number of channels as the old VHF dispensation made available in the largest conurbations. Second, previous attempts to introduce large-capacity, interactive 'two-way' addressable cable have failed, notably the Warner Cable's Qube experimental system pioneered in Columbus, Ohio in 1977 but abandoned less than a decade later as underused and uneconomic. The cultural 'fit' of 500 or more channels is not self-evident.

Thousands of channels are undoubtedly possible because of fibre. The first experimental cable television fibre trunk line was laid in 1976 and the first system was operating by November 1984 in Birmingham, Alabama. By the mid-1990s two-thirds of all cable trunk networks were fibre, but, as in the transoceanic cable, signals have to be demodulated because they cannot be amplified or distributed along 'the last mile' to the home in optic mode. Talk of a fibre-optic system in the mid-1990s was in fact premature because amplifiers and switches were not to hand. In the meantime, the US cable industry opted, in an unstructured way, for a compromise – HFC, *H*ybrid *F*ibre *C*oax. The 'law' of suppression was still at work. As with the UK failure to use digitised satellite signals to introduce HDTV, this hybrid also represents the limits of market logic and rationality. The US telephone companies, which had converted a mere 6 per cent of their trunk feeders to fibre by the mid-1990s, appeared thereby to be responding more appropriately to the challenge of what was still an incomplete technology. Nevertheless, cable operators can see the potential of a digitised fibre-optic network vastly to increase the number of available channels; indeed, exponentially to increase the number of conventional available channels. Yet, given the cultural determinants of production values, available programming and audience time, how these were to be filled remained obscure.

What is clear is that cable in America represents one of the consciousness industry's real triumphs as a majority of Americans now pay twice, through advertisements and subscriptions, primarily to watch television channels they used to pay for only once. This has been done in obedience to the 'law' of the suppression of radical potential whereby the new technology over a period of fifty years has been absorbed by the institutional structures of the old. This process has not only reduced cable's, and (probably) DBS's, disruptive potential, it also ensured that those same structures will remain profitable. Although taken over and somewhat battered and by no means inured to the consequences of myopic managements, nevertheless all the major American broadcasting players are still in place. Elsewhere, the new distribution technologies had much less effect on the old broadcasting structures than had neo-liberal political thinking. Unless politics intervened to prevent it, there was little to suggest that the same essential pattern of relative containment that had been seen in America would not happen in these other countries too.

From "Media, Technology and S[illegible]ety"
Brian Winston, 1998

18

THE INTERNET

PROTOTYPES AND IDEATION: COMPUTER NETWORKS

The history outlined in this third section demonstrates that the idea of networks is as old as telecommunications. Quite extraordinary claims were nevertheless made for the results of simply (comparatively speaking) linking distant computers together – the Internet. It is, of course, always possible that some technological development will have profoundly disturbing social effects, despite the fact that, over time, most such technologies exhibit far less radical potential. However, if a claim for radical exceptionalism (as it might be termed) is to be sustained, it would seem reasonable to suppose that the technology ought to exhibit some exceptional elements from the outset. This the Internet cannot do. The history and pattern of its development and the pace of its diffusion are, when all hyperbole is laid aside, not markedly different from the accounts given of the other networks here discussed – or, indeed, in general, from the technologies described in the earlier parts of this book.

The ground of scientific competence for the Internet includes the existence of computers and the use of machine code compilers – languages – as a basis of communicating with them. The existence of telecommunications networks, which date back into the nineteenth century, is also obviously crucial as are the theoretical tools for the design of such networks, exemplified by the development of Information Theory in the late 1940s. This theory emerged, as we have seen, from Norbert Wiener's wartime work on predictive gun-sights (which had led to the idea of 'cybernetics'); and the formulae developed in 1949 at Bell Labs by Shannon and Weaver for designing the most efficient telephone systems possible. Cybernetics was widely discussed. Norbert Wiener's best-selling popular outline of these concepts, *The Human Use of Human Beings*, appeared in 1954; but Wiener's *Cybernetics: or Control and Communication in the Animal and the Machine* was published in 1961, which spoke to its continued currency. Cybernetics and Information

Theory were important to the Internet because Information Theory commoditises information, draining it of semantic content. Encoded electronically and treated as being without meaning, messages became far more malleable than they were traditionally.

Prototype activities leading to the Internet would then include the distant operation of a single computer by telephone wire. This was first done by George Stibitz with the IBM Model 1 in 1940, so the concept of remote operation via keyboard and telephone line can be said to antedate the first true computers by a number of years. By the 1960s, both GE and a specialised firm, Tymeshare, sold systems allowing for remote access to computers via telephone links (Hardy 1996: 5). Time sharing involved programming a computer so that it could deal with numerous separate jobs at the same time without any individual user being aware of delays. The concept was applied first by proponents of main frames against supporters of minis and then by proponents of minis against supporters of PCs, in both cases effectively suppressing the building of even smaller machines. It is the creation of programming protocols to allow users to share the computing power of a single machine with maximum efficiency that is important to the development of the Internet. From this comes the use of real-time main frames linked to many distant terminals for such purposes as airline reservation systems. The first such was based on a smaller version of Whirlwind developed by IBM for American Airlines and was on stream by 1964. It was, at the time, the largest real-time system in the world (Augarten 1984: 208).

The transformation to the ideation stage of the Internet occurred when the concept of an associative system for the organisation of data impacted on the growing sophistication in the research community about the handling of electronic data within networks. Of specific importance here is the idea of breaking up continuous messages, of the sort which Information Theory addressed, into smaller discrete 'packages' of information in order to maximise efficiency further. Both of these elements were articulated early enough for the Internet to exhibit the same comparatively slow pace of development which we have noted in all other connections in this book.

