Information age? The challenges of displaying information and communication technologies

Introduction

> We can see now that information is what our world runs on: the blood, the fuel, the vital principle. (Gleick, 2011, p 8)

> Information is not an abstract entity but exists only through a physical representation, thus tying it to all the restrictions and possibilities of our real physical universe…information is inevitably inscribed in a physical medium. (Landauer, 1999, pp 63–4)

On 24 October 2014 the Science Museum opened a major new permanent gallery, Information Age. Five years in the making, the gallery examines the last two hundred years of information and communication technologies, inviting visitors to take a long view on our ability to generate, share and store information. In creating the gallery we were conscious of a pervasive myth of our current age: the idea that we are living in a world where our connected digital devices have made us faster and more efficient, and that this rapid transformation of technology has caused a paradigm shift in one positive leap for humanity. In Information Age we wanted to challenge this idea, inviting our visitors to consider their personal experience of change through technology, but to see it in the context of the experience of our predecessors. We wanted visitors to encounter the novelty of the electric telegraph in the 1840s, to understand the ways that the use of new telephone technologies supported and disrupted existing social structures, and to view 'new' computer networks such as the World Wide Web as a part of the 'old' networks of the telephone and telegraphy. But such an approach brought with it a number of challenges for a museum display.

This paper examines the approach of a major new gallery on information and communication technologies in the Science Museum, situating it in the context of current ideas around the history of technology and exploring the way the curatorial team addressed the challenges of display and interpretation. As a short discussion piece it looks at four broad questions: How has

the concept of information, and more importantly an 'Information Age' been conceived across differing disciplines? What opportunities can user focused histories present to a gallery on information and communication technologies? What are the challenges for presenting such an abstract concept in a gallery environment? And how can a museum do justice to the display of a technology that is in one sense physical, made up of cables, transmitters and receivers, but at the same time ephemeral and transient, as the information passes through the network? In this way the paper shows how current museum practice both responds to academic themes in the history of technology, whilst negotiating an interpretation approach that engages the public in the history of information and communication networks.

Figure 1

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The alluring aerial tuning inductor from Rugby radio station was placed at the heart of the *Information Age* gallery to juxtapose the idea of old and new technologies. Using call-sign GBR, Rugby sent out Very Low Frequency (VLF) messages from 1926 until 2003.

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A broad concept of Information

The first challenge for a gallery on the Information Age was that the concept itself is loose and open, used in many different disciplines, in many different ways. For those from a science and electrical engineering background the idea of information has a very specific meaning – a unit of information or binary digit forming a 'bit' that can be quantified and shared between a transmitter and receiver. But for the social sciences, in particular sociologists, the idea of an information age – a society brought about by new information and communication technologies – is a complex and multifaceted one that has caused much debate and discussion since it came to the fore in the 1970s.

The concept was perhaps first alluded to by John Stuart Mill (1806–73) in The Spirit of the Age (1831). Here Mill suggested that progress was not due to an increase in knowledge or the discoveries of science, but due in part to the distribution and sharing of knowledge in society:

Men may not reason, better, concerning the great questions in which human nature is interested, but they reason more. Large subjects are discussed more, and longer, and by more minds. Discussion has penetrated deeper into society; and if greater numbers than before have attained the higher degrees of intelligence, fewer grovel in that state of abject stupidity, which can only co-exist with utter apathy and sluggishness. (Mill, 1831 in Himmelfarb, p 56)

Although not driven by a sense of technological progress, Mill's notion of knowledge distribution came at a time of rapid industrialisation. During the nineteenth century there was a vast growth in the need to process information. The development of the insurance and banking industries, alongside the creation of a complex national and international telegraph network, brought with it a new reliance on the transfer and sharing of information, and a new era for the information machine (Campbell-Kelly and Aspray, 2004). At first much of the calculation and record keeping was done by people, then known as 'computers'. These were clerks that calculated the numbers by hand, later using mechanical desk calculators such as comptometers. But the rapid increase in the volume of information needing to be processed and stored required a new type of machine that could cope with all this information at an industrial scale. Help came at the end of the nineteenth century in the form of Hollerith's punched card machines. Hermann Hollerith (1860–1929) devised a series of these electromechanical sorters and tabulators which could rapidly count and store the digital information held on thousands of individual punched cards. The devices were rapidly adopted for numerous purposes, from calculating the census to payroll and structural engineering. They would go on to lay the foundations for our information processing industries.

