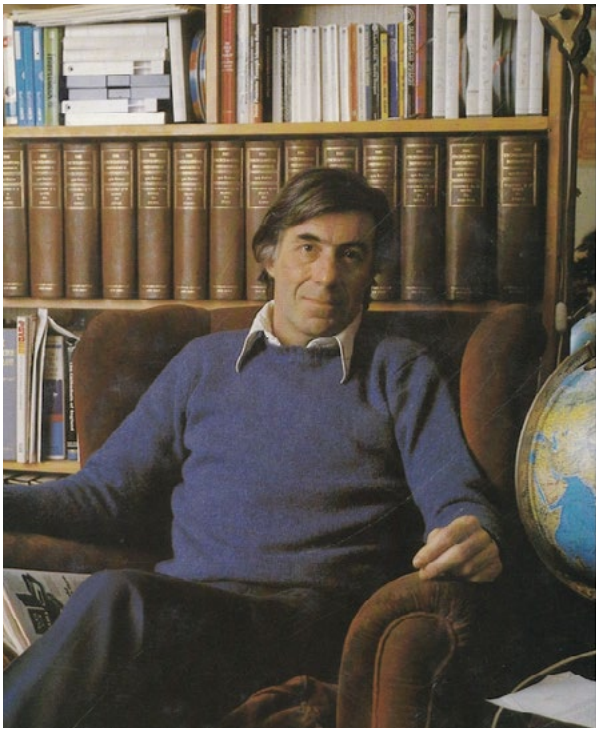
Brian Shackel's article *Ergonomics for a Computer,* published as early as 1959, is considered one of the first articles to emphasise the ergonomics aspects of computers.

What is Ergonomics and how Does it Fit with Using Computers?

Ergonomics is a science concerned with designing machines and other things people use so that they interact most efficiently, safely and comfortably with their intended users. It has to do with our human bodies, brains, and senses interacting safely with easy-to-use machines. Ergonomics and Human Factors became of particular importance during WW2 when pilots and other soldiers were under pressure operating the controls of aircrafts and other machines.

Brian Shackel understood very early how important ergonomics was to the development of the computer industry. A UK pioneer figure in HCI, he completed his first study of Human-Computer Interaction by re-designing the console of the EMIDEC 2400 Computer, while working at EMI

EMI began to be involved in manufacturing computers in the 1950s along with many other companies in the UK and abroad. EMI was far from being the only computer manufacturer concerned with the design and the ergonomics of a computer console; there were other US and European companies that had an interest in ergonomics and industrial design applied to computers. Olivetti in Italy, IBM and RCA in the US, Compagnie des Machines Bull in France to name a few, all worked with ergonomists and industrial designers to improve their products. The Ulm School of Design in Germany was in particular focusing on designing new kinds of interactions between humans and machines in collaboration with industry. However, all these efforts were isolated and spread out: there was no international community of researchers and specialist groups on Human-Computer Interaction and their conferences were not established until the early 1980s.



Christopher Evans, from the back cover of the **Mighty Micro** book (1979). Picture by Oliver Hatch.

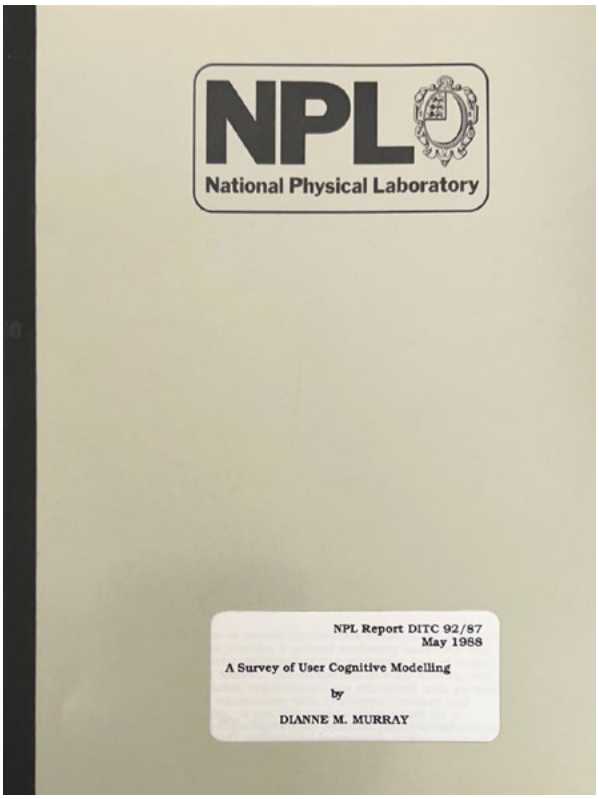
So in the 1970s, the field of **Human-Computer Interaction** was still in in its infancy, and there were only a few centres in the UK that focused on HCI research and development, such as the Man-Machine Interaction Group at the National Physical Laboratory, and the Human Sciences and Advanced Technology Research Group at the University of Loughborough among others. These centres played an important role in the development of the field in the UK, and many of them went on to become major contributors to HCI research and practice, and their founding members established the discipline in the UK.

Christopher Evans and the National Physical Laboratory

The NPL was a major Government Research Laboratory and the national Standards centre. It was located in Teddington, near London, and was famous in part because Alan Turing worked there on the ACE computer project after World War 2. After an early career as a science journalist and writer, Christopher Evans, with a degree in psychology and a PhD in Physics, had been asked to set up a new informatics group to research Man-Machine Interaction there. Evans worked at NPL from 1964 until his premature death in 1979.

Dianne Murray, who has worked at the NPL and was a Usability and Interface design consultant for more than thirty-five years, remembers the atmosphere in the lab: "It was very much a research laboratory, and was much more like a university campus than any organisation. The atmosphere was very serious, but very innovative as well, because we were allowed to do essentially blue-sky research without necessarily having a particular goal or a particular product which we had to develop at the end of it."

Dianne Murray and working at NPL



A Survey of User Cognitive Modelling. A NPL Report by Dianne Murray. Courtesy of Dianne Murray.

Microtext manual and floppy disc. Courtesy of Dianne Murray.