Take the idea of associative databanks: in July 1945, in a popular (but nevertheless quite densely argued) article Vannevar Bush envisaged a machine which, in essence, allows for the entire compendium of human knowledge to be accessed or searched in an associative manner. It will be recalled that Bush was intimately concerned with the development of the computer. Shannon's professor at MIT, he had built the differential analyser which sat in the basement of the Moore School and had facilitated further computing developments during the Second World War from his position in the US Office of Scientific Research and Planning.[1] This article represents the first published articulation of the idea of a *web*.

Bush conceived of what he called the 'memex', essentially a microfilm/audio recording device, which would allow 'selection by association rather than by indexing':

> When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by tracing it down from subclass to subclass. It can only be in one place . . . . The human mind does not work that way. It operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate *web* of trails carried by the cells of the brain.
>
> (Bush 1945: 105; emphasis added)

The memex was to be a sort of multi-screened microfilm reader[2] operated by a keyboard into which a user could scan an entire personal library as well as all notes, letters and communications. Further notes and comments could be made photographically or on audio using built-in systems. 'All this is conventional,' wrote Bush, 'except for the projection forward of present-day mechanism and gadgetry.' He goes on:

> [The memex] affords an immediate step, however, to associative indexing, the basic idea of which is a provision whereby any item may be caused at will to select immediately and automatically another. This is the essential feature of the memex. The process of tying two items together is the important thing. . . . When the user is building a trail, he names it, inserts the name in his code book, and taps it out on his key board. . . . It is exactly as though the physical items had been gathered together to form a new book. It is more than this, for any item can be joined into numerous trails.
>
> (Bush 1945: 106)

Given that this was published in advance of ENIAC's completion, it is not surprising that Bush did not envisage the computer as one of his present-day 'gadgets' – although he was one of a handful of people who knew about the Moore School's work. Nevertheless, his *Atlantic Monthly* article does clearly point the way to a conceptualisation of data arranged as webs rather than the branchings of a tree which computing power would, in fact, most easily allow.

The other basic element for the ideation transformation, the breaking up of messages within an electronic network, is not quite as old as this. It appears in the literature in the early 1960s. At that time, Paul Baran was a RAND researcher working, on behalf of the US Airforce, on the problem of military communications systems in case of nuclear attack (Baran 1964). In a 1964 paper, he proposed breaking up all messages within the system into what he called 'message blocks'. This attack on the internal integrity of the message clearly required an intellectual jump of some significance but, without wishing to belittle Baran's achievement, he was aided by the insights of Information Theory. Just as it had allowed for the design of telephone exchanges which would send calls along the least congested routes thus maximising the overall utilisation of the network, so Baran's scheme envisaged individual messages being broken up and sent in discrete packages around a network to achieve the same result – a more even flow of data through the entire network.

The same concept also occurred to the British computer pioneer Donald Watt Davies who, at the National Physical Laboratory, had helped to build Pilot Ace. Watt Davies's version of Baran's 'message blocks' was remarkably similar, even down to his proposals about optimum transmission rates and size. His notion of how these blocks of data might be routed, however, was slightly different; and he came up with a different term for them, one which was actually to prevail – 'packets' (Hafner and Lyon 1996: 64–5). Baran's 'distributed adaptive message blockswitching' became Watt Davies's 'packet switching'.

Baran's use of the term 'distributed' speaks to the initial supervening social necessity for the Internet. His proposal follows a slightly earlier concept, dating from 1962, for a distributed network of computers (nodes), designed to survive the failure or removal of one or more of them. The supervening social necessity was the need for a literally atomic-bomb-proof communication system. Here again, basic received telephone network design had already encompassed decentralised, distributed systems which could survive partial destruction. Decentralisation was critical to this and to Baran's plans, because it prevented network failure should network control be knocked out. Control was distributed. It was also a highly redundant system in that all essential functions were duplicated and reduplicated. Baran built such a principle of 'redundancy of connectivity' into his plans as well.

Significantly, the differences between Baran and Watt Davies arose because Watt Davies was being inspired by a quite different sort of supervening social necessity. By the early 1960s Britain's pretensions as a major nuclear power were not as strong as they had been and, even at the NPL, strong cold war considerations were no longer such a driving force. Watt Davies was working to an agenda in computer science, a more purely intellectual set of questions arising out of the possibilities of linking computers to explore what might be accomplished if such a thing were done. This was also a supervening necessity in the United States and it has led to a rather interesting obfuscation of the origins of the system which has significant cultural ramifications.

Among the pioneers who built the network which was to evolve into the Internet, there are those who wish to deny quite strenuously the centrality of

the need for nuclear-bomb-proof communications systems and to stress instead their interests as being purely scientific. Of course, to do this requires a certain cognitive dissonance on their part as they were all working for the Pentagon or for firms contracted to the Pentagon, even if their announced purposes were not overtly military.[3] Given the current state of the public record, the links between Baran's clearly military inspired thinking and the project which actually produced the prototype ARPANET are obscure. But it is clear that the supervening necessity for networking the main frames came from the same military concerns as had caused those main frames to be built in the first instance. Given the intimate connection of the computing project in general with the cold war and, specifically, nuclear confrontation, it is scarcely surprising that thought was given to the need to back up computing systems in case of nuclear attack. Obviously the way to do this was to yoke these very large machines together.

Confusion arises because the computing science agenda, which sought to do the very same thing, was also legitimate. Indeed – as with Sputnik and the ICBM – it was legitimate enough to act as a perfect 'cover' for the military agenda. In his 1964 paper Baran had already queried a civilian dimension: 'Is it time now to start thinking about a new and possibly non-existent public utility, a common user digital data communication plant designed specifically for the transmission of digital data among a large set of subscribers?' (Baran 1964: 1179). The Internet emerges in the US in the 1970s as a species of spin-off from a (largely still classified) national security project rather than any sort of discrete 'invention'.

