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NEW INFORMATION AND COMMUNICATION TECHNOLOGIES, SOCIAL DEVELOPMENT AND CULTURAL CHANGE

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Preface

In the late 1990s, we stand on the eve of the total digitalization of all forms of information transmission, except those occurring on a non-mediated, person-to-person level. Sound, text, voice and image will soon be relayed across vast distances in the binary language used by computers; and this will open possibilities for the high-quality transmission of information, in a volume and at a speed almost unimaginable a few years ago. The cost of doing so is also likely to decline dramatically.

Digital technologies are already bringing about profound changes in the economies and societies of countries around the world — speeding the automation of work, facilitating borderless financial transactions, delivering global news and entertainment to vast new audiences. As these technologies permit the fusion of the telecommunications, computer and entertainment industries, they encourage a titanic struggle among some of the largest corporations in the world for control of a consolidated information industry.

The potential of digital technologies to improve the livelihood of people is great. In remote regions, the disadvantage that comes with isolation can be significantly lessened through access to rapid and inexpensive communications. Like-minded people can co-operate across great distance to defend human rights or promote other projects of common interest. Remote sensing can be used to protect the natural environment. The list of possible contributions to human development is long indeed.

Yet there are also obvious dangers in the current highly charged competition to gain control over digital technologies. Already existing trends toward polarization in the world economy can clearly be worsened. Digital advantage can reinforce the possibility that ever smaller groups of people will determine the future use of an ever larger proportion of global resources. Development can be concentrated in regions where the information infrastructure is most developed, to the detriment of areas that are not endowed with the most modern capabilities. And within societies, a growing “knowledge gap” can separate individuals who have access to the latest equipment, and have been trained to use it, from those less well endowed.

In the following pages, Cees Hamelink reviews the background of the current “information revolution”, explains its principal technical features and explores possible scenarios for the future. He challenges the frequently held disposition to accept the current direction of change without question. The course of technological development, he reminds us, is always shaped by human beings with particular interests and goals, and a certain (sometimes implicit) view of the future. The latter should be examined openly, not taken for granted.

We have the obligation to think first of the kind of society we want to see in future, and then to influence the design and deployment of new technologies in ways that are most likely to further our goals. In this regard, institutional innovations are as important as scientific or technological breakthroughs in creating new opportunities for human development.

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June 1997

Dharam Ghai
Director

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Summary

A particularly important aspect of contemporary technological innovation is the quest for new ways to capture, store, process, transport and display information. Although the prevailing expectation is that progress in this field will have a profound impact on societies, expert opinions differ about whether this impact will be positive or negative. In fact it is difficult, if not impossible, to foresee the future social and economic implications of the adoption and proliferation of new information and communication technologies, and this creates a serious problem for policy makers. In the following pages, a case is made for accepting the ambiguities inherent in the current process of technological change and giving concerted attention to specification of the social and institutional changes that will be required to strengthen its potential for social development.

The Development of Information and Communication Technologies

Four stages in the development of technologies to capture, store, process, transport and display information can be identified throughout human history. From the first stage to the fourth, constraints upon the distance, speed, volume and reliability of information handling have progressively been reduced.

In the **first**, and longest, phase (from approximately 35,000 BC to Samuel Morse's first telegraphic transmission in 1838) information was handled through recourse to physical and mechanical power. Media for the transmission of information included fast-running couriers, carrier pigeons, smoke signals, talking drums and semaphores.

In the **second** phase, following the invention of electricity, electro-mechanical power permitted the development of the telegraph, telephone, radio and television.

In the **third** phase, the possibilities of electronics were explored, with the invention of the electronic computer, transistors, semi-conductors (such as silicium) and integrated circuits (or "chips"). The integration of telecommunication and computer technologies began.

Initially, these two technologies were developed and utilized in distinct ways. For almost 80 years, telecommunication technology generated and upgraded techniques for transmission between people-centred artifacts such as telephones, facsimile machines and television systems. Eventually, switching techniques began to make networking possible.

Meanwhile, computer technology evolved from the first electro-mechanical calculator in 1939 to the first — huge — electronic computer (the ENIAC), developed during the Second World War. During the 1950s, the invention of the transistor made it possible to design computers of smaller size, operating at higher speeds, and permitting more versatile programming and reduced energy consumption.

