COMMUNICOPIA

The shape of things to come

Suddenly, the air is filled with strange buzz-words: cyberspace, the internet, e-mail and, most awe-inspiring of all, the information highway. This is the language of the Knowledge Age, and it is arriving faster than most of us appreciate. If you're wondering what's going on out there, log on to this user-friendly report by JOHN MAY

ILLUSTRATION BY MICHAEL STONES

'The digital age means information on demand. Any place any time, at the right price. Plus instant gratification'

THIS INVESTIGATION began when I had lunch with US Vice-President Al Gore in London on the eve of the Rio Earth Summit. Gore is unquestionably the most powerful and high-profile advocate of the idea of the Information Superhighway. It is this idea – envisaging a global network of computers capable of moving huge amounts of information via satellite and cable – that is the driving force behind what is called the digital revolution.

Since that lunch I have talked with scores of experts operating in different areas of this exploding network. I have balanced their accounts with the practical, everyday experience of ordinary PC users to build up a comprehensive picture of how the digital revolution will change our lives, and how we can all play a part in deciding future developments.

This change is taking a different shape within each cultural context and the British version will have its own specific nature and character. What is common to everyone, however, is the way our patterns of thought are being obliged to change. We are moving from a world where events are unrelated, and hierarchical power structures predominate, into a world where the principle organising structure is a network.

In a network, everything – people, ideas and events – is linked, connective and interactive. This fundamental change is the most significant aspect of what we are experiencing and will have the profoundest effect of all on our development as a species.

The prime attributes of the 'new industrial revolution' are convergence and connectivity. The convergence between the worlds of computing and telecommunications connects individual computers into networks – within companies and buildings, within countries, throughout the world. The key resource of the new revolution is information – whether sound, pictures or text – in digital form (the binary code of the ones and zeros of computer language). And driving it all are three key technologies: the computer chip, the fibre optic cable and the satellite (see right).

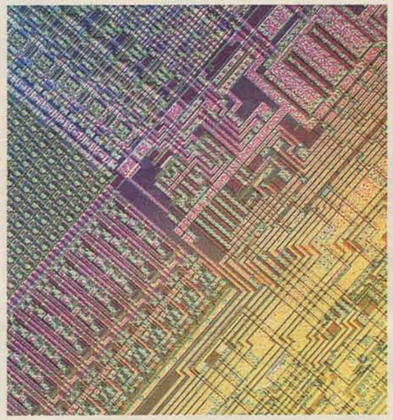
Now corporate forces are gathering to build the information highways (I-ways), that will link the world and pave the way for what investment researchers Goldman Sachs call Communicopia.

This will create a situation which one expert, Professor Peter Cochrane of BT, describes thus: 'Information on demand. Any place. Any time. In the right format. At the right price. Plus instant gratification. You hit the key. You say the word. You get a response.'

Most people are undoubtedly having problems grasping fully what is happening. The rate of change and the sheer volume of information is overwhelming. 'It may be,' says John Seeley Brown, director of Xerox's Palo Alto Research Center, 'that we feel we're drowning in information because the information we're getting doesn't easily fit into our current models for understanding the world. The knowledge economy is fundamentally different from the industrial economy, and we haven't begun to come to terms with how different these two economies are.'

This article is an attempt to give you a context in which to think about what is happening, a framework in which it is possible to integrate the millions of separate bits of information into a meaningful whole. ▷

THE BIG THREE TECHNOLOGIES



The silicon chip

THE integrated circuit (the 'chip') was invented by Robert Noyce of Intel and Jack Kilby of Texas Instruments in 1959. An entire circuit of electronics shrunk to a micro size, it is constructed mainly of silicon, oxygen and aluminium – the three most common substances in the earth's crust. The chip reduced the cost of electronic circuitry by a factor of one million. Moore's Law, coined in the early days of the chip by Intel's chairman Gordon E. Moore, states that the density of transistors on a computer chip would double every year or so. This has proved to be the case: on average, every 18 months.

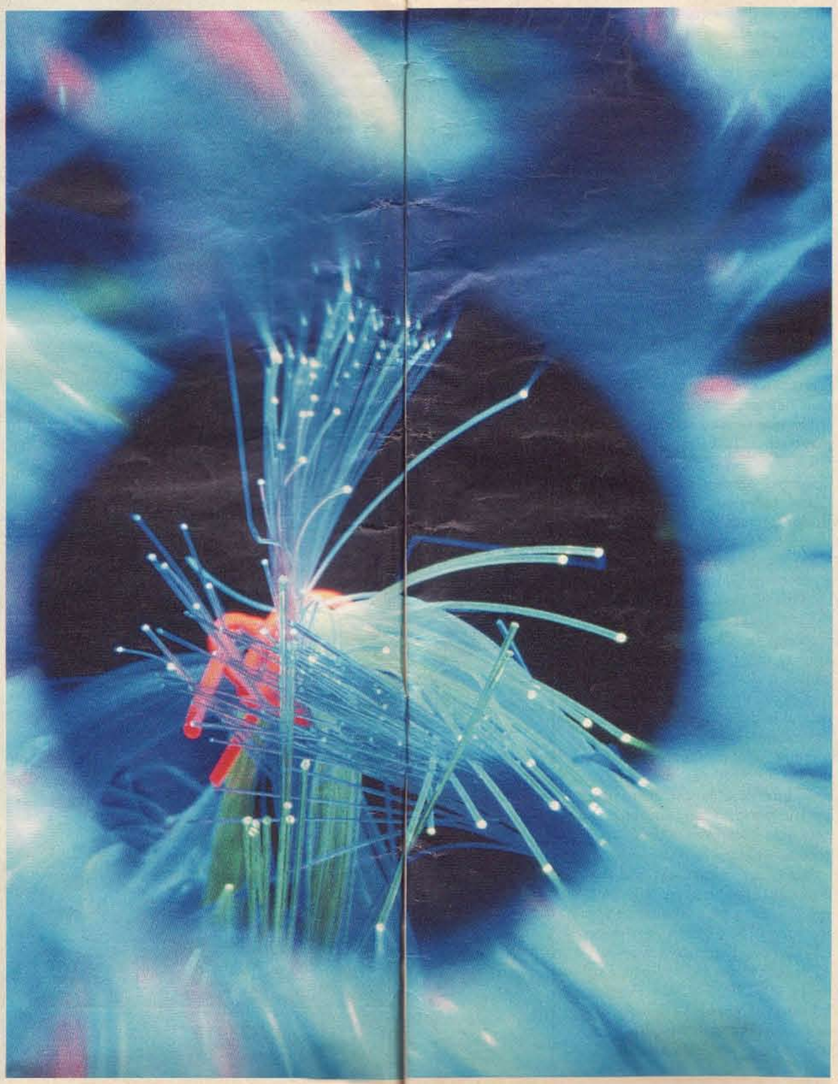
In 1971, engineers were etching lines in silicon that were 6.5 microns (millions of an inch) wide. This meant that 2,300 transistors could be fitted on a chip the size of the head of a drawing pin. Memory chips held 1,024 bits of information and microprocessors could handle eight bits of data at a time. Seven generations of the technology later, they can now etch circuits 0.5 microns across, making it possible to fit 35 *million* transistors on a chip. Each of these can store 64-bit microprocessors that are 550 times as powerful as the first Intel chip.

By reducing the line width by half, the number of possible transistors you can fit on the chip jumps tenfold. Denser circuitry means transistors are closer together, thus requiring less time for the signals to move between them. The 64-megabit chips of today will be replaced by ones carrying 256 megabits before the end of the century. Chips as powerful as supercomputers will cost a few hundred dollars.

If there is a limiting factor, it will be the cost of the manufacturing equipment required to achieve this micro-engineering. Intel's first chip-manufacturing plant in the late Sixties cost $3 million. That is now the cost of one piece of equipment in the newest chip factories, which today cost $1 billion. It is estimated that this cost could be ten times higher by 2000.