The enabling agency for the Internet, ARPA, was created by the DoD in 1957 as a first response to Sputnik. The Advanced Research Projects Agency was to be a species of rapid response unit to ensure that the Russians would not catch the Americans napping again. Of course, as we have seen, the real reason why the Americans were 'caught napping' was nothing more than inter-service rivalry; but it was in nobody's interest to admit this. Better to claim to have been genuinely wrong-footed and, as Eisenhower almost certainly intended, unleash unprecedented public largesse upon the military-industrial complex and its outposts in the universities. ARPA had been dreamed up in 1957 by Neil McElroy, Eisenhower's Secretary of Defence, a non-military type who had been poached from Procter & Gamble where he had been the CEO. He was not likely to cramp the President's military style. That ARPA confronted no real technological gap was not a problem for a man who understood intimately the usefulness of soap operas to the selling of soap powders. However, the agency's first largely space-based agenda was almost immediately passed to a second post-Sputnik organisation, NASA, which had the same remit to halt inter-service rivalry and a more direct claim on space. ARPA survived into the Kennedy era and prospered by becoming instead a patron of advanced earth-bound military research projects. As such, it picked up a SAGE back-up computer and a more general responsibility for blue sky computing projects.

Joseph Licklider, who, as we have seen, was one of the first to think about computer interfaces other than keyboards and screens, was appointed director of ARPA's computing projects. Between 1962 and 1964 he moved the emphasis from command and control to graphics, war-games, better languages and time sharing systems. This agenda became, within ARPA, the Information Processing Techniques Office (IPTO). A basic problem for Licklidder was the lack of language and machine standardisation. In a memo he wrote:

> Consider the situation in which several different centres are netted together, each centre being highly individualistic and having its own special language . . . is it not desirable or even necessary for all the centres to agree upon some language or, at least, upon some conventions for asking such questions as 'What language do you speak?'
>
> (Hafner and Lyon 1996: 38)

For Licklider this remained a somewhat hypothetical, if fascinating, problem since he did not believe that the computers would need to be networked except on 'rare occasions'. Could it be that a post-nuclear attack situation would be such a 'rare occasion'? He added: 'It seems to me to be important, nevertheless, to develop a capability to integrated network operation'. It is on this basis that Licklider's successors at ITPO continued to develop the idea of a network of, essentially, university computers, but only at a theoretical level. This 'academic' as it were supervening necessity was not strong enough to ensure that work in programming and in the metal would go forward.

Nor, curiously, was the other more militaristic social necessity working very well either. Although Baran made good progress as an advocate for a packet switching system with his RAND colleagues, his approaches to AT&T, thought to be necessary if the system was ever to be built, met with considerable hostility. The Telephone Company would not let Baran even have a copy of their longline maps. The Airforce took Baran's side but, the vogue for inter-service agencies still continuing, it was no longer their decision. A new Defence Communications Agency (DCA), dominated by telecommunications traditionalists, was given responsibility instead. Baran gave up. This series of failures can be seen as a phase in the suppression of computer networking's radical potential. What was underpinning these hostile attitudes, perhaps, was the establishment of an extremely extensive, highly redundant system based on more traditional telephonic approaches. This would account for AT&T's opposition. Their attitude and the attitude of the DCA makes sense only if it is assumed that they thought they had the problem solved by other means.

Thus by the mid-1960s only one prototype system was in place. It had been built by Watt Davies within the NPL and with the enthusiastic backing of the GPO. When in 1967 the nascent computer networking community met, at ARPA's behest in Ann Arbor, they did have before them at least a small-scale demonstration that packet switching and the distributed network would work; and that turned out to be enough for the ITPO team to clear the log jam of the previous years.

It became clear to them, as it had previously to Watt Davies, that the difficulties of networking wildly different machines with vastly divergent languages could not be resolved except by introducing minicomputers into the structure to act as interfaces. (The CDC PDP 8, the first mini, had been on the market since 1963.) The idea broached at Ann Arbor was to network the minis, which would share language and protocols, while each main frame team worked out how to get its monster machine to address its 'own' (as it were) mini. They christened the minis IMPs (Interface Message Processors).

This solution, which represents a final element of ideation for the network, also had another major advantage. The problem was that, at first sight, networking seemed to those who ran the main frames to be little more than an extension of time sharing. Time sharing between institutions jealous of their computing time was not necessarily perceived as a welcome goal. However, the idea of introducing a further computer to handle networking chores served to distance the concept of networking from that of time sharing as well as offering potential collaborators more computing power. It made the whole thing far more attractive.

At the end of that year, the IPTO people at ARPA finally discovered Baran's work of the early 1960s via a paper read at a conference in Tennessee by one of Watt Davies's British associates. Baran now became informally involved and ARPA seriously committed to building a network along the lines that had been emerging over the previous seven years (Hafner and Lyon 1966: 77). Although the scheme that became ARPANET was clearly focused on academic sites, this does not mean that the computer science agenda was entirely dominant. It should not be forgotten that all these machines were still closely bound into defence work of one sort or another wherever they were sited. Nor should it be forgotten that the initial ARPA contract was for four IMPS, at $360,000 each, and the programming to make them work together at a further initial cost of $640,000. Not even at the height of the cold war would the American government fork out $1 million just because some computer guys wanted to play at linking their machines together. The military hovered like Banquo's ghost over the feast.

In the summer of 1968 the prototype phase moves significantly forward towards the 'invention'. Having been rebuffed by both IBM and CDC, who claimed the minis could never be made small enough to allow the idea to work, IPTO bought the IMPS from Honeywell. They were a new model type designated the DDP-516 in (enter Banquo) a 'ruggedised' case specially designed for battlefield use. In typical DoD fashion they cost about four times as much as the CDC PDP 8s (and ten times as much as the CDC 9s which came on the market the following year).