Murray was seconded to work with **Nigel Bevan**, another UK HCI pioneer, who was persuaded of the importance of international standards to improve the design of user interfaces. One of Bevan's concerns and a major field of research was the potential negative effect on health and posture of working with visual display terminals. Bevan began his research in Man-Machine Interaction, researching keyboard and keypad layouts for his PhD and subsequently he joined the National Physical Laboratory in 1973 where he remained for 25 years, becoming the Head of the HCI Group and the Head of the Usability Section.

Bevan and Evans worked together, initially on physical interfaces for the disabled and then on a doctor-patient medical interviewing application called **MICKIE**. This application was also displayed in the London Science Museum during the 1980s. Murray and Bevan worked on a follow-up to that project called ***Microtext***, a successful software package for the BBC Micro, which was popular in schools and provided an 'authoring system' for educators/teachers to create their own lessons.

Brian Shackel and the HUSAT Research Group

In 1970 Shackel left the Ergonomics Lab of EMI and moved to Loughborough University as Professor of Industrial Ergonomics and set up the **Human Sciences and Advanced Technology (HUSAT)** Research Group.

Shackel was persuaded that the emergent computer revolution needed an injection of human factors to ensure computers could be properly used by people and the group's mission was to make them user friendly. HUSAT comprised ergonomists, psychologists, computer scientists and industrial designers.

During the 1970s, interactive computing technology found its primary applications within the realm of work applications. HUSAT was actively involved in assessing these applications, drawing attention to issues of user-friendliness and inadequate system specifications. As a result, projects were initiated to assist design teams in accurately defining user requirements and creating functional and user-friendly modes of interaction. While a significant portion of funding originated from industrial channels, research council funds also contributed to investigations concerning the human consequences of computer applications.

The group's approach involved forming close collaborations with both technology providers and users and, whenever feasible, offering tangible contributions to emerging advancements. As an example, **Tom Stewart**, a founding member of HUSAT, was working on displays and how to make these legible, comfortable, minimising eye strain, set at the right height, and so on. As another example Phoenix Assurance, along with other UK insurance companies, sponsored some research with HUSAT and Moorfields Eye Hospital in London when colour Visual Display Units began to replace the phosphor green screens. The research related to readability and how the brain reacted to different colours. The team at HUSAT also comprised **Ken Eason**, **Leela Damodaran**, and other young enthusiasts, like Martin Maguire.

Ernest Edmonds on Brian Shackel

Until his retirement in 1992 Shackel worked to develop an international community dedicated to the subject, becoming a founding figure in the emergence of usability and user-centred design. He also led BLEND, one of the first major projects to evaluate the promise of electronic journals. **Dianne Murray** remembers BLEND: "interesting but difficult to implement and quite hard to write articles. However, there was an influential group of HCI people involved."

Ernest Edmonds and Leicester Polytechnic

Professor **Ernest Edmonds** remembers when he set up one of the earliest British groups on HCI at **Leicester Polytechnic** during the 1970s: "by 1974-ish I was head of the computing department and I arranged, had it agreed that Human-Computer Interaction should be a research focus at Leicester Polytechnic. We were in touch with Loughborough University because Brian Shackel was there running HUSAT, and so we formed an alliance with those people. HUSAT was concerned with the human factors side of it, we were concerned

with the implications of those human factors for the technology, how should you design software, what should the software architectures be, and all those kinds of questions."

Ernest Edmonds HUSAT

Edmonds has made other significant contributions to the field, founding the **HCIRU** (Human Computer Interface Research Centre) at Leicester Polytechnic in 1982. He also established **LUTCHI** (Loughborough University of Technology Computer-Human Interaction) when he moved to **Loughborough University** in 1986.

Harold Thimbleby on Brian Gaines

John Long and the Ergonomics Unit at University College London

The Ergonomics Unit at UCL was founded in the mid-1960s with a focus on the physical environment (heat, lighting, stress). Later interests shifted towards the cognitive, and the Unit moved to be associated with the Psychology Department, under the leadership of Professor Long.

John Long is considered one of the founders of UK HCI as a discipline. He was already exploring the HCI area with IBM during his time at the Medical Research Council's Applied Psychology Unit in Cambridge, from around 1974.

Harold Thimbleby on John Long

His research started in the psychology of typing and how we correct typos and with work on menu design; he was later interested in frameworks of HCI, method development and evaluation methodology, analysis and design of socio-technical systems. He also applied his expertise and knowledge to Computer-Supported Cooperative Work, the study of how computer systems can support collaborative activity and coordination, analysing psychological and social behaviours and connecting them to available collaborative tools. When Long retired in 2001 the **University College London Interaction Centre** (**UCLIC**) was founded under the Directorship of Professor **Harold Thimbleby**. UCLIC is currently directed by Yvonne Rogers.

Applied Psychology Unit in Cambridge

The Medical Research Council's Applied Psychology Unit in Cambridge, also known as **MRC APU**, comprised of a group of psychologists keen on using computers and understanding interaction from a psychology point of view. Dianne Murray remembers the group in Cambridge: "They also investigated, from

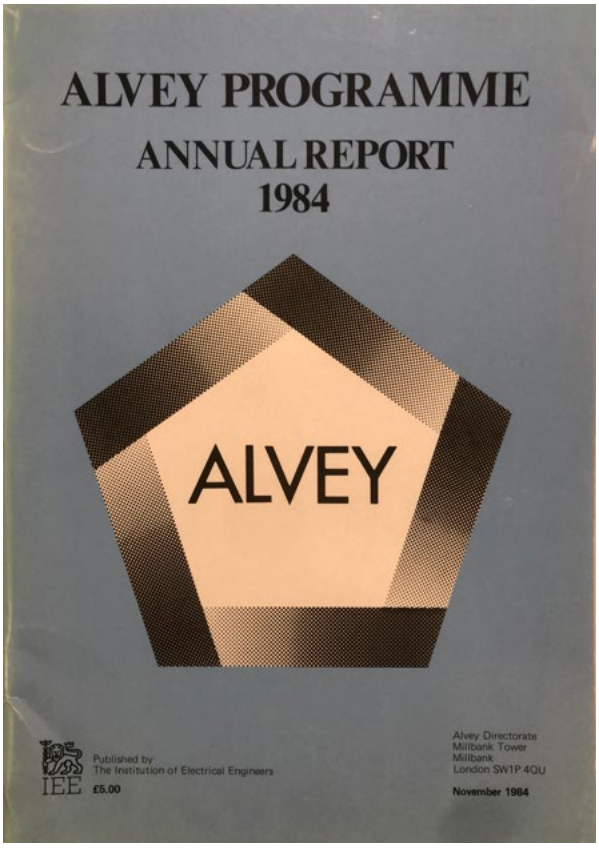
a cognitive standpoint, the Psychology of Programming, how software developers actually worked to create new software and formed PPIG (Psychology of Programming Interest Group) involving Thomas Green, David Gilmour and Marian Petre".

