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The Internet and the World Wide Web

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Computers began to find their way into the cinema in the 1950s, but these early computers were seldom connected to any others. It was not until 1983 and the release of *WarGames* that the networking abilities of computers insinuated their way into popular culture, resulting in a mixture of awe and dread. In that film, a young high school student connects his computer, via telephone, to what he believes to be a computer game company. In truth, he has unintentionally hacked into a military computer, which he almost provokes into starting World War III. *WarGames* distinguished itself from earlier films about computers in its emphasis on computer-to-computer communication for its narrative arc. This film and the 'cyberspace' of William Gibson's novel *Neuromancer* (1984) introduced computer networking into mainstream narrative texts.[1] Moreover, they roughly coincide with one of the various 'births' of the Internet. In 1982, the basic rules, the fundamental protocols, governing the networking of networks were finalised. Indeed, it is from these protocols that the name, 'the Internet', derives. In the early 1980s, however, the Internet was still the arcane province of inventors, government engineers and computer hobbyists.[2]

For many in the general public, the Internet remained a rather murky, ill-defined notion until the World Wide Web began popularising network access in 1993. However, the Web itself was actually invented two years before that rush of media and public attention. Furthermore, the principles that underly it can be traced back at least 50 years. To understand the origins of the Web, we must look at how its concept of interlinked documents evolved and how an interface for navigating through those links emerged.

TEXT BECOMES HYPER

The principal conceptual source for the Web is the work of Vannevar Bush in the 1930s and 1940s. Bush proposed a unique method of data storage and retrieval in the 1945 essay 'As We May Think', which appeared in *The Atlantic Monthly* and was disseminated widely through excerpts in *Life* magazine. At a time when the first fully electronic computers had barely materialised, Bush was envisioning the Memex, a radical data system. The Memex would contain *all* of one's books, letters, photographs, microfilm and so on, and facilitate access to them through a few flips of levers, resulting in material being projected onto a

desktop screen. Moreover, Bush envisioned a unique method for creating 'trails' through these data. As one hopped from item to item, a record or 'trail' was kept of the route one took, connecting items to each other. The Memex was never actually built, but clearly it provides the conceptual framework for much of what we take for granted in today's Web browsing: links between text and images, bookmarks, the ability to move backwards through the Web pages you have already visited, and so on.

The Memex's principle of linked data bore fruit in 1960 when Ted Nelson began work on Project Xanadu, a largely unrealised effort to implement his concept of 'non-sequential writing'.[3] For Nelson, as for Bush, thinking is not sequential or linear. Instead, it jumps from one concept to another. It is associative and nonlinear. The computer, Nelson argued, could facilitate this associative and non-sequential logic. In 1963, he coined the terms 'hypertext' and 'hypermedia' to refer to this associative linking between words and images in Xanadu.[4] But Xanadu still remains mostly incomplete. Even though its proponents declare that the Web is a 'diabolical dumbdown of [their] original hypertext idea', until now it has proved to be the most successful 'non-sequential' phenomenon in the history of computers.[5]

The legacy of Memex may be observed in several important hypertext experiments in the decades after 1945, but none of them attracted much attention from the general public.[6] Hypertext would not become part of our lexicon until the early 1990s. At that time, Tim Berners-Lee, an English computer programmer, was working at CERN, the European Laboratory for Particle Physics near Geneva, Switzerland.[7] In March 1989, he circulated a proposal for a hypertext-based 'information mesh'. This mesh became identified as the 'World Wide Web' during 1990 while he was actually creating the program to run this system. Berners-Lee began demonstrating Web software in late 1990 and in summer 1991 it was installed on CERN's main computers, announced to the public via various Usenet newsgroups, and its software (both client and server) distributed freely via the Internet.[8] Berners-Lee had created the two basic building blocks of the Web: a protocol for exchanging files across the Internet and a set of conventions determining how text would appear in Web browsers. With the hypertext transfer protocol (HTTP) and the hypertext markup language (HTML), Bush's dream of the Memex was beginning to become a reality. And even though Nelson, who coined the term 'hypertext', dismisses the Web as a bastardisation of his Xanadu project, it is clear that HTTP and HTML brought hypertext navigation out of research laboratories and into homes and offices across the world.