Although the idea of a society defined through the transfer of information has its roots firmly in the nineteenth century, it wasn't until the twentieth century that the concept of an information society became a central feature of much discussion in scientific and sociological literature. Perhaps most notably, the mathematician and engineer Claude Shannon defined information theory and gave it a mathematical underpinning with his seminal paper 'A Mathematical Theory of Communication' (Shannon, 1948). In this article Shannon looked at how to send messages electrically, through a process of encryption and transmission. He argued that from an electrical engineer and a mathematician's perspective the semantic meaning of the communication being transmitted was not important. Instead the focus should be on the selection of material to be sent. Shannon showed how communication could be determined mathematically by focusing on the transmission of a signal between sender and receiver, through a channel. For Shannon all channels contain noise, or error, and the challenge for an engineer was to reduce the ratio of the noise in relation to the signal, whilst working within the capacity of the channel. He developed the idea of entropy in information, as a way of measuring the amount of uncertainty in a message. Similarly, his idea of redundancy provided a way of looking at the predictability of the information carried. For instance, if a letter was predictable it was redundant, and therefore didn't need to be carried through a channel.

At first Shannon's ideas did not find much traction (Gleick, 2011, pp 233–44), but later their relevance was identified in areas such as cryptography and compression, and more broadly in science and engineering. By the 1950s information theory even found purchase with linguists, biologists, psychologists, social scientists and visual artists (Eames and Eames, 1953), who picked up on the relevance of the concept to human cognition and personal communication. Shannon himself cautioned that information theory was becoming a 'bandwagon' and suggested that 'it has perhaps been ballooned to an importance beyond its actual accomplishments' (1956, p 3). Despite these concerns, his theory still forms the basis for the compression and transmission of all digital information today.

As well as being tackled mathematically, the concept of a new age of information was also brought to the attention of social scientists and economists by the sociologist Daniel Bell. The idea of a post-industrial society was expressed in his book *The Coming of Post-Industrial Society* (1973) where Bell argued that the Western World was moving towards a service economy and away from a production economy, later coining the concept 'the information society'. Critics of his argument maintained that nothing had changed and that this state is just a natural extension of capitalism, as society moves towards the production of goods and services that are desired rather than required.

More recently the idea of an information age, underpinned by the creation of new technical networks, was put forward by Castells, who argued that information is the basis for productivity and power, enabling existing power structures to maintain control, with the relationship between capitalism and technology one of mutual reinforcement:

The rise of the network society…cannot be understood without the interaction between these two relatively autonomous trends: development of new information technologies, and the old society's attempt to retool itself by using the power of technology to serve the technology of power. (Castells, 1996, p 52)
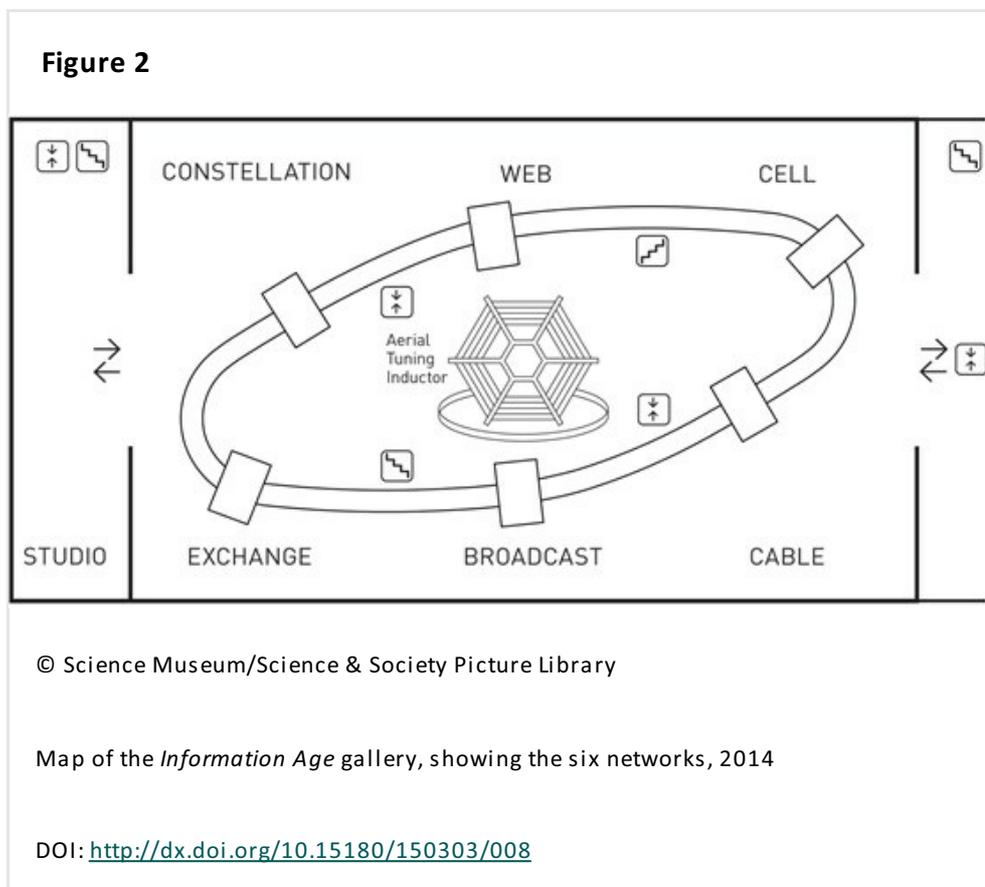
Whilst acknowledging the maintenance of existing power structures, both Bell and Castells' sociological accounts imply a discontinuity with previous forms of society and economy. Webster (2006) suggests they fail to acknowledge the continuity that exists within different periods of capitalism, or that the technological networks of the nineteenth, twentieth and twenty-first centuries (broadly construed as people, organisations and technologies) contain similarities and coherence.

It was for this reason that we wanted to examine the historical form of such change in the gallery, enabling visitors to question whether they really are living in a new information age, or whether many of the structures of society and technological networks have similarities to those that came before.

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Storytelling in the information age

To enable visitors to engage in the elusive idea of information, and the form of an information age, we chose to take an interpretation approach based on multiple narratives. Rather than attempting to provide a grand narrative addressing the question of 'Are we living in an information age?', or presenting a single viewpoint on the changing nature of our capitalist society, we identified a series of historical moments that could each provide a lens on the socio-cultural history of the technology. We chose these moments to show how new forms of information and communication technologies had shaped new structures, such as industry, entertainment and employment, whilst reinforcing existing ones.

Figure 2

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Map of the *Information Age* gallery, showing the six networks, 2014

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Dividing the gallery into six 'networks' (of people, places and ideas, as much as technologies), we chose transforming events or moments in history where social and economic change was as evident as any major developments in technology. In this way the *Information Age* gallery is first and foremost a human history, told through the stories of the ambitious Victorians who wrapped a cable across the world, the BBC producers who hoped to bring the world together using satellite technology, or the Cambridge entrepreneurs who stumbled across a low-powered microprocessor that would fuel the development of the smart

phone.

Figure 3

© Andrew Meredith for Universal Design Studio

A view of The Constellation and The Exchange Storyboxes in the Science Museum's Information Age gallery, 2014

In each network we identified three or four stories, making a total of 21 across the gallery. Through each story, we explore the ability of technology to shape, transform and solidify existing social relations and power structures. One example, showing the multiple ways technology and society are co-constructed, is the story of the development of the manual telephone exchange. This provided a new generation of women with an opportunity for employment which they were previously distant from, but it also maintained a hierarchy between the switchboard operators and their supervisors that enforced strict rules about gossip and etiquette on the telephone.[1] Through oral histories and the display of our CB1 manual telephone exchange from 1922, we illuminated the skills that these women developed operating complex technical machines. As well as the experience of operators working in an exchange, the gallery also explores the implications of the introduction of the later Strowger equipment, where the development of faster technology made a largely female workforce redundant in the drive for modernisation. The idea was that through such stories we would show not only moments of 'new' technology and rapid change, but also how slow and personal such transformations could be. The Strowger telephone exchange was first patented in 1891, yet the last manual telephone exchange was operated in Britain until 1976.