Harold Thimbleby HCI is Psychology

Apart from these main centres, other academics were scattered around the UK and did HCI research: one example is **Alan Newell**, who has worked on HCI primarily for supporting elderly and disabled people since 1970; he was based at the University of Southampton before moving to Dundee University, where he is now Emeritus Professor.

☛ Read the interviews: **Ernest Edmonds Dianne Murray Alan Newell Harold Thimbleby**

[1980s-1990s] The Alvey Programme and the Establishment of a HCI Community in the UK



The Alvey Programme Annual Report (November 1984), covering the first 15 months of the Programme. Courtesy of the History of Computing Collection, Swansea University.

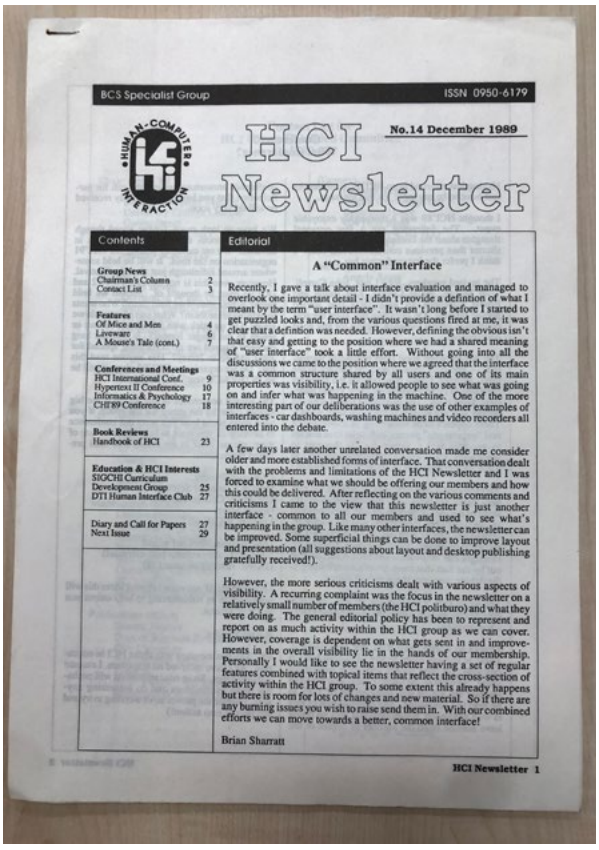
The Alvey Programme was a large-scale research and development initiative that was launched by the British government in 1983. One of the key goals of the Alvey Programme was promoting collaboration between industry, academia, and government in the development of information technology. The Alvey Programme changed the way computing research was organised in the UK and it was focused on 4 strands: Software Engineering, Intelligent Knowledge Based Systems, Man Machine Interaction and Advanced Microelectronics (Very Large Scale Integration Design, to produce integrated circuits).

The Alvey Programme Man Machine Interaction objectives were twofold: first, to raise the level of UK user interface design, in terms of innovation and design methodology, in order to let industry be competitive in the world markets; second, to improve the British capabilities in pattern analysis, to make possible the use of advanced speech recognition and image synthesis techniques in the user interface, such as voice operated typewriters and methods of text-to-speech conversion.

Alvey influenced and gave strength to the field, contributing to establishing a community and was very important in providing funding for HCI projects. Three HCI centres were established: one in Scotland comprising the universities of Heriot-Watt, Strathclyde, and Glasgow; one in the Midlands; and one in London, based at UCL.

In parallel, **HCI groups in the British industry** emerged and developed: IBM at Hursley Park, International Computers Limited (ICL), where Andrew Hutt led the group, Standard Telephones and Cables (STC) in Harlow, and also involved were Logica and Data Logic.

In November 1986 Rank Xerox announced the decision to open **EuroPARC** in Cambridge, a systems research laboratory in HCI allied with the Xerox Palo Alto Research Center (PARC). The centre was officially dedicated in June 1988, directed by **Thomas Moran**. He was principal scientist and manager of the User Interface and the Collaborative Systems Areas at Xerox PARC (1974-2001) and one of the authors of the seminal HCI book, *The Psychology of Human-Computer Interaction,* published in 1983. He worked with Xerox designers in the 1970s to formulate the design methodology for the Xerox Star "desktop metaphor" user interface. The goal of the lab was to understand the broad range of processes by which information systems were shaped to be useful and usable, including how people make use of systems, how designers designed them, and how they evolved with use and redesign. In particular the team at EuroPARC explored collaborative tools (SharedARK) that also involved video and audio and user-driven, bottom-up innovations through tailorable user interfaces.



BCS Specialist Group ISSN 0950-6179

HCI Newsletter

No.14 December 1989

Contents

Editorial

A "Common" Interface

Recently, I gave a talk about interface evaluation and managed to overlook one important detail - I didn't provide a definition of what I meant by the term "user interface". It wasn't long before I started to get puzzled looks and, from the various questions fired at me, it was clear that a definition was needed. However, defining the obvious isn't that easy and getting to the position where we had a shared meaning of "user interface" took a little effort. Without going into all the discussions we came to the position where we agreed that the interface was a common structure shared by all users and one of its main properties was visibility, i.e. it allowed people to see what was going on and infer what was happening in the machine. One of the more interesting part of our deliberations was the use of other examples of interfaces - car dashboards, washing machines and video recorders all entered into the debate.

A few days later another unrelated conversation made me consider older and more established forms of interface. That conversation dealt with the problems and limitations of the HCI Newsletter and I was forced to examine what we should be offering our members and how this could be delivered. After reflecting on the various comments and criticisms I came to the view that this newsletter is just another interface - common to all our members and used to see what's happening in the group. Like many other interfaces, the newsletter can be improved. Some superficial things can be done to improve layout and presentation (all suggestions about layout and desktop publishing gratefully received!).