ILLUMINATING THE WEB

It has become commonplace to remark upon the meteoric rise of the Web, but in 1991 it was essentially a text medium that seemed no more remarkable than other information-distribution systems such as the University of Minnesota's Gopher. In June 1993, two years after the Web's release to the Internet at large, there were approximately 130 Web servers worldwide and it was showing good but not outstanding growth. One year later, the number of servers rose to 2738, more than 20 times more than the previous year. During the next year, the number increased another eight-and-a-half times to 23,500 servers, a

phenomenal 179,769 per cent growth rate over two years.[9] The impetus for this mid-1990s Web interest was a browser that could effectively handle images and position them on the screen. In 1993, the Web's first 'graphical user interface' (GUI) was introduced, which turned the Web into the Internet's 'killer app', an application that attracted millions to the Internet.

When CERN released Web software to the Internet in 1991, most personal computer users were accustomed to a graphical user interface. Berners-Lee's text-based Web seemed like a throwback to pre-Mac, pre-Windows computing. To succeed, the Web needed its own GUI and that was just what Marc Andreessen and a team of students at the University of Illinois at Urbana-Champaign provided. Andreessen was working as an undergraduate intern at the University's National Center for Supercomputer Applications (NCSA). In just three intense months, Andreessen and NCSA staff member Eric Bina generated 9000 lines of programming code and created a Web browser that wholly integrated images into the Web experience. They called their browser Mosaic and announced its release on Usenet newsgroups on 23 January 1993. The initial release of Mosaic was built for the Unix operating system, which runs on very few home computers, but Windows and Mac versions arrived later that year and requests for Mosaic soon swamped NCSA.[10] Its instantaneous success heralded the beginnings of a new, graphically oriented Web.

Andreessen did not remain long at NCSA once the popularity of Mosaic became obvious. He and the other key members of the Mosaic team were courted by Jim Clark, the founder of Silicon Graphics and a successful producer of high-end graphics computers. In April 1994, they incorporated a new company to create a Web browser similar to Mosaic. In fact, they initially intended to call the company Mosaic Communications, but when they found they did not have legal rights to the Mosaic trademark, they changed the company's name to Netscape and the browser they were to create became known as Navigator (though most people just referred to the browser itself as 'Netscape').[11] Tackling the programming job with the same mad enthusiasm that they had with Mosaic, Andreessen and his Netscape team released their first version of Navigator in December 1994, just eight months after the company's official incorporation. Navigator was a noticeably better browser than Mosaic. It was faster, crashed less and displayed images and text in new ways. Further, Navigator's success was nurtured by the free distribution of its fully functional 'beta' (test) versions, which were always available for download. Most of Navigator's sales were to corporate buyers; individuals tended to rely on the free beta versions. Moreover, Netscape's Web server (and not its client, Navigator) provided its principal revenue stream. Netscape was one of the most successful of the so-called 'dotcom' businesses (so named for the '.com' ending to their domain names), with an initial public offering on the stock market that placed its worth at $1 billion.

Netscape's success did not go unnoticed by Microsoft, which thus far did not even own a browser. In late 1994 and 1995, while preparing Windows' first major revamping in five years, Microsoft CEO Bill Gates was suddenly awakened to the Web's significance. Microsoft quickly bought the software code for the Spyglass browser, a commercial version

of NCSA Mosaic, and dubbed it Internet Explorer 1.0, bundling it with Windows 95 when it was released in August. Windows 95 significantly improved Windows' networking capabilities and graphical interface (becoming a virtual clone of the Mac interface), but Internet Explorer was not as stable, efficient or fully featured as Navigator. Still, the call to arms had been sounded. Throughout 1995 and 1996, Microsoft and Netscape battled back and forth with new releases every few months. Microsoft integrated Internet Explorer deeper and deeper into Windows and did everything it could to discourage Windows' users from installing Navigator. Netscape joined in the chorus of voices claiming that Microsoft's actions were a monopolistic attempt to control the Web and an anti-trust suit was filed against Microsoft in 1997. The case would not go well for Microsoft, but by then Navigator's market share had decreased dangerously and it had gradually lost its technological advantage over Internet Explorer. In March 1999, AOL acquired Netscape and, even though Netscape remains as a separate entity today, the releases of Navigator have slowed to a crawl. There are even indications at this time (summer 2001) that Netscape may get out of browser business altogether.