An interactive on the *Information Age* gallery invites visitors to experience life working as a telephonist on a manual telephone exchange

The long view

The newness of 'new' technologies has been addressed by historians (Marvin, 1988; Edgerton, 2006), with Edgerton arguing that the history of technology is too focused on the moment of invention, to the detriment of developing a richer history that incorporates the technologies that have become so everyday they are often perceived to be mundane. Traditionally, museum displays have also been open to this criticism, emphasising novel technologies and a moment of discovery or invention, rather than the arguably more transformational period when technologies are used and integrated into people's everyday lives.

The aim for each of the networks in the Information Age gallery was explicitly to focus on this long use, for instance showing in The Exchange network not just the personal motivations of Alexander Graham Bell when developing the prototype telephone, but the opportunities that telephony subsequently opened to a new female workforce. It also highlights the way telephone usage was negotiated in the home, and its ability (nearly eighty years after Bell received the first patent) to act as the technological platform for innovative new services to those desperately in need, through the Samaritans helpline.

Taking as a starting point the work of Oudshoorn and Pinch (2003), which showed how users are involved in the co-constructing of technologies, we wanted the gallery to reflect the experience and contribution of users as well as innovators. To achieve this we interrogated both the (relatively) short histories of specific inventions and the longer histories of diffusion and use within society. This approach also opened up the interpretive landscape of the gallery, away from the familiar histories of white middle or upper class male inventors, allowing us to bring to the fore histories which illuminate the contributions of more diverse sections of society to the shaping of technology. In this way we could show how information and communication technologies can both work to disrupt existing social structures and be used to maintain existing power relations.

The benefits of such a user-focused approach are demonstrated, in terms of both historical research and gallery output, in our approach to the history of the world's first business computer, the Lyons Electronic Office, or LEO. LEO 1 was developed for the Lyons catering firm by the Cambridge Computer Laboratory (then known as the Mathematics Laboratory). In 1949 a team at Cambridge led by Maurice Wilkes and Douglas Hartree had developed EDSAC, a new computer for university research purposes. The team at Lyons heard about the machine and saw the potential benefits that digital electronic computing could offer to their business, so they approached the university with an offer to part fund the development of EDSAC in return for subsequent help creating their own business oriented machine.

During the research phase of the Information Age gallery we were able to work closely with surviving members of the LEO team to record their oral histories and explore not only the creation but the operational history of the machine. The result was an oral history with a much wider range of roles and a far greater gender balance. There were many women among the voices of the engineers, programmers, data entry clerks and teashop manageresses that we interviewed, all of whom were either given new roles at Lyons or whose working lives and functions were considerably changed through the introduction of the computer. The resulting audio exhibit in the gallery doesn't look at the development of LEO per se; it explores the range of ways that the machine both supported and changed existing hierarchies between the engineering, clerical and managerial staff at Lyons, to show how the computer changed forms of work and control over production. The use of the machine throughout the 1950s for bakery valuations and payroll calculations and the way that this changed the nature of work at Lyons is of at least as much importance in understanding the impact of the world's first computer for business applications as the more limited and traditional study of the team that 'invented' LEO.

Yet despite our attempts to take a long view on the history of technology, and extensive historical literature that promotes this approach, society and the media still expect science museums to conform to the norm, presenting stories of invention, preferably by a lone genius (Jordanova, 2014; Schaffer, 2014). Such narratives also intertwine with a prevailing belief in modernity and a myth of exponential progress that privileges the 'now' as a time of ever more rapid, more pervasive and more significant technological change (Lane Fox, 2015). Information Age encourages the audience to challenge this view. With a perspective of multiple 'nows' over the last two hundred years and many moments of change which could, from the perspective of the time, make a reasonable claim to be unprecedented, the gallery intentionally questions the current view of relentless change, acceleration and progress through our digital devices; to show, as Wajcman (2015) does, that we are not mere hostages to our communication devices, but that society co-constructs the forms of technological use that we partake in.