Fibre optics

THE fibre optic cable, which can carry millions of messages simultaneously, was born out of a new science, optoelectronics, a marriage of light and electricity. Optoelectronics gave us LEDs (light-emitting diodes) in 1961 and similar devices are in place in every laser printer, bar-code scanner, laptop computer and compact disc. They transfer electricity to light and back again through the medium of semiconductors (such as gallium arsenide) which give off light when a current is passed through them. Optical fibres, tiny glass threads the thickness of a human hair, have an immense carrying capacity, 10,000 times that of copper wire. At present these carry pulses of light at only one wavelength or colour; but one channel is big enough for the contents of the *Encyclopaedia Britannica* to be sent down it in one second. There is the potential to create *thousands* of lanes within the same fibre.



THE IMAGE BANK. SCIENCE PHOTO LIBRARY

Satellites are set to proliferate under plans by competing consortiums to link the world via cellular phone networks

***Left*, fibre optics is one of the key technologies driving the information revolution**

The satellite

ARTIFICIAL satellites, predicted by Arthur C. Clarke in a famous article in *Wireless World* in 1945, now span the heavens. Developments are taking place in this area that will transform telecommunications. We are used to the idea of people using mobile phones and to the idea that our telephone calls are routed to other countries via satellite links, as are television pictures. People who use cellular phones know the disadvantages: the reception is often poor, the spectrum is crowded and not everywhere is within reach.

Now a number of companies are examining new networks of communications satellites, linked to earth stations and landlines, that will overcome these problems. You could be in the middle of the Sahara, but someone could call you and you could dial out.

There are five competing consortiums, all aiming to have their operations in action before 2000. The leader of the pack is Motorola, the world's largest manufacturer of cellular equipment.

Its project, called Iridium, would cost $3 billion and comprise 66 satellites flying in 11 nearly polar orbits, 420 miles above the Earth. These satellites will talk not only to handsets and ground stations but also to each other. This means direct phone-to-phone communication without using ground stations. Motorola predicts two million customers for Iridium by the turn of the century. Handsets will cost $2-3,000; calls will be charged at $3 a minute.

A potential major challenger to Motorola (the other corporate groupings propose smaller systems using earth stations) is Inmarsat. An international organisation with 66 member countries, it already runs the voice and data satellite communications system for ships at sea. Its main terminals are the size of filing cabinets and cost $45,000 each; newer briefcase models still cost $25,000 and calls are expensive – $5.50 a minute. Despite that, the number of these terminals is expected to grow from 30,000 in 1992 to 75,000 in 1997. Many are found in aircraft, enabling passengers to make in-flight calls and send faxes.

Inmarsat's proposal, codenamed Project 21, is still in the planning stage but it has the potential to establish a global monopoly on satellite phones. After all, it has the governmental clout, a network of satellites in place and good cash flow.

Even more ambitious is the new scheme being floated by Bill Gates of Microsoft in association with McCaw Cellular. They propose a $9 billion plan to launch 840 communications satellites by 2001. Why so many? The satellites concerned are Leos (Low Earth orbit satellites) which circle the globe at distances of between 550 and 6,000 miles, as opposed to Geos (Geostationary Earth-orbiting satellites), which orbit at 12,000 miles. Geos have a life of up to 12 years, Leos last just five. In addition, Leos are less powerful than Geos, so more of them are needed.

'On the Internet everyone is in the same place at the same time – cyberspace'

THE THREE technologies – the chip, fibre optics and satellites – provide us with unlimited computing power and bandwidth on a global scale. The world telephone network already links all countries through fibre optic cable and satellite. Satellite television continues to spread over the globe. The world's major financial and corporate computer communications systems are already in place. The newest manifestation of this global connectivity is the Internet.

On the Internet, everyone is in the same place. That place has been dubbed 'cyberspace', a term coined by the science fiction writer William Gibson. 'This sense of place,' says science writer Mike Holderness, 'is based on logical connections between pieces of information rather than physical location.'

The Internet is a creation of the nuclear age. In the late Sixties, the US Department of Defence needed to construct a command and control system that would function after a nuclear war by dispersing its major computers and linking them up. The resulting network was called ARPANET, after the Advanced Research Projects Agency that handled the task.

Researchers working on DoD contracts were quick to see the possibilities of the system and began exchanging information and ideas through it. They were joined on the Net by universities. Companies needing to do business with both worlds quickly set up their own connections into it. Subsequently, access was made available through the public phone system, allowing anyone with a modem to log on.

The Internet could be thought of as the 'network of networks'. It is composed of an estimated 10,000 of these and there are a further 900 networks running outside this main conglomerate.

The grass-roots element of the Net are the BBSers, who operate their own Bulletin Board Systems among their own 'virtual community'. Like local radio stations, they cater for a small audience, although this is not geographically located but could be spread all over the world. By 1993 there were some 60,000 BBSs operating in the US alone. There are now an estimated 23-35 million users connected to the Internet – ten million of whom have come on-line in the past nine months. A new user joins every ten minutes. This, wrote John Seabrook in the *New Yorker*, 'amounts to a massive cultural upheaval, as though a whole generation of immigrants to the New World had come over all in one day.'

By the end of February 1994, national computer networks in 72 countries had 'full connections' to the Internet. This kind of connection is one which can handle the high-speed data transfer of large files such as satellite images. E-mail, the electronic postal service of the Internet, can be sent and received in a further 56 countries – it is estimated that 239 other countries should be on-line by 2000.

The kind of thinking that has been used to build these global systems is now being applied on a national level. The idea of connecting all the computers in a country through a fibre optic network, which would also be linked to the home and business to form the 'nervous system' of a new society, has found common expression as the 'information highway' – the I-way for short. Its most public champion is Vice-President Gore, whose father, interestingly enough, was the architect of the Interstate Highways Bill that led to the construction of the freeways. Network building clearly runs in the family.

Since President Clinton and Vice-President Gore assumed office, the National Information Infrastructure (NII) has remained at the forefront of the agenda. Developments in the US are prefiguring some aspects of what is likely to happen in the UK, so are worth exploring in more detail.

It has been generally agreed that the NII will be built and operated by the private sector. The government, according to Gore's vision, will focus on co-ordinating network standards, funding advance research into high-speed networks, applications development, pilot projects for education and protecting the public's privacy, freedom of speech and other such issues. The telephone companies and cable television operators will be the principal carriers of traffic into the home.

The networks will be built of a hybrid of fibre optic cable, existing copper wire and coaxial cable. Fibre will form the major arteries of the distribution system, the copper and coaxial will take it from the main trunk route into the home.

Many believe that the key competitive service that will drive investment in this area is going to be the direct delivery of movies to the home, so-called 'video on demand'. This would be followed by a cornucopia of other voice, image and data services that would sprout once the system is in place. Others disagree, arguing that history has shown us that the predominant uses of such a system may differ considerably in reality from those being hyped today.

In the States, cable television goes into 60 per cent of homes. The separate cable systems that exist today will be joined together to form regional hubs which will be joined, in turn, to form the national network. The cable systems are mainly coaxial; these will be replaced by fibre optics to the level of the neighbourhood 'node'. Each node will serve 200-1,500 homes. From node to home will remain coaxial.

The telephone systems' broadband networks have been in place much longer and reach into a greater number of homes. With new digital compression, storage and transmission techniques, they can now send video through their existing copper cables.

Cable and television companies cannot develop their systems on their own and are establishing creative alliances. The computer industry is also after a piece of the action, its object being to produce the set-top boxes (really computers in disguise) that will decode the signals coming over the cable.

A battle over the NII has been raging between the cable and television companies, in the deregulated market created by the break-up of the nationwide Bell Telephone system, as to who should carry what services. If telephone companies offer videos, cable revenue will fall; if cable companies offer phone services, the 'Baby Bells' will lose revenue. Cable also wants to protect itself from competition from direct broadcast satellite services. They struggle for supremacy, forming alliances with content-providers in an attempt to offer the most competitive and attractive service. The dramatic events are still unfolding in the daily newspapers.

The idea of the national information infrastructure may be most fully developed in the US but similar schemes are being discussed around the world. In China they call it the Golden Bridge project; in Singapore, the Intelligent Island.

Particularly interesting is the situation in Japan. Having been subject to years of propaganda regarding the imminent takeover of the US economy by the Japanese, it now appears that the US is leading the world in developing an information economy and Japan is way behind in both personal computer use and networking. Japan has only one-third as many PCs per capita as the US. Only 10 per cent of Japanese businessmen use them and only 13 per cent are connected to networks compared with 50 per cent in the US.