LOOKING THROUGH THE WEB WINDOW

In a narrow sense, the Web could be thought of as only the text, images and sounds that are shared via the hypertext transfer protocol, such as those appearing on a simple Web page of text and still images. But that view of the Web is not true to Berners-Lee's original conception. He conceived the Web as a gateway to a broad spectrum of information sources. Thus, a remarkable variety of data has always been accessible through Web browsers. In other words, the browser–client has always been able to communicate with many different types of Internet servers (for example, Gopher and file transfer protocol). We view all manner of Internet resources through the windows that our Web browsers have become. Additionally, Microsoft and Netscape have bundled other Internet clients (principally e-mail and Usenet) with their browsers, blurring the distinctions among Web browsers and e-mail/Usenet readers. It is small wonder that novices do not comprehend the difference between the Web and the Internet.

The enormous variety of applications and services we routinely employ through our Web browsers makes it quite difficult to chart a comprehensive history of the post-1993 Internet. We will, however, sketch the evolution of a few key concepts and technologies, especially those pertaining to the convergence of the Web, television, cinema and other mass media.

AUDIO AND MOTION VIDEO

The introduction of audio and motion video to the Web has been slow, at least in comparison to the Web's normally hyperactive evolution. The graphics-centred Web that evolved in 1993 and 1994 was mostly silent and mostly still images, with some primitive animation. Soon after, however, audio/video add-ons or 'plug-ins' began to appear for Web browsers. Progressive Networks, which would become RealNetworks, pioneered the effective delivery of audio/video with RealPlayer in 1995. RealPlayer was among the first to use 'streaming'

technology over the Web. Previous forms of audio/video delivery required that users transfer entire files to their computers and then launch a media player to listen to them, a process that could take minutes or hours. Streaming media technology, just like radio and television, permits the listener to hear audio and see video within seconds of requesting it.

RealNetworks aggressively marketed RealAudio and RealVideo throughout the late 1990s and now claims 'to deliver content on more than 85 per cent of all streaming media-enabled Web pages'.[12] However, Apple and Microsoft have not conceded the delivery of audio and video to RealNetworks. Apple's QuickTime software has been around for as long as the RealPlayer and was the delivery system of choice for early attempts at multimedia Webcasting such as the Cable News Network's *CNN Interactive*, which formed in January 1995 and hosted about four QuickTime 'movies' (as Apple calls them) per day.[13] Microsoft has been catching up to RealNetworks and Apple with its Windows Media Player, which it has made integral to Windows in much the same way as it integrated its Web browser.

Despite RealNetworks', Apple's and Microsoft's efforts, most users still have trouble watching video over the Web. The image and sound quality is poor or choppy, and the video window is often very small. These technical difficulties have contributed to the failure of older media's attempts to colonise the Web. Television networks and film studios have effectively used the Web to promote programmes and films (for example, *The Blair Witch Project* (1999)); however, they have yet to succeed with the distribution of original content over the Web. This has largely been left to sites that feature independently produced short films, music videos, games and animation. Indeed, for independent producers the Web holds out the promise of the worldwide distribution of video produced on a shoestring budget. Ever since the invention of 8mm film, it has been possible for independent, avant-garde, student and amateur film-makers to make works for very little money, but until now there has been no method for them to distribute those works internationally. *Ifilm.com*, *MediaTrip.com*, *Shockwave.com* and other Web sites encourage independent video producers by distributing their work globally. Web evangelists are already predicting a video revolution with new, previously disenfranchised voices being heard, but it seems more likely that marketing will become the main factor determining which voices are heard above the ever-increasing din of media texts competing for users' attention.

The limitations to Web-based video delivery will not last forever, as audio and video formats improve and users obtain faster connections to the Internet. We have already seen in the early 2000s that audio (without video) can be 'transmitted' very effectively across the Internet. Thousands of conventional radio stations began sending their air signals over the Net once a critical mass of Web users had the capability to receive Internet audio transmissions and computers equipped to play audio. Full-screen, full-motion video cannot be far off. It seems likely that in the near future, television stations and film studios will have the same delivery capability as radio stations.

Merely having the appropriate video technology does not guarantee that traditional television or film corporations will succeed on the Web. They also must revise the mode of presentation of their products. Television and film are fundamentally 'push' media. The

entertainment/information is pushed at viewers from traditional television or cinema screens without viewers being able to pick ('pull') some bits while rejecting others, or change what is happening on-screen. The television remote control has made television into a more interactive medium providing viewers with some 'pull' to their viewing experiences. But the television remote control is still nowhere near as interactive as the computer mouse. Moreover, the Web is a fundamentally pull medium. *Nothing* appears in one's Web browser until the user requests it by clicking on the screen or typing in a Web address.[14] In terms of the client-server model, while standard broadcasting stations (servers) are always sending their signal, pushing/beaming it towards television sets (clients), Web servers only transmit data when the client specifically pulls/requests it. Moreover, Web clients can also transmit data back to servers through forms and interactive games, which is impossible in traditional television systems.