However, the more serious criticisms dealt with various aspects of visibility. A recurring complaint was the focus in the newsletter on a relatively small number of members (the HCI politburo) and what they were doing. The general editorial policy has been to represent and report on as much activity within the HCI group as we can cover. However, coverage is dependent on what gets sent in and improvements in the overall visibility lie in the hands of our membership. Personally I would like to see the newsletter having a set of regular features combined with topical items that reflect the cross-section of activity within the HCI group. To some extent this already happens but there is room for lots of changes and new material. So if there are any burning issues you wish to raise send them in. With our combined efforts we can move towards a better, common interface!

Brian Sharratt

HCI Newsletter 1

BCS HCI newsletter, cover, no. 14, December 1989. Courtesy of the History of Computing Collection, University of Swansea.

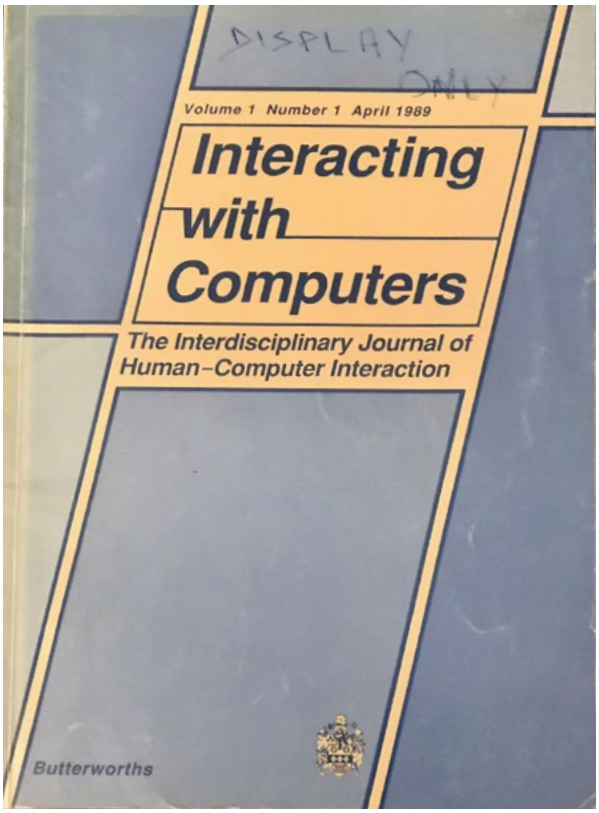
Another key moment in the evolution of the UK HCI community of researchers that added momentum to the discipline in the UK was the establishment of the **British Computer Society Specialist Group on Human-Computer Interaction** in 1984. Its aim was promoting the study and practice of human-computer interaction in the UK at a time when the field of HCI was still in its early stages, and the development of interactive systems was becoming increasingly important in many areas of industry and academia. The HCI Specialist Group was formed to provide a forum for researchers, practitioners, and students to exchange ideas and collaborate on new projects. It had a newsletter and throughout the 1980s and 1990s, the group played a key role in advancing the study of HCI in the UK and connecting with the international community.

The Specialist Group organised a number of conferences, workshops, and seminars, which provided opportunities for researchers and practitioners to share their work and discuss new developments in the field. The group still exists today under the name of Interaction, a name chosen "to reflect its more international profile, its emphasis on interaction, and its commitment to engaging with all levels of interest in the subject, whether from academic, commercial, government, policy-making or media circles."

Nigel Bevan at the National Physical Laboratory had the idea of setting up the Group, after the example of the **ACM Special Interest Group on Computer-Human Interaction (SIGCHI**) in the US, which was founded in 1982.

Dianne Murray and the Specialist Group of the BCS

Dianne Murray BCS HCI vs SIGCHI



Cover of the first number of **Interacting with Computers** or **IwC**, 1st April 1989. Courtesy of Dianne Murray.

These were the years when other conferences started: the first CHI conference (of the SIGCHI) was in Boston in 1983; the first INTERACT conference, launched by Brian Shackel, in 1984 in London, and the first UK HCI conference in 1985.

In the same period Dianne Murray and Dan Diaper started the process of creating the journal of the BCS HCI Group, ***Interacting with Computers*** or "**IwC**" the Interdisciplinary Journal of Human-Computer Interaction. Murray speaks proudly about the journal: "We felt as though we needed the tagline to ensure that people knew what sort of journal it was, and although it was the journal of the BCS HCI Group, we also intended it to be international, and to cover many areas of Human-Computer Interaction."

It was generally felt there were differences between the UK/European approach and the US. The North American researchers were more interested in practical applications and in the mechanics of interaction and interface design, whereas the UK community was more psychologically and ergonomically focussed.

Murray continues: "There was a dichotomy if you like, and the UK was very much closer to what was happening in Europe and to European researchers and cogni-

Meeting at an **Interact** conference. From left to right: Tom Carey (Canada), Dan Diaper (UK), unknown person, Dianne Murray (UK), Marilyn Mantei Tremaine (USA), Tom Hewett (USA). Courtesy of Dianne Murray.

tive ergonomics at that time. So, there was a bit of a bias in the US and Canada to North American work, and it took quite a long time before British work began to be recognised totally."

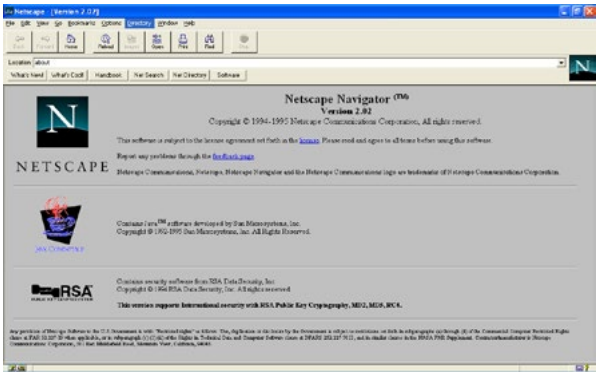
☛ Read the interviews: **Gilbert Cockton** **Alan Dix** **Ernest Edmonds** **Linda Macaulay** **Dianne Murray** **Harold Thimbleby**

[1990s-2000s] World Wide Web: a New Paradigm of Information Sharing

Another major development in the history of computing that changed the way we interact with computers is the World Wide Web.