The shadow of Banquo was also present as IPTO let the contract for the conversion of these machines, the actual building of the net and the development of the necessary programming to a firm at the heart of the military-industrial complex – Bolt, Beranek and Newman. This was a Boston consultancy company then employing 600 people which had started out in the acoustics business. On the civilian side, they had scandalously fouled up the acoustic design of the Avery Fisher Hall in New York and had then got into audiotape analysis (where, for example, they were to deal with the Watergate missing tape section). Eighty per cent of their business was for government and, eventually, in the 1970s they were to be fined $700,000 for overcharging. On the other hand, BBN had employed Licklider in the late 1950s because of his psychoacoustics background and had provided him with one of Olsen's first machines, a PDP 1. The Pentagon attended IPTO's first briefing of BBN.

FROM NECESSITY TO DIFFUSION: ARPANET TO INTERNET

Just as the barely perceived distinction between the military and computing science supervening necessities allows some to argue that the project was not in essence a military one, so the fact that the BBN team left the main frame programmers free to deal with a number of issues, the protocols for incoming data for example, encourages the notion, even at this very early stage, that the network was democratic, not centrally controlled. The BBN team worked on the Honeywells, the routing algorithms and the protocols for the IMPs, while the main framers worried about the bridge between their machines and the IMPS. Very rapidly, the main frame teams formed themselves into a *Network Working Group* (NWG). This was independent of the BBN group and it became ever more significant. For example, within the first month, the team at the Stanford Research Institute (SRI) established the prompt system, now used for log-in name and password, by creating the L-O-G-I-N command. Host-to-host protocols – Telnet, Network Control Protocol (NCP), File Transfer Protocol (FTP) – were all created by the NWG independently of BBN, never mind ITPO/ARPA. Eventually this model, whereby groups of independent users affect the structure of the network, was to become by the early 1990s a crucial element in the argument that the Internet could not be controlled.

The first phase began at BBN on 1 January 1969. The first of the adapted IMPs was due at UCLA in September. The basic concept was a mixture of what Baran

and Watt Davies had been proposing at the start of the decade but with far less emphasis on redundancy. The cover, computing science, was thus very much in place. The first reprogrammed IMP arrived on time at UCLA, as did the second at the SRI a month later. By the end of 1970 there were ten centres and two dedicated cross-country lines. By 1971 the system was working, albeit with down-time of a day a month. BBN developed the concept of remote diagnostics and maintenance from its node to combat problems. But, although the network worked, Licklider's hunch that it would be needed only on 'rare occasions' was apparently being borne out. After a year, it was operating at only 2 per cent of its capacity. The cover was starting to look thin.

Those involved resorted to a perfectly legitimate public relations blitz. At a 1972 Conference on Computer•Communication in Washington a massive series of demonstrations was organised, most of them, it must be admitted, rather asinine – remote chess games, quizzes and an interactive programme involving a psychotic character, PARRY. PARRY was at UCLA while the 'doctor' was at BBN. But all this had the desired effect. The system acquired a name, ARPANET, and the computing community was made aware of networking possibilities. Two major initiatives emerged – international communication and, most important of all, electronic mail.

Apart from ARPANET, and the Watt Davies network at the NPL, there were by this time two other operating systems. One, christened ALOHANET, used radio links to network the University of Hawaii's computers which were sited on four different islands. A French team was establishing Cyclades. SATNET used satellite links to make good the drop-out deficiencies in contemporary transoceanic cables, albeit as a temporary solution because a large number of high-volume high-quality maser-amplified cables were being planned. But there were enough net-works in existence for the idea of a network of networks to be born at this conference. Not only that, the NWG, with its endless exchange of suggestions and decisions on protocols and other operational details, offered a viable model as to how work could go forward internationally without any formal authorisation being required. Again, the cultural sense of being outside external authority was reinforced.

It might be argued that this happened because the spin-off could be allowed to spin even further as it had (from the DoD's viewpoint) the useful effect of deepening ARPANET's military cover. Be that as it may, the NWG became the INWG, the *International Network Working Group*. In 1973, at a conference in the University of Sussex, Vint Cerf, who had been at UCLA and was involved in the NWG from the very beginning and Bob Khan, the information theorist on the original BBN team, presented the group with draft protocols to allow networks to talk to each other. After a further year's work, these became the

Transmission Control Protocol (TCP), the essential programme at the heart of what was to become the Internet.

The 1973 Sussex meeting was also where the first international e-mails made their appearance. Cerf was delayed because of the birth of his child, news of which was e-mailed to the conference. (It will be recalled that the first British telegram was about the birth of one of Queen Victoria's children.) Another man had left the meeting early, forgetting his razor. From the States, he used ARPANET and a temporary satellite link, set up for the conference, to get a friend to find it for him. This was nothing but the international extension of a strand of development which had been underway for some time.

For time sharing systems on single computers, the concept of creating a designated file where messages between users could be left had been developing since the early 1960s. For example, there was a programme designated MAILBOX which had been installed at that time at MIT. Following the 1972 Washington conference, Ray Tomlinson, one of the BBN team, took the idea a stage further. His mailbox programme could receive messages from right across the ARPANET. It is to Tomlinson that we owe the '@' in e-mail addresses. Within a year, 75 per cent of ARPANET's traffic was in this e-mail form. Tomlinson had restored the net's cover but it remained one of the most expensive communication systems ever devised; and one whose real costs and purposes seemed to be almost totally hidden from those who used it. It should not be forgotten that in 1973 most computers were main frames and that even the so-called minis still cost thousands of dollars each. The Altair, that extraordinarily limited personal device, was still two years in the future. E-mail was thus the domain of a very privileged élite, made somewhat less élite by a move at this same time to cheaper 'non-ruggedised' IMPs, Honeywell 316s. To augment the limited interface available on these new machines, the BBN team set about building a TIP, or Terminal IMP, which would allow for sixty-three terminals to feed into the original ARPANET IMP. As the 1970s progressed, this sort of extended distribution of access, although still very much limited to university computer science departments, allowed for a number of other unplanned developments, spin-offs; the creation of mail lists (MsgGroup) in 1975 would be a significant example of this.