There have been attempts to transform the Web into a broadcasting-style, push experience, but they have so far met with failure. The most notable among these was PointCast, an application that sent news, weather, stock prices and so on to users' desktops, without them being specifically requested. PointCast was released in 1997 amid a flurry of media attention that presented it as the vanguard of a new Web. The cover of *Wired* magazine declared, 'The Web browser itself is about to croak. And good riddance. In its place . . . PUSH!'[15] But three years later, PointCast and the other 'push' applications met their demise. The PointCast failure does not necessarily mean that old broadcasting models will never work on the Internet. Indeed, they may find a new home in the transmission of data to personal digital assistants (PDAs) and cellular phones, as is suggested by the remnants of PointCast found in Infogate, an '*alerting service* offering the prioritized delivery of personalized news, financial information, sports, weather and messages via the Internet to your computer or wireless device'.[16] But PointCast's failure does fuel the debate raging over whether old-guard television/film producers will be able to market interactive television or interactive film successfully, or whether they would even want to do so. As the debate continues, the casualties of television networks' and film studios' Internet attempts mount. For instance, NBC formed *NBC Interactive* (*NBCi*) in 1999 with more than $100 million in cash. It boasted, '*NBCi* is driving the evolution of the Internet with interactive online and on-air content, rich media, search and directory, community features and e-commerce'.[17] Two years later, *NBCi* suffered huge financial losses. In the spring of 2001, NBC's parent company, General Electric, put NBCi out of its misery by folding its remaining services into its television-network business.[18] A similar fate was met in 2001 by *Entertaindom*, an attempt by AOL Time Warner to create a media hub.[19]

NBC and AOL Time Warner may have been thwarted in their Internet forays, but the purveyors of sexually explicit video have not. Much as pornographers led the way in the exploitation of the photograph and the videocassette, they have also been at the vanguard of Web-based commerce and putting real-time, interactive video online. Among the most successful of these is Danni Ashe, who created *Danni's Hard Drive* just two years after the initial release of Mosaic and used it to market nude images of herself and others.[20] Ashe,

whom the Guinness World Records once named the 'Most Downloaded Woman', and others in the sex industry were quick to pick up on technology linking video cameras, still or motion, to the Internet, but they were not the first with this technology. The first 'Webcam', or, more accurately, 'netcam', went online in 1991, as the Web was being developed at CERN. The Trojan Room Coffee Pot netcam was set up on a computer lab in Cambridge, England, by Quentin Stafford-Fraser, who explained its function:

> Some members of the 'coffee club' lived in other parts of the building and had to navigate several flights of stairs to get to the coffee pot; a trip which often proved fruitless if the all-night hackers of the Trojan Room had got there first. This disruption to the progress of Computer Science research obviously caused us some distress, and so *XCoffee* [the netcam device] was born.[21]

Although the still image refreshed only three times per minute and was initially limited to this lab's computer network and not the Internet as a whole, the Trojan Room Coffee Pot established that an individual could cheaply transmit video images across a network.

In April 1996, Jennifer Ringley, a student at Dickinson College in Pennsylvania, started a computer-connected camera in her dormitory room that periodically sent images of herself to her personal Web site. Much like a surveillance camera, *JenniCam* captured her quotidian life, mostly her staring at a computer screen, but also occasional glimpses of her masturbating or, after she graduated and moved to Washington DC, being intimate with her boyfriend. Soon other amateur exhibitionists and the sex industry were also using Webcams. Now there are Webcams showing everything from traffic and weather at key transportation junctures to the view from a Berlin taxi cab to the Dallas site of President John F. Kennedy's assassination (the Dealey Plaza Cam presents 'the ONLY LIVE view available in the world from the Sniper's Perch').[22]