Such an approach involves significant research work for a museum. In attempting to address the balance between displaying a history of use and a history of invention, it was necessary to seek out and reflect a range of voices often absent from written histories. These are the histories 'from below'; not the formal histories of governments and those in a position of authority, but the often unrecorded experience of daily life at every level in society. To capture these accounts we developed a variety of research strategies and audience participation projects with the direct aim of reflecting diverse histories in our displays (for more information see Bunning et al. in this issue). The results can be experienced in the gallery in a number of ways, such as through the voice of the black activist and singer Paul Robeson, who gave a concert from New York to London using the first transatlantic telephone cable, the TAT-1; through the Cameroonian entrepreneurs who have learned to develop and mend mobile phone technology, self-taught through the internet; and through the stories of the Samaritans' first callers and listeners who saw the potential of the telephone for helping those desperately in need.

Figure 5

Paul Robeson and Alfie Bass communicated via the first transatlantic telephone cable, the TAT-1, in 1957. The installation is played above an original submarine repeater used to amplify the signal travelling through the cable.

This detailed historical research opened up a far richer – often female – narrative for the gallery. It would be tokenistic and ahistorical to present women as playing a major role in the creation of early communication technologies – there simply is no

female counter-part to Charles Wheatstone, Alexander Graham Bell or John Logie Baird, because women had little access to the education, capital and resources available to male inventors and scientists. But if women rarely made these machines, they were central to the way they were used, adopted and integrated into society, changing social relations in the process. By focusing on the ways that technology was operated and used we can see the strength of women's roles in information and communication technology – as programmers, communicators, operators – who all helped to define the meaning of these information machines as they became central to our world.

## Translating abstract ideas into physical space

Another challenge for science and technology museums is that often they are charged with representing a scientific idea – or a concept – to visitors, but the idea itself has no physical manifestation that can be placed in a gallery. When that theory is associated with the idea of information the challenge is no less difficult.

Alan Turing's 1936 paper 'On Computable Numbers' (1936) was a thought experiment designed to explore the concept of a universal machine, a machine that could manipulate symbols according to a series of logical steps. His published paper is the only physical manifestation of these fundamental ideas that formed the basis of modern computing. Similarly, Claude Shannon first set out his ideas for information theory in his 1948 paper, giving a mathematical underpinning to the transfer and reception of information. Apart from his published paper, the Science Museum has no physical artefacts that directly represent Claude Shannon's ideas. Both concepts are fundamental to the intellectual underpinnings of the creation of information and communication technologies. Yet both are contained within complex academic papers which mathematically express an idea, but in a way that is alien to the experience of most museum visitors.

Acknowledging that both Turing and Shannon were central historical characters in the gallery, we chose to tackle this by viewing all of these concepts as socially constructed and therefore as legitimately understood through their human and personal history. For the *Information Age* team these seminal papers could be explored through the people and times in which they were imagined and through the subsequent technologies which rely on these initial ideas. We displayed the front page of the published papers, alongside objects from Bell Labs and Manchester University where Shannon and Turing respectively worked. Turing's paper was placed near the Pilot ACE computer, the prototype computer which was based on Turing's initial 1946 designs but completed in 1950 by another team.

By placing Shannon and Turing's academic papers side by side we could also allude to a little known moment at the end of 1942. This was the point when Alan Turing and Claude Shannon met in a cafeteria at Bell Labs during the Second World War to discuss their shared interests. Although Shannon's paper on information theory was yet to be published, both men had a common interest in cryptography and the question of whether a machine could mimic a human brain. By positioning their portraits and papers side by side, the gallery invites visitors to imagine these two great minds coming together to make their own links between the people, their conversation and ideas.