The power of such user groups grew with the network. Between 1973 and 1975 a node was added every month. There were now some 2000 users. In August 1973, for example, 3.2 million packets were being transmitted. The users contrived more than basic procedures. For example, on 12 April 1979 Kevin MacKenzie, a brand new member of the MsgGroup, invented 'Emoticons' [:-)]. Licklider and Albert Vezza noted: 'One of the advantages of the message system over letter mail was that, in an ARPANET message, one could write tersely and type imperfectly, even to an older person one did not know very well, and the recipient took no offence' (Licklider and Vezza 1978: 1330).

Feeding the cultural sense that here was a realm barely controlled by the Powers That Be was the failure of the authorities to impose their will on these emerging structures. It was not until 1979, five years after the INWG agreed the initial TCP Internet protocol, that ARPA created an Internet Configuration Control Board, but, if only because it was so late, it had very limited success as a control mechanism (Dufour 1995: 29). As far as some INWG people were concerned the message was: '"Time to roll up your toy academic network." . . . They thought TCP . . . and Internet were just that – an academic toy' (Hafner and Lyon 1996: 247). There were also a number of scandals in the world of academic computing as a radicalised student generation realised how central the universities' computing centres were to the war effort in Vietnam and other cold war agendas. ARPANET itself was used to move illegal army intelligence files around, which caused a predictable uproar when the story broke. This sort of thing was not helped by ARPA being redesignated DARPA, the Defence Advanced Research Projects Agency, in the early 1970s.

In the event, DARPA's only successful interventions in shaping the emerging Internet were minor. The Agency managed to destroy a user group, USING, which had set itself up as a sort of lobby to monitor DARPA's activities. As the net's first historians put it: 'DARPA saw no need to share authority with a tiny self-appointed watchdog group made up of people the agency viewed as passengers on its experimental vehicle' (Hafner and Lyon 1996: 230). The other great DARPA success was the domain name system, agreed in 1986 which introduced in the US the terms 'edu' for universities, 'com' for commerce, 'mil' for military, etc. But these were the exceptions.

Overall, it is perfectly possible to see why the idea was abroad that the net was, to a degree unique in the history of telecommunications systems, in the hands of its users:

> Originally, the Internet was a post-apocalypse command grid. And look at it now. No one really planned it this way. Its users made the Internet that way, because they had the courage to use the network to support their own values, to bend the technology to their own purposes. To serve their own liberty.
>
> (Sterling 1993)

But such strident technicist rhetoric cannot disguise the fact that Banquo's ghost had not gone away. The hyperbole simply ignored the fact that, at least until the collapse of the Soviet Union and probably thereafter, the network was still, essentially, maintained for Licklider's 'rare occasion'; the noisier network users were, the louder they proclaimed their power, the better hidden this real purpose remained. By 1979, for example, only sixteen ARPANET sites were on campuses.

The remaining forty-six were buried in the military-industrial complex. (The system was costing $14 million a year to run and was transferred to the DCA in 1973. Licklider's 'rare occasion' had still not happened but it might. In 1983, the military side of the operation was spun off into MILNET, which was integrated into the recently created Defence Data Network (Hardy 1996: 7). ARPANET itself was closed down, significantly, in 1989, the year the cold war (supposedly) ended.)

I would want to go further and argue that even on the other genuine computer science agenda side, there was also a considerable measure of cognitive dissonance. The bottom line is that these networks were developed at vast expense and, for all that users were allowed to (as it were) dot the 'i's and cross the 't's on how they were operated on a daily basis, the essential power was still vested elsewhere. Consider the National Science Foundation's role.

A 1974 NSF report spoke of creating 'a frontier environment which would offer advanced communication, collaboration, and the sharing of resources among geographically separated or isolated researchers' (Hafner and Lyon 1996: 240). This became more pressing since, as we have seen, only a handful of universities were on the ARPANET and the DCA would not allow uncleared departments to hook up. By 1979, there were 120 computer science departments and most of those not yet on the net saw that as a real disadvantage when recruiting staff or pursuing research project funding. The problem was that in that year, for example, it cost $100,000 to run an ARPANET node, whether it produced traffic or not. Obviously this was well beyond the resources of most of these 'separated and isolated researchers' with whom the NSF was concerned. In May 1979 a group of non-ARPANET computer departments met at Madison and decided to build a cheaper, slower and less redundant network, to be called CSNET, the Computer Science Research Network. Nevertheless, the meeting still put a $3 million price tag on the five-year plan.

The NSF was not initially convinced but the proposal was re-submitted with a full business plan. (No trace of Banquo's ghost here.) By carefully designing different levels of service, for example, offering only an e-mail facility, it was possible to suggest that CSNET could become self-sufficient via user fees after an initial start-up period. These fees could amount to as little as $21,000 in a full year, primarily for telephone line charges. The NSF agreed and coughed up $5 million for start-up costs and CSNET was established. For the first time, the advantages of computer networking were made available to academics beyond the computer science departments. By 1983, with more than seventy sites on-line, this network was financially stable. On the back of this success, in 1985 the NSF agreed to build and manage a 'backbone' linking its five supercomputing centres. Regional nets were designed to feed into what was to become the NSFNET and the remains of ARPANET were also connected to it.