Moves are being made and few doubt that the Japanese will catch up. The Education Ministry plans to spend $2.6 billion to place 22 PCs in each primary school and 42 in each junior high in the country by 2000. In 1993 the Finance Ministry allocated $4 billion for new social infrastructure, the Ministry of Posts and Telecommunications deregulated the cellular phone market and laid detailed plans to bond with the US information highway.

In Europe, state-run monopolies dominate European telecommunications, but that is changing and in 1998 there is a prospect of voice-telecoms deregulation. By belatedly eliminating local and long-distance monopolies at the same time, Europe may be able to leapfrog the US.

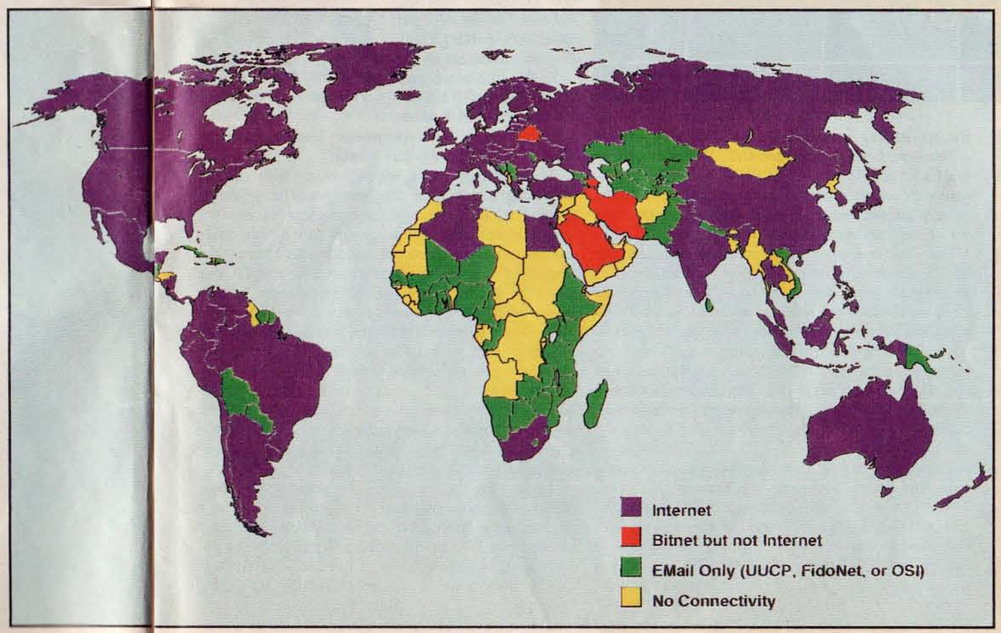
Most European countries now recognise that maintaining global competitiveness requires good, cheap voice and data systems and the building of the I-ways. Telecommunications' role in stimulating the economy is also recognised; the low-tech Minitel system in France has already created 350,000 jobs in a decade.

The phone monopolies have already been served notice in the form of the announcement on April 11 this year that 30 European-based manufacturers led by Rank Xerox have chosen a consortium led by BT and AT&T to build competing private networks that will bypass local phone companies with more sophisticated services.

The European Union plans to invest $76 billion in the next five years for advanced networks, interactive video services and the rest.

Europe's $5.8 billion market for mobile communications is set to nearly triple to $15.9 billion by 2000. A pan-European standard for digital networks (Global System for Mobility), has been adopted by 17 countries in Europe, 16 in Asia and 15 in the Middle East. This makes Europe a more homogenised market than the US, which still has two competing digital standards. ▷

The international network map, *below*, shows the North-South divide on the information superhighway. The 90 countries outside the Internet are the most populous and there are fears the 'information deficit' may get worse



THE THOUGHTS OF AL GORE

Al Gore articulated his ideas in an article entitled 'Infrastructure in the Global Village' in the September 1991 issue of *Scientific American*. Some of the key thoughts are as follows: 'New technologies that enhance the ability to create and understand information have always led to dramatic changes in civilisation. The printing press unleashed the forces that led to the birth of the modern nation state. It made possible the widespread distribution of civic knowledge that enabled the average citizen to affect political decisions.

Now come distributed networks connecting myriad computers . . .

'The US should lead by building the information infrastructure essential if all Americans are to gain access to this transforming technology . . . High-speed networks must be built that tie together millions of computers, providing capabilities that we cannot even imagine.

'It used to be that a nation's transport infrastructure determined success in international economic competition . . . today transport is less important compared with other factors, such as the ability to move information and to increase the value of this information.

'The absence of the high-speed data highways constitutes the largest single barrier to realising the potential of the information age. Present policy, which is based on copper-wire networks, is hindering deployment of the new fibre technology . . .'

LINKING UP THE WORLD

THE PROMISE of the digital revolution is new global awareness and true global connectivity. First thoughts might suggest that the advent of this new revolution will only deepen the economic gulf between North and South, East and West. The 90 countries outside the Internet are the most populous. The 'information deficit' may get worse and the worst hit will be Africa.

But new thinking in development circles recognises that the future lies in marrying the notion of sustainable development with the idea that telecommunications should be a part of every country's basic infrastructure and that the key to real development is the empowerment of people.

Traditionally, the business of communications has been fragmented in both government and donor agencies; each has established its own databases and spread information through its own chain of field workers. Bernard Woods, formerly senior communications specialist for the World Bank, believes that the future lies in establishing networked community information and learning centres to provide data and training on agriculture, health, nutrition, forestry and the like.

Almost every script and alphabet will soon be available on computers. Pictures, sound, graphics and numbers can overcome illiteracy. This technology is particularly good, Woods claims, at interactive instruction in maintenance and repair of machinery at village level. Buddhist monks in Bali are now managing an expansion of their ancient irrigation programme with the help of Apple computers. Computers can run on 12 volts, printers on 20; with an extra battery the solar panels used to run fridges could operate them. Low-orbit satellites and radio antennae can unite remote areas and people and empower communities.

The transformation wrought by the arrival of the information economy could greatly boost living standards in the developing world. According to Pete Engardio in *Business Week*: 'Places that until recently were incommunicado are rapidly acquiring state-of-the-art telecommunications that will let them foster internal and foreign investment. It may take a decade for many countries in Asia, Latin America and Eastern Europe to unclog bottlenecks in transportation and power supplies. But by installing optical fibre, digital switches and the latest wireless transmission systems, urban centres and industrial zones from Beijing to Budapest are stepping into the Information Age.

Singapore is to be digitally linked with China

'All these regions see advanced communications as a way to leapfrog stages of economic development. Widespread access to information technology promises to speed transition from labour-intensive assembly work to value-added industries involving engineering, marketing and design.'

The Pacific Rim Asian countries are speeding down the information highway. China plans to spend $100 billion on telecom equipment, adding 80 million phone lines by 2000, four times the number it has now. By the end of 1995 each of China's 26 provincial capitals (except Lhasa in Tibet) will have digital switches and high-capacity fibre optic links to Hong Kong, Taiwan, Singapore and Thailand. Shanghai is pursuing the dream of becoming a world financial centre.

In Thailand there are now 500,000 cellular phone subscribers. This is because the waiting list for conventional phones is immense and Bangkok's phone system is virtually paralysed. In Vietnam, which has one phone for every 435 people, and an annual per capita income of just $220, it is planned to add 300,000 phone lines a year running through optical fibre. India plans to install lines to all the country's 576,000 villages within the next three years as part of a $7.7 billion modernisation plan.