Figure 6
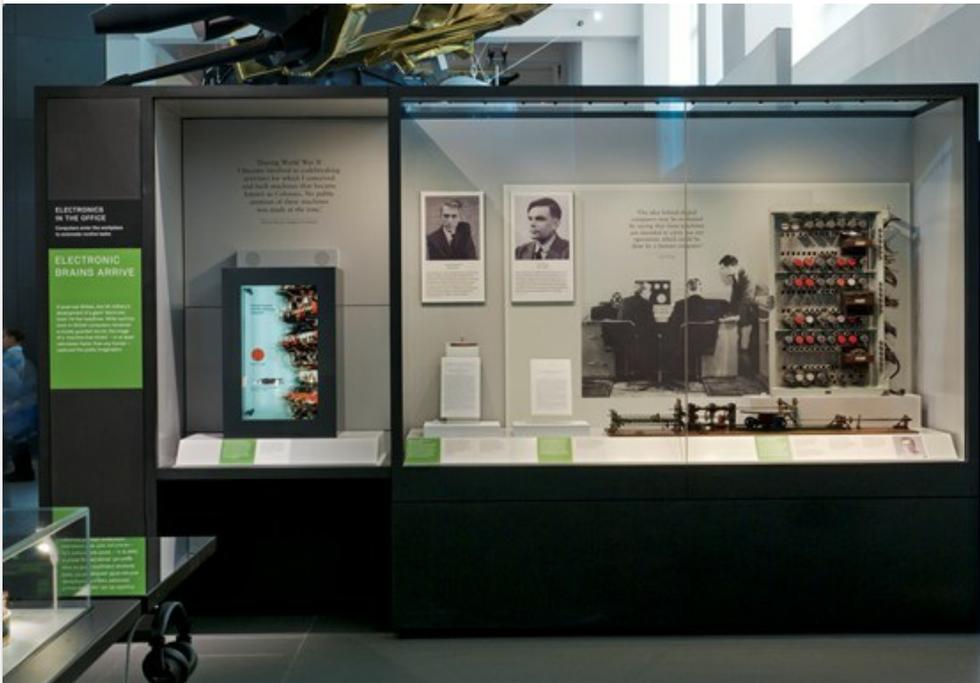
View of one of the cases in Information Age on computing, showing Alan Turing and Claude Shannon side by side, alongside a valve from the Colossus computer and a part of the Manchester Mark 1* machine

Displaying hidden infrastructure and the non-material nature of information

Another challenge for *Information Age* was that of displaying the physical and non-physical nature of information. Museums capture and display the material evidence of information and communication technologies – the machines that enable us to transfer, store and manipulate information. It is through the computers, books, microfiche, floppy disks and punched cards that information is stored and passed between people; the materiality of the information gives it a legacy. But by focusing on the more accessible and recognisable materiality of information, museums tend to concentrate on the consumption side of information technologies. We display the devices that consumers used or had access to; those that may evoke nostalgia for the objects of the past. We often fail to represent the hidden or more mundane infrastructure technologies. This may be because they are more difficult to understand, or as hidden technologies may relate little to visitors' lived experience, but they are just as vital for enabling information to be transferred. They form a central part of the invisible network of transmitters, masts, routers and copper and fibre-optic cables that wrap around our world. The geography and ownership of such infrastructures says as much about the purpose and practice of the information and communication technologies as the more familiar end user devices.

It was for this reason that the *Information Age* team tried to ensure that we included many representative examples of technologies that would normally have been concealed from the end users. The cluster of exhibits on *The Cable* included an exhibit facade that was covered in many different forms of cable, from early telegraph cables surrounded by gutta percha to telephone wires and thin fibre-optic cables. Other highlights of the gallery display are infrastructure technologies that have a big impact through their size or aesthetic, such as a hugeaerialtuning inductor from Rugby Radio Station (1943), an early

Google 'corkboard' server (1998) that enabled the company to support web searches, an actual Eurostar 3000 communications satellite (2000) and the BBC's first transmitter, 2LO (1922). We even commissioned a model of the Shabolovka radio tower in Moscow (1922) to show how the social and cultural trajectories of post-revolutionary Russia helped to shape the form of radio technology in the Russian landscape.

But this still doesn't overcome the issue that the actual information transferred – the bits and data – is transient and insubstantial. By acquiring and displaying the machines, we are not acknowledging the history of the media they conveyed. When the machines are turned off, and the messages cease to flow, the signal is no longer captured or transmitted. Just as the scientist Landauer ([1999, pp 63–7](#)) described the notion that information has an existence independent of its physical manifestation as 'quaint', so, conversely, the idea that we can display the technology without its non-physical manifestation seems dated, providing as it would only a partial understanding of the social construction of the technology. For some technologies information is physically embodied when it is stored (in a letter, a telegram, on a punched card, on a map) but for others it becomes ephemeral when it is shared. Television and radio programmes define the culture and history of information technologies, yet few science and technology museums have tackled the display of this media as part of a broader understanding of information and communications technology. Computers are defined as a 'universal machines' due to their ability to use a series of logical instructions (programs) to manipulate data for a range of different functions, but it is this central universality, the software, that is rarely displayed in museums.