The Webcam, whether created for personal reasons or as an element of a commercial enterprise, typifies the Internet's client-server model that so baffles traditional broadcasters. Users must seek out *JenniCam* and request its images before they appear on their computer monitors. Just before the decade ended, a variation on this client-server model would further baffle and infuriate the producers of copyrighted audio and video. Shawn Fanning, an individual who is 'driving the evolution of the Internet' much more than *NBCi*, released the file-sharing software Napster and thereby sparked a storm of controversy and litigation. In defiance of copyright laws, Napster users shared music files in MP3 format. Founded in May 1999, the Napster corporation was sued six months later by the Recording Industry Association of America (RIAA) for 'contributory and vicarious copyright infringement'.[23] Napster lost that case and was driven into bankruptcy in 2002, but Napster users and the RIAA alike realised that the peer-to-peer (P2P) genie had been released from the bottle as other Napster-like services – for example, Gnutella and FreeNet – already arisen.[24]

P2P's basic principle threatens the foundations of the recording, broadcasting, film and publishing industries because it radically restructures and decentralises distribution. In P2P

transactions, there is no central server. Even the Web, with its widely distributed information-sharing, still requires an HTTP server to provide data to HTTP clients. This is not the case with P2P transactions: in P2P, individual clients (peers) connect with one another and share data on an equal basis, client-to-client, and not server-to-client. Each P2P client is also able to act as a server. In this regard, Napster was not a pure P2P service. Napster clients or peers connected with their first servers, find out where other clients or peers located, then made a peer-to-peer connection. Because Napster clients connected through its server, the Napster corporation was vulnerable to charges that it was abetting music thieves. However, other P2P software does not use a central server and thus will be more difficult to litigate against. Moreover, the files they share are not limited to music. They can easily contain films or software or anything else that may be contained in a digital format. The essentially decentralised nature of P2P software is obviously anathema to major media corporations and their investment in the copyright system. P2P proponents make no secret of this. As Ian Clarke of FreeNet contends, 'You cannot guarantee freedom of speech *and* enforce copyright law. It is for this reason that FreeNet, a system designed to protect Freedom of Speech, *must* prevent enforcement of copyright'.[25]

ONLINE GAMES AND VIRTUAL REALITY: INTERACTIVITY AND IMMERSION

In the previous segment, we have seen how the Internet is changing the delivery of sounds and images to our homes. We have discussed this transformation in terms that are basically familiar to established media forms such as recorded music and video. The viewing and listening experience of a Napster-obtained MP3 file or a Webcam image is not so different from listening to a CD or watching a videocassette, even if the way users acquired them has changed. Users still do not alter such music or video as they passively hear and view them. What of those media experiences, however, where users *do* affect texts *as they experience them*? What of the new level of interactivity found in online games? What of the immersive experiences that have come to be called 'virtual reality' (VR)? How has the Internet changed the acts of viewing and listening?

One component of any computer game is a strong sense of interactivity between the user and the screen. The actions the user takes, such as mouse clicks, key presses, joystick twists, and so on, have an immediate impact upon what occurs on-screen. The 1970s' video game's interactive interface illustrated a significant shift from television's passive experience, especially at a time when remote control devices were relatively rare. Moreover, video games approached virtual reality when they began to bring the viewer into a navigable space that was viewed from a first person perspective. The arcade game *Battlezone* (1980) and the Apple ii game *Flight Simulator I* (1980) both placed users inside virtual machines, providing a sense of space and the ability for users to move forwards into that space, to move along the z-axis, and to *choose* which ways they move.[26] This is a crucial aspect of virtual reality, as it enables virtual reality to simulate how humans move through the real world.

The on-screen worlds of *Battlezone* and *Flight Simulator I* provided a virtual space through which players 'moved', but their imagery was far from photorealistic. In 1992 and 1993, id Software's releases of *Wolfenstein 3-D* and *Doom*, respectively, heralded a substantial increase in the level of graphic detail in personal computer games, as well as establishing a new degree of on-screen carnage.[27] *Wolfenstein 3-D* inaugurated the 'first-person shooter' genre, which has since evolved into games such as *Quake* (1996) and *Half-Life* (1998). In first-person shooter games, players typically adopt the first-person perspective of combatants moving through a virtual arena, as in a cinematic subjective shot. Unlike antecedents such as tank games or flight simulators where one is confined to the space of a cockpit, in a first-person shooter game one inhabits the virtual body of an individual moving through space. First-person shooters, tank games and flight simulators all use first-person perspective, but the first-person shooter games heighten the degree of movement and immersion because it is a virtual human body in motion, independent from a machine.