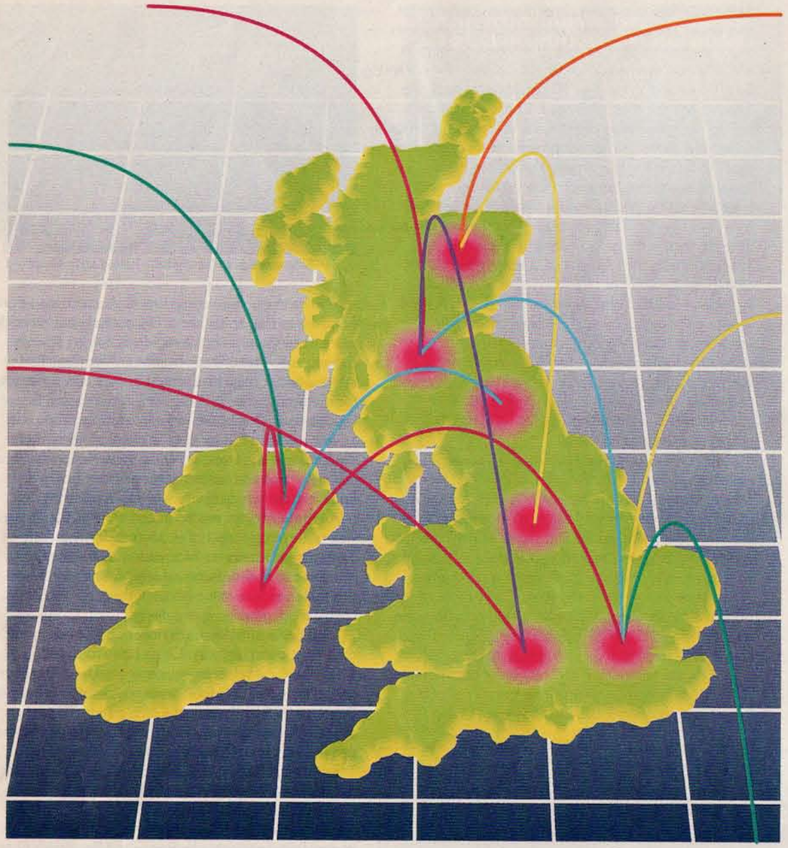
The fastest growing cellular phone market in the world is Latin America where only seven per cent of the people have access to a regular phone. This is good news for telecoms companies, particularly as research shows that Latin Americans like to spend two to five times as long on the phone as their US counterparts.

In Eastern Europe it is Hungary that has gone fastest down the digital track. With 700,000 people waiting for phones, it has been laying optical fibre for three years and has just licensed a Dutch/Scandinavian company to build what is claimed to be one of the world's most advanced cellular digital communications systems.

Russia has the potential to thrive in the Information Age because of the strength of its education system in science and maths. But its phone system dates from the Thirties and to bring the infrastructure up to the new standards Russia needs some $40 billion – money the country does not have.

THE IMAGE BANK

‘We’re about a decade ahead of Europe in our technological thinking and ability’



stake in Energis, one way they can obtain a licence to operate an international telephone service in Britain.

To further complicate matters, half the regional electricity companies now see themselves as all-round utilities and are considering entering the telecoms market in their own right.

In addition, British Rail Telcom, British Waterways and others have telecom aspirations. Cellnet and Vodaphone, the two main analogue mobile phone services, are both building networks and there will be a slow but gradual migration to digital services.

To find out more about I-Way UK, I visited Professor Peter Cochrane, head of BT’s Core Research group, which employs 600 people at Martlesham, near Ipswich. He has strong views on the situation and is not afraid to express them.

‘We’re about a decade ahead of Europe in our technological thinking, our infrastructure, our ability and the freedom of the market,’ he said.

‘When you look at the United States, we have a distinct advantage. We’re a small, compact country of 55 million people against a United States population of 230 million over a vast area. The advantage they have is they’ve got a government ratification for a superhighway.

‘The big problems we face as a society are physical travel, health care, education, commerce – all having to be done more effectively, faster and at a lower cost. There is no plan, no strategy for the industry of the UK. It is left to market forces on the assumption that market forces will make us lean, mean and fit.

Professor Peter Cochrane

‘We spend £35 billion on company training schemes in the UK per year. We spend £27 billion in education in the UK. We lose more than £15 billion – £10 billion of that in London alone – in traffic jams. Now that doesn’t seem to make any kind of sense. It’s absolute lunacy.

‘If we are not careful, we will end up with a totally miserable society. The first group will be miserable because it has no money and lots and lots of time – the unemployed. The second group will be miserable because it has lots of money and no time. They are the employed. It doesn’t make any sense. We stand to lose a lot of the creativity of the population by not accessing it, the way we did during the last Industrial Revolution. The problem is the inability of society to organise itself so we can subsume the technology without damaging groups of people.

‘One of the biggest problems is Keynsian economics, which was founded on the basis of an infinite source of material, an infinite marketplace and a linear path between the two. None of that is true. It never was true. Today it is grossly in error.

‘Look at the Treasury model for industry, it’s a joke. It is not sophisticated and yet we’re trying to run a country, an economy, on that basis. The world model doesn’t exist. We have not only a country of have and have-nots, but also a planet of have and have-nots.

‘The only hope we’ve got of getting something sophisticated is the computer, the coms network, the distributed processing; to augment the ability of the human imagination and get the data into the right form. Information itself is the only means of solving the damned problem. The phone network is the nervous system of society. The computers are the neurones of society. They control everything already.’

THE UK

BRITAIN has the most competitive communications market in the world, with a bewildering number of companies and technologies competing aggressively for market share of business on the I-ways.

As in the US, our phone service has been deregulated (since 1984) and, as a result, British Telecom is now facing competition. BT has its fibre optic network in place – 3 million kilometres of it – and wants to expand the services it can offer. But, in order to allow the cable television network to develop, the Government has banned BT from carrying television programmes down its network (video on demand) until at least 2001.

Its principal competitor is Mercury (owned 80 per cent by Cable & Wireless and 20 per cent by Bell Canada Enterprises). By June 1993 it had spent £2.2 billion building Europe’s first all-digital fibre network (5,690km of optical fibre cable and 2,700km of digital microwave links) and has so far captured nearly 10 per cent of the total telecoms market and nearly half the outgoing traffic from the City of London. In August 1993, an agreement was signed between Mercury and the six leading investors in the UK cable market – Telewest, Nynex, Southern Bell, Videotron, General Cable and Encom – thus allying Mercury’s intelligent network and strength in the corporate sector to cable’s infotainment packages and its connections with homes and small businesses

The cable operators (COs) are mainly subisidiaries of US phone companies, anxious to learn the television trade from which they are banned at home. They are licensed to broadcast programming within a fixed local franchise but can also apply for a licence to provide residential and business telecoms. So the customer gets a line from the COs, not BT; the COs then connect their local network to Mercury’s national and international network. Customers get one bill for all cable, television and phone services. (BT, Mercury and the cable operators plan to invest $37 billion over the next six years in networks that will carry voice, video and data to businesses and homes).

Nor is this the only competition BT faces. The National Grid Company (owned by the regional electricity companies) has invested £200 million to set up Energis, which is building a 1,800km fibre optic network by wrapping the cables around overhead electricity cables (at a quarter the cost of digging up the roads). US Telecom companies AT&T and Sprint are seeking a

David Shaw, MP

Nic Hopkins of the Centre, sometimes called Her Majesty’s Boffins, believes there is a ‘useful level of momentum on this issue’ and is aware of its importance to matters such as open government.

Although he said, ‘We have no brief to define the future,’ he believes that first access to the I-ways will come through small businesses and schools and through public information kiosks.

Trying to determine how much government information is available electronically is a difficult matter. Hansard and the HMSO catalogue are certainly not. The first MP in the House to use e-mail, David Shaw (Conservative, Deal and Dover), says nearly 100 MPs are on the Parliamentary and Data Video Network (PDVN). This enables them to communicate with their constituencies, and to access House of Commons resources when in their constituencies.

Shaw was part of the committee that has developed a £6 million plan for an enhanced PDVN network, currently awaiting approval from the Finance Committee. Half the cost relates to removing the asbestos in the Commons basement so that cabling can be installed and to secure it from flooding – a job that will take an estimated seven years.

‘Britain,’ says Shaw, ‘has to face up to to what’s happening in some way. Whatever we do, we can’t go it alone. There’s no point in ignoring it.’

His four-year-old child now has pen friends on the Internet in Nebraska, Fort Collins and California and enjoys downloading pictures of Saturn from Nasa. Shaw is working in his community to network schools in the region.