And so we come, not for the first time, to the moment when privatisation is pitted against a 'Post Office solution'.

In the 1970s estimates were beginning to be made as to the potential impact of e-mail on the traditional mail services. The White House Office of Telecommunications Policy and the US Post Office both commissioned studies. Consultants Arthur Little told the OTP that 30 per cent of all mail would be electronic. This, of course, has turned out to be very wide of the mark.[4] It almost goes without saying that the Post Office solution was rejected. It is also obvious that, at the moment when Justice was finally having its way with AT&T, the telephone company solution was rejected also. It is a measure of the naiveté of those involved that they thought they could transfer ARPANET from DARPA to AT&T and apparently believed that it was only the incompatibility of package technology with traditional telephony that stopped this from happening (Hafner and Lyon 1996: 232). From the late 1980s on, and despite the illusion of independence which had surrounded the enterprise almost from the outset, it was inevitable that this tax-funded and government-managed asset would be handed over to the private sector.

The National Science Foundation agreed to commercial exploitation and on-line services sprang up. CompuServe, the first of these, started in 1979 and fifteen years later claimed 3.2 million users in 120 countries and was part-owned by Time Warner. Its biggest rival, America Online, claimed 3.5 million users and had commercial relationships with the German group Bertelsmann and the French group Hachette. Prodigy belonged to IBM and Sears and claimed 1.4 million users (Dufour 1966: 32–3). In 1990 at Europe's advanced atomic particle accelerator, CERN, Tim Berners-Lee created (one hopes in his own time) the protocols to allow, finally, Vannevar Bush's vision of the memex to become a reality. His 'World Wide Web' was open for business in 1992. Meanwhile a Commercial Internet Exchange had been established in 1991 (Dufour 1995: 39). The NSF, finally, in 1995 handed the backbone and its management over to the private telecommunications giants Sprint, Ameritech and Pacific Bell which became the gatekeepers of the principal access points. Those who seriously believed they were in a brave new world of free and democratic communications were simply ignoring the reality of their situation. Those from great corporations who claimed they were engineering a revolutionary new world were engaged in something else: it might be called 'selling snake oil'.[5] Objecting to Microsoft's late attempt to break into this world in the mid-1990s on the ground that its entry introduces the mega-multimedia international conglomerate into the pure realm of Cyberspace became a curious aspect of the hype. (Cyberspace, and cyberpunk, are terms popularised by William Gibson in his seminal and endlessly misread novel, *Neuromancer*, published in 1989.) What Gates' interest represented was nothing but the last phase in a straightforwardly classic expression of the suppression of radical potential whereby the new technology is distributed among the established players to minimise the threat to their businesses.

The only outstanding issue by the mid-1990s was the extent to which the net might force the telephone entities finally to abandon their traditional and increasingly meaningless time and distance pricing structures. 'Free' local calls (where the cost is actually folded into the service rental charge) in the United States meant that the use of the network apparently cost nothing once the equipment had been purchased and a contract for services made with a local access provider. Even where local calls were charged, the net seemingly cost the user little:

> The illusion of getting away with something was entirely based on the fact that data transmission times have dropped so that it takes only 2/3rds of second, for example, to send an e-mail message from the US to Antarctica. Moreover, the Net breaks up even such super-fast messages transmitting them with scant regard to the time/distance cost structures of traditional telephone use. But, however fast and however efficient the routing, this is still not 'free'. The telephonic infrastructure is being paid for by users, but minimally. That these costs become largely invisible is because the Net itself is a very efficient user (and, indeed, abuser) of the infrastructure. To believe that the Internet is, in fact, free is exactly the same as believing that commercial television is 'free to air'. It is an example of what once was called false consciousness.
>
> (Winston and Walton 1996: 82)

It did not mean very much, either, that the established players did not initially care if, at the margins of the system, pornographers, militias and assorted deviants put out messages. These flies could be swatted at any time. For example, Operation Sun Devil was carried out in the US in May 1990, as Berners-Lee was working on his 'www' protocol. Twenty-eight raids in two weeks seized forty-two computers and confiscated 23,000 disks. By June 1995, America On-Line was cutting off six people a day for 'net abuse'. As the system became less marginal, a regime was already being forged in legislation and the courts to suppress the radical potential of the Internet as effectively as past regimes have suppressed past potentials. It was easy to discern the outlines of the solution – connection charges, usage charges, copyright charges, content codes. The same computing power that was driving the system was being turned to police it – package switching notwithstanding.

By July 1995 there were supposedly anything from 6.5 million machines worldwide to 10.3 million in the US alone connected to the net. The popular figure of Internet users of between 35 and 45 million appears to have been obtained by simply multiplying the 6.5 million by seven – perhaps because in the earliest days of the ARPANET, seven users per terminal was a norm. The

range of estimates does not inspire confidence and seems, on the face of it, to be absurd. At this time, some net demographers were putting the user figure at about one-tenth of the high estimate, that is some 3 million. This would seem to be far nearer to the mark: in Britain for example, only 20 per cent of 4 million home computers were even claimed as connected in 1996 (while, at the same time, surveys claiming up to 6 million British users were regularly published without explanation as to how such a figure could be reached).

And who were these users, these 'early adopters'? 'According to the Georgia Institute of Technology, in the most comprehensive survey of Internet users to date (1994), 90% were men, 80% white, 70% North Americans, 50% spent 40 hours or more a week computing and 30% are graduates' (Winston and Walton 1996: 79).