An essential component of most virtual realities is a sense of a shared space, the illusion that one is inhabiting the same space as objects and, crucially, as other beings whether human or not. *Doom* was a pioneer in this regard because several players could enter a combat arena from different computers on a network. Although *Doom* was designed to be played on small networks or between computers connected by a phone line, it was not natively an Internet game.[28] *Quake*, in contrast, was designed to be played over the Internet, although the set-up for doing so was a bit cumbersome. Late-1990s multiplayer games became increasingly Internet-capable, culminating in 'massively multiplayer online role-playing games' (MMORPGs) such as *EverQuest* (1999).[29] MMORPGs manifest visually what has been done using text in 'multi-user dungeons/dimensions' (MUDs) since 1979.[30] An MUD is a virtual world built by its participants, usually to host *Dungeons and Dragons*-style role-playing, but sometimes with other goals of community construction (for example, *Postmodern Culture*'s PMC-MOO). Hundreds or even thousands of users may simultaneously participate. The virtual world of the MUD is described through words, but the MMORPG presents graphically rich virtual worlds through which the player moves. And, in the case of *EverQuest*, some 80,000 players may be concurrently online 'together'.

In multiplayer games on the Internet, whether 'massively' multiplayer or not, we can clearly see an online virtual reality where a virtual space is shared among participants who experience a simulation of movement through a visual realm and there interact with objects, humans and monsters. There have been numerous virtual reality projects in experimental computer labs and military flight simulators, with elaborate paraphernalia such as wired gloves (for example, the Dataglove, which transmits users' hand movements to the computer), head-mounted displays (small computer displays in helmets) and various boxes into which participants are sealed; however, the most widely distributed form of virtual reality is the online multiplayer game.[31]

AN INCONCLUSIVE CONCLUSION

The Internet and the World Wide Web continue to evolve in ways that repeatedly surprise the technological and financial experts, shift users' methods of receiving and transmitting

data, and confound traditional media corporations. Reviewing the short history of networked computing (since the first ARPANET (Advanced Research Projects Agency Network) nodes in 1969) and the Web (created in 1991), we can see how the efforts of engineers, government bureaucrats, venture capitalists, digital artists, digital activists and maverick hackers and crackers have constellated around a dispersed, decentralised exchange of data (including text, sound, image) and a human–machine interface that permits, and occasionally demands, new, interactive modes. We have concluded with a consideration of the online multiplayer game and virtual reality not because these phenomena are the ultimate, teleological endpoint of the Internet, but because they illustrate the current apotheosis of online characteristics. These include hyperactive interactivity; decentralised exchange of data; communication among dispersed participants (that is, combat; although players may chat while 'fragging' each other); a shared virtual space; disrupted, nonlinear narrative trails; and a graphically sophisticated user interface. The future Internet will probably bring new implementations of these characteristics.

Notes

1. William Gibson, *Neuromancer* (New York: Ace, 1984).
2. For histories of inter-networking, see Katie Hafner and Matthew Lyon, *Where Wizards Stay Up Late: The Origins of the Internet* (New York: Simon and Schuster, 1996); John Naughton, *A Brief History of the Future: From Radio Days to Internet Years in a Lifetime* (Woodstock, NY: Overlook Press, 2000); Stephen Segaller, *Nerds 2.0.1: A Brief History of the Internet* (New York: TV Books, 1998).
3. Quoted in Stephen Segaller, *Nerds 2.0.1*, p. 131.
4. There is some debate about exactly when these terms were first used. The official *Xanadu* Website contends that they were chosen in 1963 and first appeared in print in 1965. 'Project Xanadu History', <www.xanadu.net/HISTORY>.
5. 'THE NEW XANADU MODEL FOR THE WEB', <www.xanadu.net/xuWeb.html>.
6. See, for example, Apple's HyperCard and Brown University's HES, FRESS and IRIS projects. See 'HyperCard Past & Future', Apple Computer, <www.apple.com/hypercard/information/pastandfuture.html>; George P. Landow, 'Hypertext at Brown', Brown University, <landow.stg.brown.edu/HTatBrown/BrownHT.html>; James M. Nyce and Paul Kahn (eds), *From Memex to Hypertext: Vannevar Bush and the Mind's Machine* (Boston, MA: Academic Press, 1991).
7. CERN stands for Conseil Européen pour la Recherche Nucléaire (European Council for Nuclear Research), even though its official name is the European Organisation for Nuclear Research. For an explanation of its confusing name, see 'About CERN's Name . . . (And its Spelling)', <cern.web.cern.ch/CERN/CERNName.html>.
8. According to a chronology pieced together by John Naughton in *A Brief History of the Future*, pp. 235 and 239.
9. According to Robert 'Hobbes' Zakon on *Hobbes' Internet Timeline*, 15 April 2001, <www.zakon.org/robert/internet/timeline>.
10. For the version history of Windows Mosaic see <ftp.ncsa.uiuc.edu/Mosaic/Windows/Archive/