He says, ‘In my work as an MP, my constituents want a signed letter from me. I get 8,000 letters in and send 8,000 out in a year. Of those, 4,000 are the matters my constituents have raised that I pass on to the relevant government department; 4,000 are their replies to me; 4,000 are my letters back to my constituents. An enormous amount of paper could be reduced and time and money saved if my messages to government departments and their replies were handled electronically.’

The problem with having MPs on the Internet is, he believes, that their volume of mail could go up enormously and that it will be used as a lobbying tool. ‘It makes lobbying too easy,’ he says.

On the Left, the most advanced position is held by the National Communications Union (NCU), which in 1989 organised a conference on the possibilities of fibre optics called ‘The Network of the Future’.

In evidence given before a Commons Trade and Industry inquiry into the I-ways, the NCU’s leader, Tony Young, stated that, in his union’s view, the I-ways should be available to all.

‘Businesses should all have the opportunity to benefit from the competitive edge it will offer. So far as possible, every adult and child should have the chance to involve him or herself more fully in the community.’

The final hearing of the select committee was the first ever video-conferenced select committee meeting, during which the all-party group of MPs took evidence from witnesses in Washington DC.

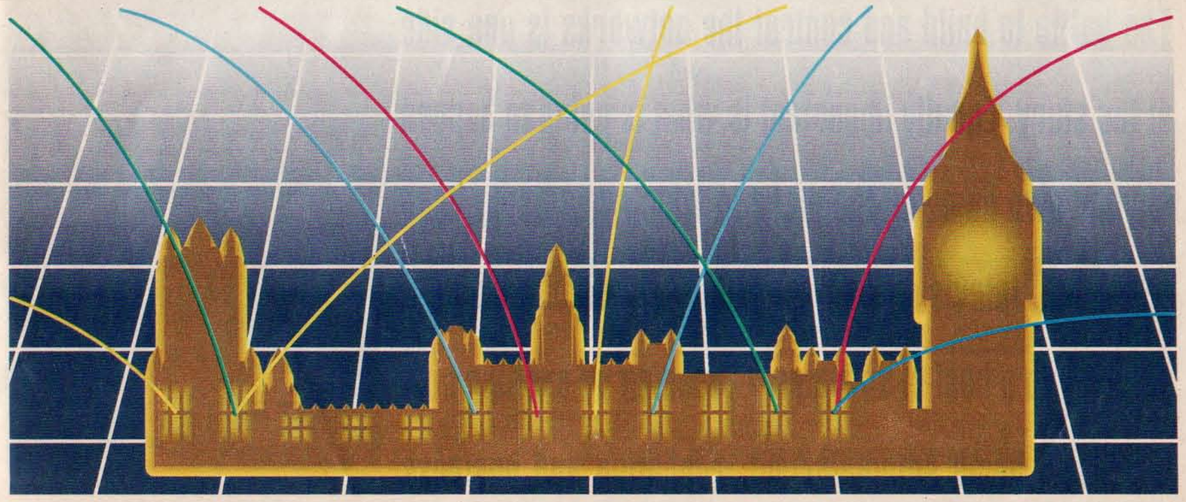
Tony Young, union leader

Their brief was ‘to assess the importance of Britain developing a national optical fibre network and to consider what system of regulation would best facilitate the provision of such a network and maximise its benefits to the nation.’

Their conclusion is simply stated: ‘The evidence we received has convinced us that the development of broadband networks and services will have enormous and far-reaching effects on the UK, and that it is vital that the UK does not lag behind other countries.’

Robin Cook, shadow trade and industry secretary, has written in *Winning for Britain – Labour’s Strategy for Industrial Success* that: ‘Labour would remove the bar on the supply of television services by BT and Mercury in return for their participation, alongside the cable TV and telephone companies, in a nationwide communication link-up.’

Labour, says Marjorie Mowlam, shadow national heritage secretary, ‘will bring the key principles [of the scientific revolution of the Sixties] forward for the Nineties to confront the challenges and the opportunities of the communications revolution.’ ▷



REG. ANDREW VALLARD

'We're not going out of the book business, we're just throwing away the paper and the print'

ILLUSTRATION BY MICHAEL STONES

The battle to build and control the networks is one side of the story. Equally important is what is going to happen in your own home or the place in which you work. Your telephone, television and computer will soon become a gateway to a host of services — opening up exciting new worlds in home entertainment, education and business

AT PRESENT your television set is a passive receiving device. You are limited to four channels with set timetables (more if you subscribe to satellite) and a couple of additional on-screen information services. And you can use it to play videos and CDs, with systems such as Philips CD-I and Kodak's Photo-CD.

The idea for the future is that your television will carry a set-top box that is a gateway to the fibre optic network. This will bring you not only potentially hundreds of channels but much else as well: video on demand, home shopping, home banking, access to a million different information services and data banks.

Your computer will become a multimedia tool, rigged out with speakers, a video camera and a modem, enabling you to transfer and receive voice, images and data. Your phone will mutate and attach itself to your television and computer. It will grow bigger, with screens and keyboards and memory; other types will grow smaller, lighter, become less expensive and more powerful and more mobile. It will similarly give you access to a world of information at your fingertips. There will be more of them.

In time these three devices will merge and connect with games systems, photo-CD and the rest of the gizmos. For the next five years at least there is going to be a messy battle of formats – until everything goes on-line.

The three areas of our lives that will be affected most in the short term are entertainment, education and business.

ENTERTAINMENT

WE ARE going through the CD-Rom revolution. These shiny discs read by lasers are like music CDs but have a much greater data storage capacity, so that they can carry not only text but also photographs, animations and video images.

The market for CD-Roms is due to expand exponentially over the next five years. US sales of CD-Rom titles in 1993 were 2.7 million, up 440 per cent from the year before. All new computers will have a player on board and adding one to your existing machine will get cheaper and cheaper. The installed base of CD-Rom drives is doubling every year in the US.

All games-playing systems will move on to them since they allow more data to be stored than a cartridge and thus provide greater graphic realism. As a result, Hollywood is merging with Silicon Valley. Live actors are being used in multimedia games. Many books, scientific journals and other forms of publishing are ▷

The light trail of a 'dataglove', used to compose music

'On CD-Rom disc you could own the entire collection of the National Gallery'

Read all about it – digitally

now appearing on CD-Rom. The game, the film, the novel can be combined into one interactive experience.

Musicians are releasing CD-Roms packed with video clips, sound bites, interactive festival sites and studios. Artists such as Peter Gabriel, Prince and David Bowie have already got their first product out and it is certain that masses of others will follow.

Peter Gabriel's first CD-Rom

Many areas of publishing are moving from paper to CD-Rom, particularly with reference and highly illustrated books. At the forefront of this transformation is Peter Kindersley of Dorling Kindersley, a global leader in illustrated book publishing. It has built its own multimedia and digital cartography departments, initially in partnership with Microsoft, and is evolving into a digital company.

Kindersley says, 'We're not going out of the book business, we're just throwing away the paper, the boards and the print. It's become an electronic thing. Books won't disappear, they'll just become marginalised, especially reference books.'

Digital techniques and technology are transforming the business and cost structure of filmmaking and television. For instance, movies delivered digitally could save Hollywood studios up to $300 million a year in distribution costs alone.

The new Hollywood is beginning to take shape. On a low-budget level there are small digital studios that can shoot live action against a blue screen, create digital sets and then merge the two, thus dramatically slashing costs.

On a grander level, the main player is Digital Domain, headed by James Cameron (director of *Aliens* and *Terminator*), Stan Winston and Scott Ross, the former head of George Lucas's special-effects house, Industrial Light & Magic. Digital sets, characters and effects will be combined with traditional film-making talents to produce powerful new forms of entertainment.

Theme parks and amusement arcades are where the R&D for these developments is taking place. For comparison, the size of the US video game market in 1994 is $5.3 billion, the US movie market is $5 billion, the US theme park market is $6 billion, the annual amusement arcade business is worth $5.3 billion.