From the very beginning it has been clear that the most unambiguously valuable facility provided by the net is e-mail. That would seem to hold for current users as it did for the ARPANET pioneers. There is no more efficient or cheaper way to communicate, especially when time zone differences are so great that no working hours are shared. It is also probably the case that, again as happened with the pioneers, shared professional or, especially, academic concerns can lead to useful multi-person exchanges. However, the radical impact of such a system on the academy, say, will be contained for the foreseeable future by traditional requirements of authorship and publication. Other uses such as the creation of a virtual social community seem to have less, if any, purpose except as a sort of hobby.

There were several other reasons for viewing the reality of the net, as opposed to the inflated rhetoric surrounding it, with a certain cynicism. The more users, the more slowly the system went. Experience suggested that California needed to be asleep if any chance of reasonable access were to be achieved. The limited Boolean logic of the search engines constituted a further constraint on Bush's vision. Worst of all is the clutter and absurdity of most information the engines have to search. The Internet represents the final disastrous application of the concept of commoditisation of information in the second half of the twentieth century. By the mid-1990s there was talk of abandoning the whole system in favour of a second Internet which could be kept preserved from the information detritus suffocating the original.

There is also little to support the idea that the net will become a crucial method for selling goods and services. Every system for avoiding shopping from the mail-order catalogue to the cable television shopping channel has never done more than provide, albeit often profitably, niche services. One of the sillier facets of Information Revolution rhetoric is the belief that technology is urgently required to help people avoid going shopping or travelling on business. People like shopping and travelling – just as they like being told, or reading, stories. So we do not need stories to be any more 'interactive' than they have been since the dawn of time; a liking for travel is why business people have avoided the lure of the video-conference phone for nearly two-thirds of the twentieth century; and we so love shopping we have made the shopping mall (as the latest incarnation of the nineteenth century arcade) into our emblematic public space. Why the slow, cluttered and inefficient Internet should be more significant than previous distant buying systems is not clear. It seemed that in the early years the only effective marketers on the vaunted Information Highway were pornographers.[7]

All in all, I am inclined to agree with American humorist Dave Barry: 'The Internet is the most important single development in the history of human communications since the invention of "call waiting" ' (Barry 1996: 121). I would add that (to repeat a phrase from *The Telegrapher* magazine in 1866), 'as surely and as naturally as water runs down hill' the Information Highway will transform itself even more than it is at present into the Information Toll Road. The overheated claims being made for it were, even before they were fully promulgated, falling victim to the inexorable operation of the 'law' of the suppression of radical potential. Beyond the hype, the Internet was just another network. This is to say its social effects could (and would) be as profound as, for example, those of that far more ubiquitous network, the telephone. As profound . . . and as unrevolutionary.

CONCLUSION: THE PILE OF DEBRIS

FROM THE BOULEVARD DES CAPUCINS TO THE LENINGRADSKY PROSPECT

7 October 1976. The Ciné and Photo Research Institute (NIKFI), Leninskaya Prospest, Moscow. A demonstration of a 70mm holographic motion picture system:

> The movie consists of a full-size girl coming right through that screen, holding a bouquet in front of her face so that everyone in the audience can move around in his seat and look at the bouquet and see her face. . . . The Brightness is amazing; it is comparable to an ordinary movie. . . . The strange thing . . . is that the screen can be viewed from both sides simultaneously. Actually half the audience can sit on one side, and the other half can sit on the other.
>
> (Jeong 1977: 143)

It is still too early to say whether this presentation will be written into the technological history of communications as holography's founding moment, the equivalent of the Lumière *cinématographe* show in the Boulevard des Capucins on 23 December 1895. Alternatively, it could be that Victor Komar, the researcher responsible for this film, will be a Ronalds, a forgotten pioneer of an elegant but rejected prototype rather than a Lumière, an 'inventor'. Either way, the pattern of competence and ideation, prototype and 'invention', socially driven diffusion and suppression is holding good for holography – just as it is holding good for the Internet. I have argued above that claims for the Internet's radical exceptionalism to this pattern cannot be based on its history thus far; on the contrary, this history conforms with that of all other networks from telegraphy on. In the same way, I want to conclude by suggesting that the next possible quantitative leap in communications, holography, is also progressing in accordance with the model I outlined at the beginning of this book.

13 THE BEGINNINGS OF NETWORKS

1 A similar Bell conservatism can be seen at work in the matter of the combined receiver/transmitter. The first such handset had been patented in the UK as early as 1877. They were issued to the US Army by the 1890s and Bell linesmen had them in 1902. Despite the widespread diffusion of the device in Europe (they were known as 'French phones'), Bell opinion was against them and as a result, Americans got the modern telephone 'station' (i.e. a one-piece transmitter/receiver cradled on a device with a numerical dial) in 1924 (Brooks 1976: 138). Perhaps Bell's slowness with automatic exchanges and handsets can be attributed to the fact that these were not, *ab initio*, Bell devices.

2 Compare Bell Lab pre-divestiture record with that of, say, the Media Lab at MIT whose only widely diffused device is the white-light hologram used on credit cards (p. 339).

3 The average telephone user has experienced improvements only at the margin, except where in the UK the cable companies were marketing telephony from the mid-1990s as a species of lost leader. Otherwise, the effect of privatisation has been to make the making of telephone calls, especially in public places and yet more especially in the USA, a lot more complicated than it used to be with strings of digits being required to access the longline service provider 'of choice' before the number can be dialled.