Over the course of the 1950s, computer and telecommunications technologies were integrated, and computer-communications networks were created that linked computers among each other and to terminals. These networks found wide application as a number of technological advances increased the capacity, accessibility and compatibility of both computing and telecommunication facilities. For example, research in the field of telecommunications yielded innovations such as satellites, modems, optical fibres and packet switching. New computer technology permitted the integration of electronic circuits on very small surfaces of silicon (the "chip"), and then created the capacity to place the complete central processing unit of a computer on one chip (the microprocessor).

The first microprocessor was manufactured by Intel in 1971, and only four years later the first computer based upon the microprocessor (the microcomputer) was marketed. This has often been identified as the beginning of the "information age". It certainly announced the sophisticated, inexpensive and flexible personal computer (PC), which began to make the capacity to handle electronic information available to growing numbers of businesses and individuals.

The 1970s and 1980s were largely characterized by further miniaturization of electronic components, exploration of new conducting materials, new techniques for faster electronic switching, expansion of memory capacity and improvements in computer software. New programming languages were developed in order to improve machine-user interaction and to render the problem-solving capacity of computers more sophisticated. The speed of peripheral equipment (all kinds of input and output devices, such as interfaces and printers) was also increased to match the performance of the central processing unit.

The **fourth** phase in the development of information and communication technologies is marked by still further reduction of constraints. Earlier analog modes of information handling are being replaced by more powerful, reliable and flexible digital systems. "The technical foundations of this process lie in the early post-war era, in the innovation of a common language of microelectronics for both computing and, somewhat later, telecommunications" (Schiller and Fregoso, 1991:195). With the development of digital switches and digital transmission facilities in the 1960s, the transition from analog to digital networks began. During the 1980s the process accelerated, and by the late 1980s between one fourth and one half of all central office telephone switches in the advanced industrial market economies had been digitized. It was also in the 1980s that the international satellite consortium, INTELSAT, began to introduce full digital services such as International Business Service (IBS) and Intelnet (a digital communications service for use with small terminals) — a step considered essential to INTELSAT's future competitiveness on the satellite services market. The next generation of advanced satellites will be compatible with the standards of integrated digital networks.

What are ICTs?

Information and Communication Technologies (ICTs) encompass all those technologies that enable the handling of information and facilitate different forms of communication among human actors, between human beings and electronic systems, and among electronic systems. These technologies can be sub-divided into:

Capturing technologies, with input devices that collect and convert information into digital form. Such devices include keyboards, mice, trackballs, touch screens, voice recognition systems, bar code readers, image scanners and palm-size camcorders.

Storage technologies, producing a variety of devices to store and retrieve information in digital form. Among these are magnetic tapes, floppy disks, hard disks, RAM disks, optical disks (such as CD-ROMs), erasable disks and smart cards (credit-card sized cards with memory and processing capacity for financial transactions or medical data).

Processing technologies, creating the systems and applications software that is required for the performance of digital ICTs.

Communications technologies, producing the devices, methods and networks to transmit information in digital form. They include digital broadcasting, integrated services digital networks, digital cellular networks, local area networks (LANs), wide area networks (WANs, such as the Internet), electronic bulletin boards, modems, transmission media such as fibre optics, cellular phones and fax machines, and digital transmission technologies for mobile space communications (the new Low Earth Orbit satellite voice and data services).

Display technologies, which create a variety of output devices for the display of digitized information. Such devices include display screens for computers, digital television sets with automatic picture adjustment, set-top boxes for video-on-demand, printers, digital video discs (which might replace CD-ROM drives and audio CD players), voice synthesizers and virtual reality helmets.

Today the common feature of these ICTs is “digitization”.

During the 1980s, digital technologies also began to be applied in the field of consumer electronics, and for such products as the compact disk (CD) a rapidly growing market emerged. When Philips introduced CDs on the Dutch market in 1983, their sales accounted for less than 2 per cent of the recorded music market; by 1986 this figure had risen to over 25 per cent. Similarly, sales of CDs in the United States increased from 8 to 200 million units between 1984 and 1989 (Robinson et al., 1991:53). “Smart” digital television sets were also developed during the 1980s. The deployment of digital technologies not only improved sound and image, but also facilitated the capacity to store, process and convert incoming signals.

Even in the early 1990s, however, many analysts were sceptical about the potential of digital technologies. As Nicholas Negroponte notes:

> In fact, as recently as 1993, some Europeans were arguing that digital video would not be a reality until the next millennium. Five years ago, most people did not believe you could reduce the 45 million bits per second of raw digital video to 1.2 million bits per second. Yet in 1995 we can compress and decompress, encode and decode video at that rate, inexpensively and with high quality (Negroponte, 1995:11).