The scope offered by CD-Roms will bring new possibilities to computer games and virtual reality

As Douglas Trumbull, (the director or special effects co-ordinator on *2001*, *Silent Running*, *Blade Runner* and *Close Encounters of the Third Kind*) put it in an interview: 'I've felt that the Hollywood industry hasn't been keeping up with the potential changes in the medium. You can make movies in the existing format . . . but the future of the cinema is happening outside of the movie industry in the new entertainment centres, and theme parks. That's where you really get a chance to experiment with the medium.'

Museums and expositions are another testing ground; both driven by the need to educate and entertain. Museum collections will increasingly be available on CD-Rom disc, allowing you to own, for instance, the entire collection of the National Gallery in digital form.

Television will become high-definition and multichannel (in prospect is a 150-channel system for Europe). Photography is making the digital transition as well. Digital cameras allow images to be stored on disc and transferred directly to a computer or down the wire. Photo-manipulation techniques and software mean the end of the photograph as the ultimate arbiter of truth.

Electronic newspapers are under development. These will be received on-line on your television or computer, or via some new portable device. You can get the whole paper or have a version customised to your taste by 'intelligent agent' software that has 'learned' your likes and dislikes. The edited highlights would be reassembled into your own personalised newspaper: The Daily Me.

Nicholas Negroponte of Massachusetts Institute of Technology's Media Lab believes this is part of a gradual move away from the concept of mass media to one of personal media. In his view of the future, there will still be general television, newspapers and magazines but these will be accompanied by a growing tier of personal media – visual and print – created by these 'agents' scouring databases on your behalf.

In the US the *Chicago Tribune*, the *Atlanta Constitution* and the *Washington Post* have daily on-line editions. *Time* and *Newsweek* are also available on-line and this development is proving to be a major new source of revenue for many magazines.

Wired, a sort of *Rolling Stone* for the Nineties, whose editorial content is centred on the digital revolution, is both designed and printed digitally and supports a host of on-line services. One of the most successful magazine launches in recent US publishing history, it is soon to produce a fully-fledged on-line version to complement the existing print form.

Telegraph Magazine

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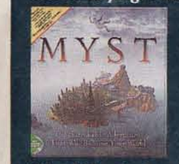
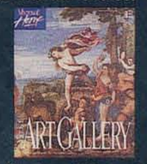
'Schools today are being forced to change by children who are living in a different world'

TOP EDUCATIONAL CD-ROMS

There are now thousands of CD-Roms on the market, most selling for around £50. Make sure your computer has enough memory and does not need extra features – always consult your retailer before buying. This was our choice:





'Myst' (Broderbund), *above left*, could not exist except in CD-Rom form. The player arrives on a strange island which he or she has to explore. There are no clues, boxes or icons to spoil the brilliant textures and clarity of the landscapes. Only the sound of the wind. The purpose may be unclear but the experience is unforgettable and genuinely new.

'Art Gallery' (Microsoft), *above right*, has the entire National Gallery collection accessible by theme, date or artist and you can also wander through the gallery on a guided tour and examine the paintings in detail.

The cartoon adventures 'Sam and Max Hit the Road', *below left*, and 'The Day of the Tentacle' (both Lucasfilm) require considerable ingenuity to puzzle out.

'Encarta' (Microsoft), *below right*, is an interactive reference package of wide scope. It combines an encyclopaedia, an atlas and a timeline. Fascinating to use.

All the CD-Roms in this survey were supplied by HMV Level One, Oxford Street, London W1. The 'Children's Computing' catalogue provides a guide to CD-Roms and offers a mail-order service. Catalogues, price £3.50, are available from newsagents or direct from Unit D3A, Telford Road, Bicester, Oxfordshire OX6 0TZ. Tel: 0869 324324

In the digital classroom, the teacher's role will change to that of 'guide on the side'

EDUCATION

THE DIGITAL revolution will trigger a change from the notion of a short intensive educational period to the idea of lifelong learning.

The teacher's role changes from being the 'sage on the stage' to the 'guide on the side'. Linking schools to the Internet will end the isolation of the classroom, allowing students and teachers to interact with people in other parts of the country or the world, and to interrogate remote databases and participate in multi-school projects. In remote areas, teachers will be able to communicate with hundreds of pupils via telecommunications in what they call 'distance learning'.

'Education has to change,' says Peter Kindersley of publishers Dorling Kindersley. 'At one time, going to school was actually going up a level. You had somebody there who knew more than you. You had books there which you didn't have at home.

'Schools are being forced to change by children living in a different world who come into this very rarefied world and find that simple things such as television sets, video recorders and computers are not there. All the things they expect in their homes are not there. They ask themselves, "Why do I live in this boring world where I can't use a video game?" '

The first steps have already been taken towards the creation of 'virtual/electronic universities'. Super-JANET, an advanced optical fibre network linking more than 60 universities, is set to double in size over the next three years. The £45 million plan to create the University of the Highlands and Islands, in an area the size of Belgium but with a small and scattered population, is based on a network with students working through PCs to get their basic course information. Tutors will hold seminars either face-to-face or via video conferencing.

BT's Peter Cochrane believes this could mark the beginning of a new chapter in higher education in Britain. In June he alarmed a group of leading academics by telling them that 'the technology that is going to take you all out is already here'.

He argues that teachers and students are drowning in information. 'People are spending 80 per cent of their time finding information, 10 per cent putting it in order and only 5 per cent of their time making decisions.'

Cochrane believes libraries will disappear for science, engineering and even arts subjects, to be replaced by CD-Roms and other digital learning tools. He points out that Britain was first off the mark with the Open University but that there has been no progression. He envisages a more interactive, dynamic and challenging version.

BT's 'experimentation with children', he claims, has shown that young people today learn in a totally different way to their parents. 'They cannot conceive of a world without video games, colour television and pocket calculators. They want good graphics, very good animation and instant gratification.' ▷

‘Networks destroy hierarchies . . . leadership becomes more important than management’

BUSINESS

NETWORKS within companies destroy hierarchies and blur the traditional barriers between departments and divisions. They allow work groups, whose members may be spread around the world in different time zones, to evolve for the solution of specific problems. The network provides a constantly updated data platform for a company’s entire staff to draw on.

In a networked business, leadership becomes more important than management, and command and control is replaced by communication. A network’s main characteristic is openness of information. This requires stronger relationships between peers, empowers employees – who can now get whatever information they need to do their job – and raises the key issue of trust.