index.html>. For Mac Mosaic, see <archive.ncsa.uiuc.edu/SDG/Software/MacMosaic/Release-info/announce.html>.

11. The remnants of Mosaic remain, however, in Netscape's products. The original code name for Navigator was 'Mozilla', a splicing together of 'mosaic' and 'Godzilla'.
12. 'About RealNetworks', <www.realnetworks.com/company>.
13. Jim B. Grant, 'Start Streaming', *VideoSystems*, January 2001, p. 46.
14. Of course, Web browsers automate this request by setting a default for the user's home page.
15. Quoted in Craig Bicknell, 'PointCast Coffin About to Shut', *Wired News*, 29 March 2000, <www.wired.com/news/exec/0,1370,35208,00.html>.
16. My emphasis. 'Download Infogate Now!', <www.infogate.com/cgi-bin/index.cgi?id=&page=download:index2>.
17. See <www.nbci.com/LMOID/resource/0,566,-5623,00.html>
18. 'GE's NBC Agrees to Buy Rest of NBCi for $85 Million', *Bloomberg News*, 9 April 2001, <investor.cnet.com/investor/news/newsitem/0-9900-1028-5550686-0.html>.
19. Steve Kovsky and Evan Hansen, 'AOL Time Warner Plans to Close *Entertaindom*', *CNET News*, 17 January 2001, <news.cnet.com/news/0–1005–200–4515788.html>.
20. *Danni's Hard Drive*, <www.danni.com>.
21. Quentin Stafford-Fraser, 'The Trojan Room Coffee Pot Biography', <www.cl.cam.ac.uk/coffee/qsf/coffee.html>.
22. For example: weather/traffic on the Tappan Zee Bridge (NY), <www.thruway.state.ny.us/webcams>; a Berlin taxi, <www.berlin.de/livetaxi>; Dealey Plaza Cam, <www.earthcam.com/jfk>. For a list of Webcams, see *Webcam World*, <www.webcamworld.com>.
23. 'Napster's Musical History', *The Industry Standard*, 12 February 2001, <www.thestandard.com/article/0,1902,22139,00.html>. For the specifics of the RIAA suit, see <www.riaa.com/PDF/Napster_Complaint.pdf>.
24. Napster is not the first file-sharing, P2P software. It is just the most notorious. Gnutella, for instance, was around well before Napster. For more information on P2P projects, see David Sims, 'O'Reilly P2P Directory', *OpenP2P.com*, 20 October 2000, <www.openp2p.com/pub/a/p2p/2000/10/20/directory.html>.
25. Ian Clarke, 'The Philosophy behind Freenet', *Freenet*, <freenet.sourceforge.net/index.php?page=philosophy>.
26. An online emulation of *Battlezone* that is remarkably true to the look of the original arcade game may be played at <www.games.com>. *MiGMan's Flight Sim Museum* features screen shots from early games, <www.migman.com/ref/simhis>.
27. As Lev Manovich contends, *Myst* (1993) was also significant in its enhanced graphic detail. Lev Manovich, *The Language of New Media* (Cambridge, MA: MIT Press, 2001), pp. 244–5.
28. Ways around this limitation have been devised: Scott Coleman and Jay Cotton, 'The TCP/IP Internet DOOM FAQ', <www.faqs.org/faqs/games/doom/howto-tcp>.
29. *EverQuest* was not the first MMORPG, but it is currently the biggest. The first such game was *Ultima Online*, released September 1997.
30. MUDs originated in the UK in 1979 when Roy Trubshaw launched MUD1 at Essex University.

31. For further elaboration on the history and theory of virtual reality, see Lev Manovich, *The Language of New Media*; Margaret Morse, *Virtualities: Television, Media Art, and Cyberculture* (Bloomington: Indiana University Press, 1998); and Janet H. Murray, *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* (Cambridge, MA: MIT Press, 1997).