14 NETWORKS AND RECORDING TECHNOLOGIES

1 There was a spin-off benefit to these film/television marriages. If the television picture was filmed at the receiving end, the film image could then be conventionally projected. By 1933 Fernseh A.G. demonstrated a variant on its intermediate film process which allowed for the projection, via a Nipkow disk, of a 180-line picture 10 x 14 feet. The technique survived to be seriously considered by Paramount for its theatre television system in the late 1940s. In the Paramount version the camera exposed the electronic picture, presumably to be received over the UHF theatre network had that been allowed by the FCC (p. 123), and 66 seconds later the developed film dropped by chute straight into the gate of the cinema projector. (The Eidophor was also in use in these experiments, as was mentioned above (p. 123), but, although it produced a large screen image, it did so directly from the received electronic signal and was not a retrieval device.) As we have seen, theatrical television was not a meaningful supervening necessity (or rather, was not allowed to be one) and these experiments were terminated.

15 COMMUNICATIONS SATELLITES

1 Verne uncannily suggested Tampa, Florida as the launch site for his rocket.

16 THE SATELLITE ERA

1 ATS 6 was part of a fad for offering telecommunication fixes, usually at grossly inappropriate levels of technology, to the developing nations. In the 1980s Intelsat was pushing Share (Satellites for Health And Rural Education) as a sixteen-month free experiment to celebrate its twentieth birthday. Such schemes have a venerable history since the socially ameliorating effects of media hardware have long been pulled. The magic lantern was recommended 'for all educational purposes' in 1705 (Eder 1978: 57).

2 It would be wrong to suggest that all these blows, foreign and domestic, destroyed Comsat. A prime purpose of the 'law' of suppression, it must be remembered, is to protect all established players. In the 1990s, Comsat was still a large telecom company with over 1,500 employees and nearly half a billion dollars' worth of annual revenue.

3 *The Economist*, which successfully expanded from Britain into the American market, might be an exception to prove this rule, the transatlantic orthodoxy of its neo-liberal editorial position in the 1980s perhaps facilitating the ease with which it crossed this border. More typical is the *New York Times*: New Yorkers exiled in Los Angeles wanted authentic editorial pages in their Californian edition to feed their nostalgia, so minimal editorial concessions were made.

4 As in the work of Cees Hamelink or Herb Schiller. For a discussion of the limitations of the cultural imperialism idea, see Tracey (1985: 17–56) or, more specifically, Mohammadi (1995: 370–7) on the use of audio-cassettes in the Iranian revolution. As Armand Mattelart put it: 'The messages of mass culture can be neutralised by the dominated class who can produce their own antidotes' (Mattelart 1980: 200).

5 Much the same point can be made about VDUs. The US National Institute for Occupational Safety and Health found that in the United Airlines office in San Francisco, an environment with a high density of VDTs (Visual Display Terminals, known in UK as VDUs – Visual Display Units, i.e. televisions), half of forty-eight pregnancies between 1979 and 1984 had ended in miscarriages, birth defects or other abnormalities. Working with VDTs can also increase risk of seizure in epileptics, according to the British Health and Safety Executive. The HSE also found facial dermatitis occurred in VDT work environments with low humidity. The clincher (perhaps) is that the American Electronics Association (who make the things) testified before the Congress in 1984 that there was no evidence as to the deleterious effects of television. Their spokesman said: 'Regulation of VDTs on any health and safety basis is unwarranted' (UPI 1984: 4).

17 CABLE TELEVISION

1 John Walson of Mahonoy City has been credited with the first cable system but this seems to be unfounded (Parsons 1996: 354–65).

2 The technological naiveté of this decision is perhaps matched only by the Court having failed, for half a century, to acknowledge that telephone wire-tapping constituted an invasion of privacy grievous enough to be protected by the Fourth Amendment of the Constitution against illegal physical searches of property. The Justices also did not do too well, initially, in the matter of copywriting the algorithms in computer programs (Winston 1995: 275).

18 THE INTERNET

1 He also thought ICBMs would never be targetable.

2 Eastman Kodak part funded the investigation into digital devices Bush conducted at MIT in the 1930s.

3 In *When Wizards Stay Up Late*, Bob Taylor, the man who first commissioned the work which was to produce ARPANET, the forerunner of the Internet, wants it clearly understood that the 'rumours' which 'had persisted for years that ARPANET had

been built to protect national security in the face of nuclear attack' were a 'myth' (Hafner and Lyon 1996: 10). Within pages, however, he is discovered driving to his office which 'was on the third floor, the most prestigious level in the Pentagon' (ibid: 11) and, a page later, that when he travelled he 'carried the rank of one-star general'. He left the Pentagon in 1968 for the University of Utah having 'burned out' trying to damage control the Vietnam body count controversy of that year (ibid: 152).

4 The real threat to the traditional Post Office actually emerged in the late 1980s in the form of rival, but equally traditional private mail carriers. Once again these were encouraged by the neo-liberal *Zeitgeist* which had a more profound effect than did the technology. Another thought: It is one of the more perplexing mysteries of late twentieth-century life as to why (1) people would think accountants (aka 'consultants') had enough imagination to undertake this sort of assessment; and (2) why their collective almost complete failure ever to predict anything correctly has little or no impact on their 'consultancy' business.

5 I take the term from one of the earliest, albeit anecdotal, books to call the Internet's bluff: Clifford Stoll's *Snake Oil: Second Thoughts on the Information Highway* (1996).

6 John S. Quatermain, described as an Internet Demographer of Austin Texas in the *Los Angeles Times*, of 5 August 1994, then estimated users worldwide at 2 to 3 million.

7 Even more marginal activities such as American audio CD dealers selling against the grossly inflated European CD prices – but since their suppliers are, more or less, those responsible for these same European mark-ups it is not hard to see how that trade can be stopped the moment it becomes noticeable.

CONCLUSION

1 All this is to discount the effects of virtual reality systems which create the illusion of the third dimension, as did the Stereopticon, by filling the entire field of vision with a small image. However, the essential dangers of bringing the eye so close to the radio frequency emissions of two tiny television screens, which is what current VR proposals involve, is likely to have some inhibiting effect on the diffusion of this technique.

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