The **World Wide Web** led to a revolution in computing and society in the 1990s. The web changed who used computers and transformed the way we access and share information, communicate, conduct business, and interact with digital services. It has become an integral part of our daily lives and continues to shape the digital landscape.

The web is important in the history of Human-Computer Interaction because it brought about a new paradigm of information sharing and communication, enabling users to access and interact with vast amounts of information through web browsers, amplifying the impact of HCI as a discipline. The focus shifted and interfaces needed to accommodate not only expert users, but also individuals with varying abilities.



Screenshot of Netscape Navigator browser about: page. Version 2.02 running on Windows XP, 29 August 2015. Public domain

UK computer scientist **Sir Tim Berners-Lee**, created the first web browser in 1990. Three years later a team led by Marc Andreessen released Mosaic, the first browser to boast a graphic interface and to be adopted by a significant number of users, followed the next year by Netscape Navigator. When Microsoft unveiled Internet Explorer in 1995 they kicked off one of the many competitions for dominance in the usage share of web browsers.

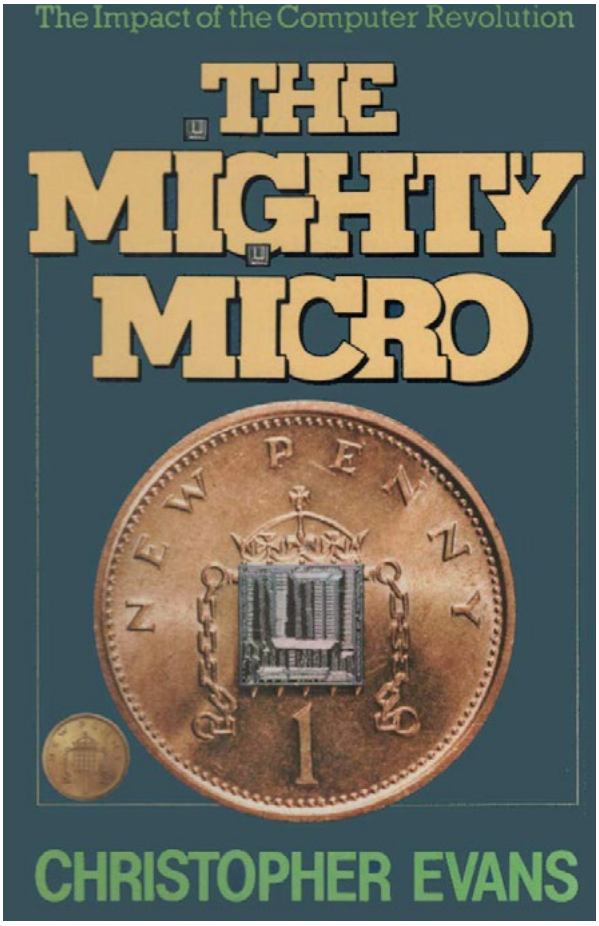
We can understand the impact of the internet and the world wide web in the words of **Linda Macaulay**, Professor Emerita of Information System Design, University of Manchester: "In the eighties most people were working in offices and they had a computer that was centrally controlled. They were doing office work and they didn't have much discretion about what they did or how they did it. Once the internet caught on in the late nineties, things changed massively. We moved to a situation where people have discretion, they have choices, they can use it or not use it. They're not just in the office, they're in their home, they're at leisure and a computer affords new opportunities at home and in leisure. From the human-computer interaction point of view, we're looking at the individual as a consumer, their consumer behaviour, it also brings in marketing; the whole interest in human-computer interaction broadened. The early 2000s was just a time of massive, massive change both in the way people interacted with computers and the opportunities that computers could give them."

Linda Mcaulay and Impact of the Internet Manchester Evening News

HCI has been vital in web development as it focuses on designing interfaces that prioritise user experience, accessibility, efficiency, error prevention, engagement, and user-centred design. Hyperlinking, along with the development of languages such as HTML and CSS, allowed for the creation of interconnected web pages with a user-friendly structure and a strong visual design. New web design principles emerged, focused on usability and user experience.

In parallel, advances in microelectronics and manufacturing techniques progressively led to the creation of smaller and more portable devices, playing a crucial role in the development of laptops, tablets, and smartphones. The late 1990s saw the rise of mobile devices: the **miniaturisation** of technology and the development of touchscreens and stylus-based input methods presented new challenges and opportunities for HCI as well. Desktop computers also advanced during this time, with faster processors, improved graphics capabilities, and larger storage capacities. HCI research focused on refining GUIs, input devices, and exploring novel interaction techniques like gesture-based input.

Read the interviews: **Alan Dix** **Linda Macaulay**



Cover of **Chis Evans** book, **The Mighty Micro**, 1979.

[2000s-onwards] The Computer Becomes Ubiquitous

Miniaturisation has also been instrumental in other areas such as medical devices, consumer electronics, and wearable technology, giving rise to what has been called **ubiquitous computing**. The landmark article introducing ubiquitous computing is **Mark Weiser**'s piece in Scientific American, published in September 1991. Weiser worked at Xerox Parc in the end of 1980s when he developed the concept. However about ten years earlier UK HCI pioneer **Christopher Evans** anticipated the concept in his book ***The Mighty Micro***, published as early as 1979.

Also known as "pervasive computing" or "ambient intelligence", ubiquitous computing refers to the concept of seamlessly integrating computing technology into the everyday environment to create a network of interconnected devices and systems. The goal of ubiquitous computing is to make technology pervasive and invisible, integrating it into the fabric of our lives. These devices can include sensors, actuators, displays, and other computational elements. By making technology ubiquitous, it becomes integrated into our physical surroundings, creating an environment that is intelligent, responsive, and capable of supporting a wide range of applications and services.

Interacting with Touch and Movement

The wide-spread introduction of smartphones, starting with the launch of the iPhone on the 29th of June 2007, popularised **capacitive touchscreens and multi-touch gestures**. The iPhone 1 in particular allowed a user to control the device through their finger and this was a real revolution at the time.