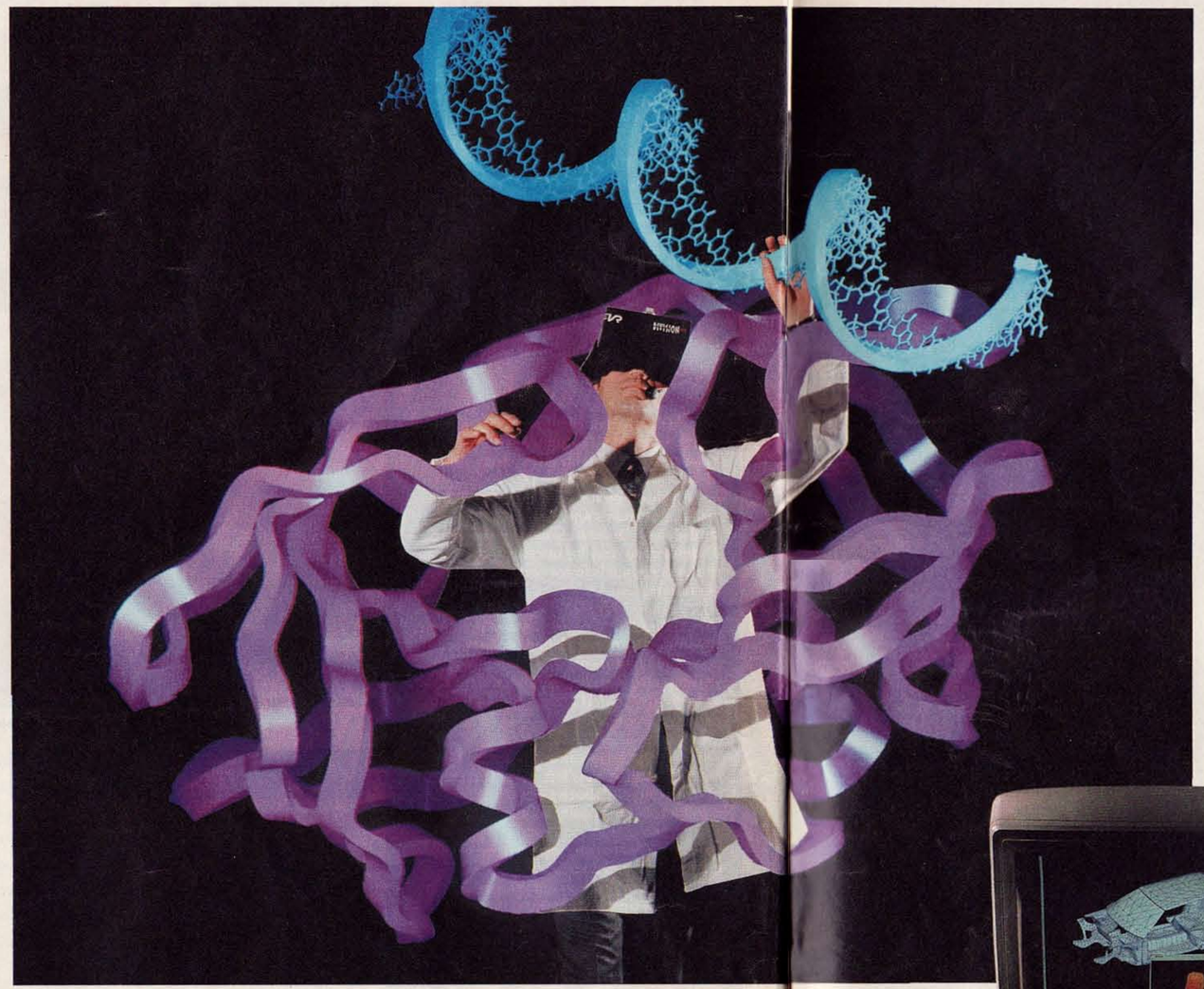
As the functions of computers and telephones merge, office workers of the near future will have a PC screen that acts as a sort of universal mailbox, providing access to voice mail, e-mail and faxes.

As companies have switched from mainframe computers to PCs, so there has been a rise in Local Area Networks (LANs) to link them all together. Companies with scattered plants have built Wide Area Networks (WANs) for the same reasons.

The largest internal satellite communications network in Europe will connect 6,000 Volkswagen dealers in several countries. The network operates through Very Small Aperture Terminals (VSATs), which are only a fraction of the size and price of conventional dishes. An increasing number of companies will use VSAT networks because the availability of fixed land lines is poor and the system can be installed in a matter of weeks.

Alongside these developments is the growth in ‘teleworking’ or ‘telecommuting’, which has developed in parallel with the rise in portable computing and mobile telecommunications. Thirty per cent of the workforce in many major US corporations now operates outside the traditional office, and the trend will increase as cheap video-conferencing allows more workers to interact with their colleagues in this way.

Companies will encourage teleworking because it saves them money. A 1991 study by Warwick University claimed the average saving per employee was £1,500-3,000 a year. Others estimate it as high as £5,000. For many, the traditional office will cease to be the centre of many people’s working lives. Telecommuting has a direct environmental impact as well. The average worker in Britain spends 480 hours a year commuting, the equivalent of 60 working days. Commuters’ cars produce 19.8 billion gallons of exhaust fumes per day. Move information, not people is the watchword of this shift in work patterns.



Video-conferencing, *above*, allows long-distance interaction

One demographic effect of such a shift is the movement of development away from the urban regions: companies will establish hub offices, or telecentres, communicating with a network of telecottages – small communal offices where freelancers from different companies can share facilities. Such schemes are already running in the UK. What is clear is that flexible working from a distance must be balanced by social contact and team cohesion to overcome isolation.

In many areas of science, architecture and engineering the digital revolution is well advanced. Drug designers use complex molecular modelling software packages and virtual reality to design new compounds. Environmental scientists can now visualise complex natural phenomena for both analytic and predictive purposes. Architects can not only conceive new buildings as three-dimensional models, but can also ‘walk through’ them to ‘visualise’ for themselves and their clients how the finished building will look. Engineers can build structures inside the computer and then subject the model to stresses and strains, and measure its resistance factors.

In manufacturing, computer-aided design linked to robotics enables car models to be constructed in digital form and then realised as 3D models by computer-controlled robots with laser cutters. On the factory floor, personal computers now control automated production and manufacturing systems. One of the big developments for retailers, apart from touch-screen information points and other such useful gimmicks, is Electronic Data Interchange (EDI), This allows customer and supplier to exchange routine documents, such as orders and invoices, using standard electronic forms. Britain leads Europe in EDI usage in the private sector. Seven thousand companies and organisations are estimated to be using EDI, and their numbers are increasing at 20-30 per cent a year.

Tesco has been a pioneer, automating its entire transaction chain from sales to stock to goods to invoices to payments. This had the effect of reducing stock levels, allowing just-in-time manufacturing, bringing suppliers and customers into a closer partnership. The system automatically leaves an ‘audit trail’ for checking and accountancy purposes.

In the US, the QVC all-shopping television channel reaches more than 50 million households via cable. At present, customers phone in their orders. The next step will be tried out by Time-Warner with ‘Shopper-Vision’, a prototype interactive television experiment with 4,000 homes in Orlando, Florida. The viewer will interact with a ‘virtual store’ via a set-top box. They can select items from on-screen shelves, zoom in to read the labels, place the articles in a ‘shopping basket’ and pay by credit card, or add the money to the monthly cable bill. The groceries are delivered from a warehouse within hours.

In 1993 Americans purchased an estimated $200 million worth of products from on-line services; this compares with $63 billion spent on goods from catalogue retailers via mail order. With an increase in home shopping, the development of out-of-town supermarkets may be stopped in its tracks, with a consequent impact on traffic flows and leisure time. On the other hand, shopping has an important social function: it is a good reason to get out of the house.

Computer and communications technology are also beginning to transform the nature of the political apparatus at local, city, regional and national level. A major part of politics is making decisions over the management and implementation of resources. To be able to visualise the flows of energy within systems, capital through a market, or traffic through a city is a valuable new tool. It should enable planners and politicians to address problems in new ways and, equally, will enable citizens to get a clearer view of how the system works, and to be more involved with the various scenarios that are being planned for our future.

***Above*, a scientist explores an enlarged ‘virtual reality’ image of DNA. *Right*, computer-aided car design allows the use of 3-D images**

This is where Geographical Information Systems come in. Put simply, these are layers of data about a country, region, area or city composed of series of digital data that can be viewed in any combination. Thus a city can be ‘mapped’ in layers – the sewers, the road systems, the traffic flows, the location of parks, emergency services and so on, allowing all kinds of authorities and users to get a new view of the area they are managing. One example is the digital road map of Europe, currently being compiled. It will allow businesses of all kinds to plan their transport problems more efficiently. The data should eventually be available on in-car navigation systems.

Visual imaging has many medical applications. *Above*, it assists in the performance of minimally invasive surgery

In the UK a digital National Land Information System is under construction, due for completion by the end of the century, integrating information from such bodies as HM Land Registry, the Ordnance Survey and the Valuation Office.

This Domesday 2000 project will include a national Land Use Stock System that will accurately define patterns of land use in both rural and urban areas for the first time.

The NHS will be transformed by the digital revolution. Health-Oriented Telecommunications (HOTs) holds the promise of a better state of health for less money. Much of the health system is to do with information: diagnostic, therapeutic, consultative. At present, most hospitals employ up to six people searching for lost medical records within the building. But in the future, everything from insurance information to X-rays and MRI scans will go digital – making individual medical histories available on line to anyone with the right codes anywhere in the country. And eventually, everyone may carry some of that information with them on a ‘smart’ card. ▷

Shopping via the television

‘Computers are already raising serious questions about the privacy and security of ordinary citizens’

DEMOCRACY IN PERIL?

AT THE moment we have a representative democracy. What the digital revolution suggests is that there is a possibility of creating an interactive democracy – one in which ordinary people become more informed and more able to participate in the democratic process. A new political language may emerge in the same way that socialism, liberalism, conservatism and all the other ‘isms’ have in the past.