The Nature and Advantages of Digitization

Digitization is the process through which information (whether relayed through sound, text, voice or image) is converted into the digital, binary language computers use. Computers cannot understand information in the form of pictures or words, but only when it is broken down into binary digits or bits: "zero" or "one", "yes" or "no", "on" or "off". The conversion of information into this form makes it possible to transmit information from different sources through one channel and to reduce the risks of distortion. Thus the use of the digital language facilitates the convergence of computers, telecommunications, office technologies and assorted audio-visual consumer electronics. Their integration, in turn, allows information to be handled at higher speed, with more flexibility, improved reliability and lower costs.

Through digitization, the capacity of communications channels is greatly expanded, there is more scope for consumer choice, and more possibilities for interactive systems are created. Furthermore, digitization considerably improves the quality of voice and video transmissions. And economic efficiency is enhanced because conversion to digital forms of storage, retrieval and editing generates savings in time and labour. For high quality video, for example, images can be digitally compressed and then transmitted over satellites at 56,000 bits per second as a computer file. This digital data can be stored on computer disc systems until it is played back at the original speed. Since digital compression and storage systems are light-weight, the new technology can be especially useful in news gathering.

Digital compression techniques in television offer important economic advantages for satellite broadcasting. More television channels can be put on fewer transponders, which implies considerable savings. (To take one example: the cost per year of using one transponder on the Asian satellite AsiaSat is US$ 1.5 million. With digital compression one can accommodate 10 channels on a single transponder.) Digital compression techniques will also increase opportunities for projects like video conferencing and pay television.

In sum, the principal characteristics of the new digital technology are the following:

Convergence and multifunctionality. When all signals — whether they carry sound, data or pictures — converge into a digital form, they become (however different they may be in substance) identical in the technical sense. As a result, digital technologies are instrumental in the convergence of electronics, telecommunications and data-processing technologies. They bring the formerly separated and different "worlds" of broadcasters, cable companies, entertainment firms, telephone carriers, computer manufacturers, publishers and Internet users together.

This convergence creates new modes of information handling (e.g. digital manipulation of sounds and images) and makes information appliances multifunctional. The personal computer, the television set and the telephone begin to be integrated into real multimedia stations. Telecommunication and broadcasting are also integrated, so that telecommunication services can be provided by television cable networks or television signals can be carried by telecommunication operators. This raises complex regulatory problems (what kind of legislation should be enacted) and institutional issues (what kind of jurisdiction should various actors have), but also consumer questions about the quality of services on offer. Although it is still possible today to distinguish computer manufacturers, telephone service companies, publishing houses, broadcasting and film companies as separate corporate actors, they are rapidly converging into one industry.

Intelligence. Digital technologies are "smart" technologies. This means that they provide information appliances, communications systems and networks with a problem-solving capacity. Thus, for example, they can improve the performance of the traditional telephone by providing it with screens, modems and smart card readers. This new appliance has been referred to as the "smart phone": it can check electronic mail (e-mail), do teleshopping and telebanking, screen calls and surf the Internet for information. Future wireless phones (designed by companies like Intel and Motorola) will add computing, text-messaging and, eventually, translation capacity. In fact, Nokia manufactures a digital cellular phone that accesses the Internet, provides fax and e-mail and has a built-in personal organizer. The industry expectation is that with the growth of digital cellular networks around the world, "wireless cybercruising, using smart cellular phones or handheld personal digital assistants (PDAs)" will become widespread (Edmondson, 1996a:57). Experts predict that there will be a great need for digital agents that can download relevant data from the World Wide Web and make routine decisions in the electronic marketplace.

Ubiquity. One of the important characteristics of digital technologies is their pervasiveness. They are everywhere: in the home from kitchen to living room, in the office from electronic badge to smart phone; in health services for administrative and diagnostic purposes; in defence systems (such as "smart" missiles); in government; in education; in manufacturing; and in a growing range of service activities like banking, finance, travel and insurance. Increasingly, computers are adapted to specialized environments and are built into desks (to keep track of papers), wristwatches (to display data), or sneakers (to hold a digital business card and calendar). Cutting-edge computer makers want to create computers so transparent or unobtrusive that they virtually disappear.

The Political Economy of ICTs

The principal incentives for the development of information and communication technologies after the Second World War came from military interests, and therefore many of the innovations in electronic data processing and telecommunication technology described above have been, to a large extent, stimulated by the needs of military operations. In fact, military activities primarily involve the collecting, transporting and processing of information. Virtually all modern weapons systems are based on the deployment of advanced information processing systems. To optimize weapons system performance (precision in targeting the enemy, for example), many pieces of equipment contain "smart" components. Digital technologies have improved the capacity for observation and detection, as well as command, control and communication (C-3) functions.