Rory Cellan-Jones and the launch of the iPhone

Touch-based interactions and touchscreens have an interesting story; it was during the 1960s however that the idea began to take shape, as we have seen with Sutherland's Sketchpad, where touch-sensitive screens and light pen devices allowed users to interact directly with computer displays by touching or pointing. Resistive touchscreens gained popularity in the 1980s, but it wasn't until the 2000s that multi-touch gestures were realisable.

Michael Noll The Feely Thing

In the 2010s, the introduction of gesture recognition systems, such as Microsoft's Kinect, and motion-sensing devices, allowed users to interact with computers and gaming consoles using body movements and gestures. The development of **gesture-based interfaces** allows users to engage with 3D design spaces through bodily motions e.g., in virtual reality games. Touch interactions have extended into AR and VR environments, enabling users to interact with virtual objects using hand gestures and touch-based controls.

Read the interviews: **Mike Noll** **Rory Cellan-Jones**

The 2010s also saw the rapid expansion of the **Internet of Things (IoT)** and the proliferation of connected devices and sensors embedded in everyday objects, enabling seamless interactions between humans and their environment. HCI shifted focus towards designing context-aware systems and user experiences that spanned multiple devices. Smaller dimensions enabled greater mobility and integration of technology into our everyday lives.

Pervasiveness: The Computer and the Body

Professor Dix points out the deep interaction we have with computation: "Even if things are not in the body we have all moved to the point where there is a deep interaction between our bodily functions and computation. It might be a smart watch on your wrist, it could be the feeling of missing it when you are separated from your phone. There is the issue about the physical embeddedness of it. Our current technology is such an intimate part that we are all at a point where without that technology our bodies will not function alone. There has also been a major shift in the pervasiveness of computers in society. At the time of early computers there was a choice about who used computers: some used them, some not. With the web and domestic computing more people could use them but could choose whether or not; now the picture has changed; if you want to buy an airline ticket or fill up your tax return it is difficult not to use a computer. We have made a world now, where to be a citizen of the XXI century you need to have to be digitally connected. Digital technology on its own deepens the existing social divisions."

HCI research in the UK began to focus on issues such as accessibility and inclusivity quite early, and in particular through the work of Professor **Alan Newell,** who has worked in HCI to develop more accessible interfaces to disabled people throughout his career. People with disabilities can sometimes have difficulties in experiencing full participation in a society not always built with their needs in mind, and computing technology can make a difference in this, both positively and negatively. Computer technology has potential to overcome barriers and improve lives of people with disabilities.

Alan Newell Impact on disabled people

Extraordinary Users and the Digital Divide

Professor Newell highlights the Digital Divide*:* "A significant proportion of the population are not able to use technology. Therefore there's a divide between those who can use technology and those who can't. And that has gotten worse and worse as technology got better." HCI enables some disabled people to do some things they could not do and certainly has made a lot of difference to a number of disabled people. However we must not forget that technology sometimes makes it more difficult for some categories of poor and disabled people to take part in society.

Alan Newell the Digital Divide

Newell continues: "We tend to design for what people call 'ordinary users' and I'm interested in extraordinary users, so that's a positive way of looking at people with disabilities." Newell reflects about what is the real meaning of "ordinary" and "extraordinary": we can learn a lot about HCI from looking at disabled users. An ordinary person in an extraordinary situation, such as a pilot flying a high-performance aircraft, is in the same position as an extraordinary person, a disabled person, in an ordinary situation using a typewriter.

Alan Newell Extraordinary Users

"Throughout the history of accessible computer technologies, people with disabilities acted as the paradigmatic computer users. Technology created for their use was the foundation for technologies intended to augment all humans. Developers had to design specifically for people with disabilities in mind, making their needs primary, before they could expand the scope of computer technology to include everyone. This was not a one-way relationship between developers and users, however; people with disabilities pushed for computers that would make them more inclusive of different needs. In some senses they're the canary in the coalmine."

VUIs: Interacting with Voice

The 2010s saw the popularisation of **Voice User Interfaces**: virtual assistants like Siri, Google Assistant, and Amazon Alexa brought these into the mainstream. Users can now interact with technology through spoken commands, leading to new challenges in natural language processing and voice recognition. The voice user interface has an interesting story that also overlaps technologies developed to overcome the barriers of people with disabilities. In the 1970s the Kurzweil Reading Machine was the first device that could scan printed texts and translate them into computer-spoken words, enabling blind and visually impaired people

to experience printed materials. In 1982 the company also created the **Kurzweil Voice**, general purpose dictation software, a descendent of specialised medical dictation technology. This software was particularly useful for allowing users to compose text in word-processing software by speaking.

Michael Taylor Extraordinary Users

When personal computers arrived they introduced new barriers for some people. During the 1960s and 1970s blind people were encouraged to become computer programmers and in the US there was even an ACM Committee on Professional Activities of the Blind. Professor Newell remembers: "When Windows and What You See Is What You Get appeared, blind people who had been able to use computers until that point were not able to use them anymore, because they could not see the screen whereas they were quite capable of using command line interpretation. This is one of the examples where allegedly a move forward has put a number of people at disadvantage."

Alan Newell WYSIWIG and blind people

As computer interfaces change and evolve, they can create issues but also give solutions. **Robin Christopherson** is Head of Digital Inclusion at AbilityNet, a pioneering UK charity which has been supporting older and disabled people since 1998. His own experience of sight-loss gives him first-hand experience of the issues and power of digital tech to transform people's lives: "There was a lot of consternation in the blind world when Windows came out, because it's all pictures and graphics, and we're going to be left behind. When it was just rows of characters that was doable. It was only when 3.11 came out a couple of years later that we were able to start getting [computers] to talk, and they had some other, third parties that created software, like magnification software, to blow up the screen so that you could see it more easily if you had low vision."

Windows 3.11 was the first version of Windows that had accessibility built in. He remembers using JAWS: "I had a talking laptop, really chunky, really heavy, really ludicrous looking these days, and it had speech output which was called Job Access with Speech, JAWS for DOS. So that was my first encounter with technology that can help people with disabilities."

Robin Christopherson Talking Laptops

Accessibility and inclusivity have gained attention through the years. Aiming to make the web more usable and accessible to people with disabilities the British Computer Society launched the Disability Rights Commission (DRC) Accessibility Working Group in 2004. This was tasked with developing guidelines for the design of accessible interfaces.