The idea of a nationwide network of participatory politics dates back at least to the Forties, when the American Buckminster Fuller suggested voting on issues of the day via telephone. First popularised by Ross Perot during his presidential election campaign, an electronic ‘town meeting’ industry has developed in the US, and is now in the hands of dozens of foundations and entrepreneurs seeking to provide a mix of television, politics and interactive electronics. It could become a tool for enlightenment or the start of push-button democracy – but Perot’s version has been described as electronic town manipulation, or ‘teletyranny’.

Proponents of the electronic communications system in the US suggest it could be structured so as to help create consensus, democratise debate and energise the electorate. They see it as a supplement to the existing system – but others believe the US has outgrown its current model of government. When the Republic was founded, each member of the House of Representatives represented 30,000 people; today they have an average 575,000 constituents. Transforming the US into a direct democracy might be a natural evolution, and the choice of an electronically enlightened electorate.

Howard Rheingold, author of *The Virtual Community*, a book about the world of computer communication networks, writes: ‘The idea of representational democracy as it was first conceived by Enlightenment philosophers included a recognition of a living web of citizen-to-citizen communications known as “civil society”, or the public sphere.

‘Although elections are the most visible fundamental characteristics of democratic societies, these elections are supposed to be supported by discussions among citizens at all levels of society about issues of importance to the nation. If government is to rule according to the consent of the governed, the effectiveness of that government is influenced by how much the governed know about the issues that affect them.’

In Rheingold’s view, the rise of computer-based communication has a political significance, rooted in its capacity to challenge the monopoly of existing political hierarchies over communications media – thus, perhaps, revitalising citizen-based democracy.

As he sees it, we can either use communications technology to create the ‘electronic agora’ (named after the marketplace in Athens where people met to talk, gossip and argue) – or else an electronic Panopticon, the ultimately effective prison proposed and designed in the 18th century by Jeremy Bentham, in which a single guard could see every prisoner and no prisoner could see anything other than the guard. Theoretically, all prisoners would act as if under surveillance at all times. It is clear that these new technologies could be used to inhibit civil liberties and, in an extreme case, create electronic dictatorships far more subtle and all-pervasive than the vision outlined in George Orwell’s *1984*.

Singapore is a model for the state-controlled digital society. It has installed a world-class communications network but it bans the unauthorised use of satellite dishes and plans to control access to international data services. Everywhere you go you leave a data trace, as science fiction writer William Gibson so memorably put it. The more of your business and daily affairs you handle on the network, the more data is potentially available to both governmental and commercial interests, who wish to build up data profiles of individuals based on their tastes and spending patterns.

An example of things to come is the Federal Financial Crimes Enforcement Network (FinCEN), perhaps the world’s most effective international financial crime investigation unit. It takes in data from the CIA, the National Security Agency and the Defence Intelligence Agency and maps the trail of ‘dirty’ money around the world. It is the only federal unit devoted solely to the systematic collation and cross-reference of law enforcement, intelligence and public databases.

This is already raising questions about the privacy and security records of ordinary citizens. No one denies the value of tracking terrorist funds (FinCEN was used to trace the Islamic fundamentalist cash to the bombers of the World Trade Centre) or cracking drug cartels (FinCEN helped the Drug Enforcement Administration net the financial officers of the Cali and Medellin cocaine cartel and seize $54 million in cash and assets). But where does the application of such brute computing power end?

In the States the question of civil liberties in the digital age is currently under discussion. A group called the Electronic Frontier Foundation is a formidable lobby group, working against what they see as dangerous developments in legislation.

By linking into the Internet your computer becomes a printing press, your phone line a broadcast system. The question now is, will the freedom to communicate on the electronic information network become limited and regulated? This is a free speech issue that goes to the heart of the American constitution.

The National Security Agency, the most secret of the US government spook establishments, wants to install a ‘Clipper Chip’ – an encryption device – in everyone’s phone, fax or modem. The Clipper encrypts the data as it leaves the computer, and another Clipper at the other end decrypts it, thus allowing all users peace of mind, secure in the knowledge that their bank balance and medical records are not being tampered with. The government argued that one of the ▷

implications of the installation of such a device would be to enable organised crime to avoid surveillance techniques such as phone tapping, which have been a key weapon in the battle against organised crime.

Thus the Clipper has an electronic ‘back door’ which law enforcement agencies could use, having first obtained a court order, to tap into the data streams of suspected criminals. This is what is making people feel uneasy. The Government may try and railroad it through but at present it seems unlikely that Clipper chips will be installed.

Of course, computer security is a pressing issue. It is estimated that some $4 billion a year is lost worldwide to computer fraud. The activities of computer hackers and the spread of viruses are well documented. Encryption techniques are vital, but they constantly need to be updated.

RISKS-Forum is one of the most widely read discussion groups to be found on the Internet. Its subject is any use of computers that might accidentally lead to loss of life, property and money. It covers everything from the risks associated with remote control garage-door openers to nuclear reactor accidents caused by faulty software.

The Forum grew out of a fierce debate within the Association for Computing Machinery over the software for then President Reagan’s Star Wars initiative. Its moderator is Peter G. Neumann, who has learned the hard way the futility of trying to build risk-free computer systems. The answer, he believes, is to try to stick to a simple system, do things as reliably as you can and use intelligent people.

He told *Wired*: ‘I keep trying to put a positive spin on things, yet I’m very frustrated by the difficulties involved in getting something to work correctly. I’ve spent most of my professional career trying to make things work better. And yet, knowing that people can screw up, and hardware can screw up, and designs are typically flawed, and implementations are almost always flawed, leads me to the conclusion that it’s a losing battle. So I’m kind of sceptical of some of the really critical uses of computers in life-critical situations.’

THE NEW AGENDA

SO, IN BRITAIN, at this moment, there is an initiative to be seized and a new agenda to be defined. Any new administration, whatever its political complexion, should, in the way Gore has attempted in the US, seek to build I-ways as the nervous system and backbone of its strategy. It is essential if we are to redefine ourselves as a nation, regenerate our infrastructure and find a new place in the world. It would also be fitting and timely as we have been there before.

One hundred years ago, Britain had a powerful empire and a feverish creativity. We were also the network builders, as can be seen through the work of men such as Brunel and Stephenson, through the railways we built, the postal service we established, the sewer systems that we have now lost the craftsmanship to repair – infrastructure that has stood the test of time.

We have not lost our natural ingenuity nor our engineering heritage. It could find even fuller expression in a digital form. We need to repair our own infrastructure and help build these new systems around the world. And write the new software that controls them.

We have to transform our educational system and begin to build a system that really gives our children a purpose and an opportunity in this emerging world.

The Victorians were filled with ecstasy and dread when contemplating the birth of the 20th century. They were reeling from the effects of the new industrialism, the birth of photography, the telegraph, the telephone and the artefacts and information arriving back from all arcs of the globe, revealing the strange and unexpected nature of reality.

Darwin had destroyed centuries of certainty regarding our origins, Conan Doyle was popularising forensic science in his Sherlock Holmes stories and Charles Babbage had built a pioneer calculating machine, the ancestor of the modern computer.

They would have appreciated the strange reality we are moving into. They would have unabashedly embraced it and imagined great things.

What we need is some vision. Andre Spier, a top adviser to the South African government, has said: ‘A vision is not a blueprint, a new economic masterplan, a five-year development plan, or any other prescriptive extrapolation of the present. A vision is not concerned with change. It is concerned with transformation.’

Vision appears to be in short supply among our policy makers, our politicians, our pundits, our prophets, critics, judges, planners, rulers and bureaucrats. They should spend more time listening to children.

Children have the best idea about the digital technology. They are growing up with it. To them it is part of the landscape, part of their environment. They want to do things and they expect the machine to be able to do it. They have no inhibitions, they just dive in and find out how it works by trial and error.

They will grow up in this new world and will proceed to rewire the bits they don’t like and adapt them to their own requirements. We can ease our own transition by understanding what has taken place and thus enabling the new world to emerge. T

John May’s e-mail address is john@oikos.demon.co.uk
Additional research by Steve Alexander

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