In the *Information Age* gallery we attempted to address this problem directly by bringing the messages together with the technology. In one example we developed a series of 'radio totems' that brought some of the earliest recordings from BBC radio together with the Museum's impressive collection of home-made and manufactured radio sets from the 1920s and 30s. The plan was to create a soundscape that enabled visitors to reflect on the experience of radio as a novel phenomenon, a new medium that was still experimenting with how to 'inform, educate and entertain'.[2] In another we created a cast of a Bush 22 television that plays part of the original 1953 broadcast of the Coronation of Queen Elizabeth II so that visitors could experience the programme at the same size and quality as the original.

For computing technology displaying the media together with the technology is a challenge. Unlike the nostalgia that is evoked by, say, a telegram, the display of emails or web videos is too mundane and contemporary to be effective – there is not enough distance for reflection or consideration through an interesting cultural lens. In considering the World Wide Web we decided to focus on how information is shared and transferred through the network. Working with the inventor of the web, Sir Tim Berners-Lee, and inventor of hypertext narratives Tim Wright, we developed an environment that explored ideas such as web addresses, coding and packet switching. The plan was that the abstract concept of a distributed information network could be explained to visitors by understanding how emails, videos and text were transferred and shared on the web. The narrative was explored through a six-meter high box – a Storybox – that provided a unique experience for this network. The Storybox is 'clever', being fed with regularly updated information about the London Transport underground network, the weather and time until the museum closes, each subtly changing the narrative in real time. Thus the *Information Age* gallery not only displays the physical artefacts of computer networks, but highlights the 'messy complexity' ([Wright, 2015](#)) of networked and programmable machines.

Figure 7

The Web Storybox uses a hypertext narrative and live data feeds to explain some fundamental aspects of the World Wide Web, such as web addresses, HTML code and packet switching

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Conclusion

Claude Shannon's analysis of information ruthlessly sacrificed the meaning of the message in information, seeing the concept of information as a purely mathematical entity that could be quantified and transferred without regard to the human significance of each binary digit. In developing the Information Age gallery, the Science Museum has taken a polar opposite approach. We have shown that information and communication technologies, and the signals and messages they carry, reflect the culture and societies that use them. The gallery embraces narrative and storytelling to explore the cultural significance of information and communication technologies at particular moments in history. It focuses on a range of users of the technologies, not just their moment of invention. And it strives to look at the media that was transferred through the technology, as well as displaying the consumer devices and back-end infrastructure of information networks.

By placing the concept of information within this rich historical and cultural context, we have re-wrapped the term within its original layers of meaning (as well as adding some new museological ones) and shown that information is a generous concept through which we can explore not just the forms and social structures of the past, but the way information and communication technologies disrupt and support our lives today. Shannon may have shown that the semantics of information play no role in its mathematical theory, but as a museum we are better placed to explore and display the social, historical and cultural dimensions of information than its abstract and numerical features.

Ultimately the *Information Age* gallery will be successful if the objects and narratives we have chosen enable visitors to engage with this important and complex part of human history. As well as unique personal stories, the gallery contains over eight hundred objects from our collections, many on display to the public for the first time. In the first four months since opening,

over 300,000 people visited, making it the museum's most popular gallery to date. Further evaluation currently being conducted will tell us more about visitors' experiences and the meaning they make from the gallery. We hope the Information Age will continue to grow as a place where audiences can share and reflect on the long history of information and communication networks, whilst considering the dimensions of an information age.

Tags

- History of technology
- History of communications
- Science and society
- Exhibitions
- Curating
- Science museums

Footnotes

1. For a discussion of the introduction of female telephone operators in the UK see 'Troublesome Telephony' by Michael Kay in this issue.
2. The mission statement of the BBC coined by its first Director General, John Reith. (From the Royal Charter of the BBC, 20 December 1926.)

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