Christopherson also remembers the early days of using websites: "Luckily back in those days websites were very text-heavy. So, websites were very sort of text-focused, which lent itself to blind people. But as the decades went on, technology got smarter and smarter, more and more prolific. Accessibility thankfully hasn't been deprioritised, so, the big players, Apple, Microsoft, Google, very much prioritise accessibility, and have been very visible." He continues: "It's not to say there isn't a lot of inaccessible websites and apps out there for people with a range of impairments, there certainly are, and that's why we have to kind of carry on raising awareness, and making sure that the Government prioritises that it's a mixed bag, but all the tools are there. It's incredibly powerful what everyone's using these days, that power can be leveraged to great effect for people with disabilities too."

Robin Christopherson Old Technology

Christopherson, who was awarded an MBE in January 2017 for his services to digital inclusion, talks about the 1995 **Disability Discrimination Act** and how the 2003 code of practice that followed it changed what they did at AbilityNet: "So, in the first few years that I was working for AbilityNet, it was very much end user focused, dealing with disabled individuals, and helping them get the tech that they need in their hands. But it was only until 2003 when they published this code of practice like an appendix to the Disability Discrimination Act that definitely said, you know, you must include digital in this. It gave an example of a blind person being able to book airline tickets on a website. So, from 2003 we suddenly started to approach companies and say, 'Look, you need to start thinking about accessibility, it's now definitely a legal requirement.' So, since 2003 the other aspect of what we do, which is working with companies, to make sure that their apps and websites are inclusive, all their digital, the emails that they send out, the marketing campaigns, social media, that sort of thing are fully inclusive."

Robin Christopherson AbilityNet

Christopherson sees a lot of advancement in technologies for people with disabilities and in particular with AI at the core of many of them: "There's an app on my phone called Seeing AI, from Microsoft, and, it uses all of those different sensors to tell me what's around me, help me find objects, that you can say, 'I want to find my keys,' or, you know, dog's harness, or whatever it might be. Or just my shoes or something. It can read text, you know, either quick snapshots of road signs, whatever, or buildings as you're passing by, shop fronts. Or, whole documents. It can read the colour of what your clothing is, so that you can, you know, see if you've got the right coloured shirt on or something. It can read banknotes, so it can tell you what denomination you are about to hand over etcetera."

Robin Christopherson Soundbites

Read the interviews: **Robin Christopherson** **Alan Newell** **Michael Taylor**

Computers and Healthcare

Computers have been involved in different aspects of our healthcare since their introduction: initially computers in healthcare were primarily focused on managing patient data and administrative tasks, e.g. storing medical records, scheduling appointments, and handling billing processes, improving the efficiency of healthcare management. In the 1980s and 1990s, as diagnostic imaging, such as X-rays and MRI scans, began to be processed digitally, computers enabled more accurate and detailed assessments of medical conditions. The rise of **Picture Archiving and Communication Systems (PACS)** allowed medical professionals to store, retrieve, and share medical images digitally. In the early 2000s Electronic Health Records transformed patient information management, offering real-time access to patient histories, prescriptions, test results, and treatment plans.

The 2010s saw the rise of telemedicine and remote monitoring, thanks to the advancements in connectivity and mobile technology. Patients could consult with healthcare professionals through video calls, and wearable devices allowed for continuous monitoring of vital signs and health metrics.

Currently artificial intelligence and big data analytics help improve healthcare: machine learning algorithms analyse vast amounts of medical data to predict disease trends, personalise treatment plans, and assist in diagnostic accuracy. AI-driven tools aid in interpreting medical images, identifying patterns, and even suggesting potential treatment pathways.

Sir Michael Brady Transformation Factors

The pervasiveness of digital technologies in healthcare can create possible concerns around patient privacy, data security, and ethical dilemmas have emerged, as Harold Thimbleby points out in his book *Fix it. See and solve the problems of digital healthcare.* This is particularly true as the Internet of Medical Things emerged.

What is the Internet of Medical Things?

The IoMT refers to the integration of medical devices, equipment, sensors, and systems with the internet and other digital technologies. IoMT enables the collection, exchange, and analysis of healthcare-related data in real-time, leading to improved patient care, remote monitoring, and more efficient healthcare pro-

cesses. It encompasses a wide range of interconnected medical devices and applications, ranging from wearable fitness trackers and smartwatches to implantable devices, medical sensors, infusion pumps, and more. Its applications can be in Chronic Disease Management, assisting in monitoring conditions like diabetes, heart disease, and hypertension; IoMT can help elderly individuals maintain their independence by enabling remote monitoring of vital signs, falls, and medication adherence; it can improve hospital management but also trigger alerts and notifications during medical emergencies, enabling swift response and potentially saving lives.

Mischa Dohler and the Internet of Skills

Haptic technology has been used in medical applications, such as surgical simulators and robotic surgery systems. It allows surgeons to "feel" virtual tissues and enhances training for medical professionals. In an intriguing development, **Mischa Dohler**, in his interview, delves into the concept of applying his concept of Internet of Skills to the world of robotic surgery: the potential arises for surgeons to conduct operations remotely on patients located across the globe. This could revolutionise the field of telemedicine, enabling highly skilled surgeons to provide their expertise to underserved areas or respond rapidly to emergencies in distant locations. The amalgamation of haptic technology and the Internet of Skills could reshape the boundaries of medical practice, transcending geographical limitations and redefining the possibilities of surgical care.

☛ Read the interviews: **Sir Michael Brady** **Harold Thimbleby** **Mischa Dohler**

From Licklider to Neuralink: Brain Computer Interfaces and Human Machine Symbiosis

In 2016 entrepreneur Elon Musk founded **Neuralink**, a prominent company focused on developing advanced Brain-Computer Interfaces.

What is a Brain-Computer Interface?

Also known as a Brain-Machine Interface (BMI), BCI is a technology that establishes a direct communication pathway between the human brain and external devices, such as computers, machines, or prosthetics. The primary purpose of a BCI is to enable individuals to control and interact with these devices using neural signals, as opposed to interacting via touch-based input methods.

BCIs work by detecting and interpreting brain activity, which is typically captured using specialised sensors placed on the scalp (non-invasive methods) or implanted directly into the brain tissue (invasive methods). The captured brain-

wave data is then processed using algorithms and translated into commands that can be understood by computers or other devices.

With a goal of creating implantable devices that establish a direct link between the human brain and computers, Musk's Neuralink aims to address neurological disorders, enhance human cognition, and establish a connection between humans and artificial intelligence. Neuralink's approach involves implanting flexible threads with numerous electrodes into the brain's neural tissue to enable bidirectional communication. The company's vision goes beyond medical applications, aiming to create a seamless integration of humans with AI technology.

The vision of the company resonates with the concept of **Man-Machine Symbiosis** proposed by **J.C.R. Licklider** way back in 1960, in which he envisioned a collaborative partnership between humans and computers where their unique strengths complement each other. Licklider was a pioneering American computer scientist and psychologist and is widely recognized for his significant contributions to the development of computing, human-computer interaction, and the early foundations of the internet. Licklider highlighted that humans excel in creativity and intuition, while computers offer data processing and computation. He foresaw interactive communication through time-sharing systems, enabling users to access shared computing resources and information. His concept laid the groundwork for modern interfaces and the idea of technology enhancing human capabilities.

Kevin Warwick is a UK scientist known for his pioneering work in the field of cybernetics and BCIs. In the late 1990s, Warwick conducted experiments where he implanted a microelectrode array into his own arm to explore the possibilities of direct human-computer interaction. He also carried out experiments involving neural implants to control external devices and even communicate basic commands between his nervous system and computers.

Kevin Warwick Implant

Neuralink implant: source neuralink.com

While his work sparked both interest and controversy, it contributed to the broader understanding of neural interfaces and the potential applications of BCIs. Warwick's self-implantation experiments explored the direct connection between humans and technology, foreshadowing possibilities like Neuralink.

Read the interviews: **Kevin Warwick**

What is Distinctive About the UK HCI Community?

After the Alvey years, from the early 1990s onwards many areas of the country became involved in HCI research, partly through meetings and increasing use of email for communications; partly through the various UK HCI journals and conferences; partly because of links made between individual researchers due to Alvey collaborations and, later, by EU/EC funded major programmes such as ESPRIT, RACE and others.

There was also a gradual introduction of HCI to the university curricula, and a series of academic texts, edited books and textbooks published in the UK. There were new published standards in more specific aspects of HCI such as screen displays, keyboards, ergonomic issues and, later, 'usability' standards; finally there was a take-up of HCI research in business research centres, most notably, those of British Telecom and IBM. In addition, new small consultancies offering new services were being set up, one significant start-up being Tom Stewart's *Systems Concepts*.

I asked some interviewees what they think is distinctive about the HCI community in the UK. Professor Alan Newell says: "I think that British researchers are more interested in the sociological aspects of computers as opposed to American researchers, these are gross generalisations, who are focussed on the technology rather than the people. So I think the British researchers have raised the awareness that human-computer interaction is about people, not about computers."

HCI has always been a field with a special interest in the social, political and developmental aspects of technology. In particular, we can think of work by people such as Andy Dearden in participatory design of information and communications technology to improve lives for individuals and for communities; this is the basis of ICT4D (Information and Communication Technology for Development) pursuing effective approaches for ensuring development for the poor and marginalised.

According to Professor Gilbert Cockton, what is peculiar about the UK is the interdisciplinary working: "We don't have the hierarchies, autocracies and structures that just drive wedges between subjects. And the funding regime, so the Alvey Project made people work together, then the interdisciplinary research centres made people work together. And risk taking and boldness."

Gilbert Cockton and interdisciplinary working

Conclusions

We have seen how HCI has evolved during the last 75 years, from command-line terminals to Graphical User Interfaces, from multi-touch and gesture interactions to Voice User interfaces, powered by AI. With ubiquitous and pervasive computing, mobile phones and the IoT we live in a world where computers are everywhere and connected; they are embedded in our everyday objects and sometimes they have already entered our human bodies with the Internet of Medical Things.

HCI underscores the delicate interplay between design, accessibility, and societal impact. With its influence extending to healthcare and the frontiers of brain-computer connectivity, HCI shapes the way we live, work, and connect in an increasingly digital world. HCI is fundamental in the design of a technological device and it can lead to successful examples like the iPhone or failures like the Google Glass; the latter, despite its innovative concept, faced failure due to concerns about privacy, social acceptance, and unclear use cases, leading to limited adoption and eventual discontinuation.

The pervasiveness of digital technologies can improve people's lives but also deepen existing divisions. Digital inclusion and participation have always been a focus of the UK's HCI scholars, as they aim to maximise the potential benefits to well-being and minimise the potential harms that arise from the increasing use of digital technology. HCI research in the UK continues to be a dynamic and innovative field, with researchers exploring new frontiers in interface design and interaction techniques.

The evolution of human-machine symbiosis continues with advancements in AI, biotechnology, nanotechnology, and more. As technology advances, the potential for deeper and more sophisticated forms of fusion between humans and machines is bound to expand further. With the continued growth of computing technology and the increasing importance of it in our daily lives, the field of HCI continues to be a crucial area of research and innovation.

Elisabetta Mori

Acknowledgements:

Archives of IT

Worshipful Company of Information Technologists

with the support of

History of Computing Collection

I would like to thank:

Tom Abram, Martin Campbell-Kelly, Helen Carter and Mark Jones at the Archives of IT; Paul Excel at the WCIT; Chris Speed, John Vines and Roxanne Wong at the University of Edinburgh; Troy Astarte, Alan Dix, Harold Thimbleby and John Tucker at the University of Swansea; Michele Bottone at Middlesex University; Giulia Del Piero and Rocco Poiago.
Michael Brady, Gilbert Cockton, Mischa Dohler, Ernest Edmonds, John Long, Linda Macaulay, Dianne Murray and Alan Newell for sharing their memories with me. I also would like to thank Rory Cellan-Jones, Robin Christopherson, Chris Curry, Steve Furber, Herman Hauser, Peter Hermon, Andy Hopper, Frank Land, Mike Noll, Clive Sinclair, Michael Taylor and Kevin Warwick for sharing their memories with the Archives of IT.