Military interests motivated the construction of the first electronic networks and the design of the network that today is called the Internet. The origins of the latter are to be found in the decentralized computer network designed by the US Defense Department's Advanced Research Project Agency (ARPA) in the mid-sixties. The ARPANET was created to respond to doubts concerning the security of existing telecommunication networks, first raised in a report of the RAND Corporation. "Among the weaknesses pointed out in the RAND report were the excessive centralization of certain networks and the fact that intermediary communication nodes were dependent on major co-ordination centres and had practically no operational freedom in case of a break in communication with the control centres" (Basque, 1995:8).

Large corporations also found important uses for electronic networking. The pioneer in commercial transborder data flows was the international air transport network, SITA (Société Internationale des Télécommunications Aéronautiques). As early as 1949, 11 airlines operated a reservations system through SITA using a low-speed teleprinter system. Commercial transmissions through electronic networks commenced during the 1960s and 1970s, facilitating airline reservations, international banking and credit control.

The upgrading of telecommunication technologies and their integration with electronic data processing was thus largely promoted by international military and corporate users who needed fast, reliable and inexpensive technologies for their information handling and were willing to make exceedingly large investments. The size of the latter have grown sharply over the past decade. Investments in research and development on digital switches, for example, jumped between 1984 and 1991 from US$ 1 billion to almost US$ 3 billion. This led to intensified competition for market share that drove prices per line for digital switches down from an estimated US$ 300 per line in 1984 to US$ 225 in 1991 (see **Business Week**, 7 October 1991).

One of the inevitable consequences of rising research and development costs, combined with falling prices, is that only a limited number of firms can survive the competition. Large investment in high-risk contexts tends to restrict the market. Technical convergence thus has led to institutional convergence and to the concentration of key information services in the hands of a few mega-providers.[1] At present, ICTs are designed, developed and deployed by a highly concentrated transnational industry that generates approximately US$ 1.5 trillion annually. The leading companies in this industry belong to the world's largest manufacturing and service conglomerates (see the table below).

[1]A recent example of this institutional convergence is the joint Microsoft and NBC venture, MSNBC, for on-line and cable service (Rose, 1996). The merger is intended to create "the leaders in a converged computer-television-video world" (Rose, 1996: 40).

Leading Companies in the ICT Industry (1995)

Rank	Company	Industry	1995 Revenue (million US$)
1	HITACHI, Japan	Electronics	84,167
2	NIPPON TEL. & TEL., Japan	Telecommunications	81,937
3	ATT, USA	Telecommunications	79,609
4	IBM, USA	Computers	71,940
5	MATSUSHITA ELEC. INDL., Japan	Electronics	70,398
6	GENERAL ELECTRIC, USA	Electronics	70,028
7	SIEMENS, Germany	Electronics	60,674
8	TOSHIBA, Japan	Electronics	53,047
9	DAEWOO, South Korea	Electronics	51,215
10	SONY, Japan	Electronics	47,581
11	DEUTSCHE TELEKOM, Germany	Telecommunications	46,149
12	NEC, Japan	Electronics	45,557
13	IRI, Italy	Telecommunications	41,903
14	PHILIPS ELECTRONICS, Netherlands	Electronics	40,148
15	FUJITSU, Japan	Computers	38,976
16	MITSUBISHI ELECTRIC, Japan	Electronics	36,380
17	ABB ASEA BROWN BOVERI, Switzerland	Electronics	33,738
18	ALCATEL ALSTHOM, France	Electronics	32,154
19	HEWLETT-PACKARD, USA	Computers	31,519
20	FRANCE TELECOM, France	Telecommunications	30,060
21	MOTOROLA, USA	Electronics	27,037
22	SAMSUNG ELECTRONICS, South Korea	Electronics	24,151
23	CANON, Japan	Computers	23,012
24	BT, Britain	Telecommunications	22,612
25	GTE, USA	Telecommunications	19,957
26	SANYO ELECTRIC, Japan	Electronics	18,541
27	BCE, Canada	Electronics	17,939
28	BELLSOUTH, USA	Telecommunications	17,886
29	SHARP, Japan	Electronics	17,102
30	ELECTROLUX, Sweden	Electronics	16,219
31	INTEL, USA	Electronics	16,202
32	MCI COMMUNICATIONS, USA	Telecommunications	15,265
33	COMPAQ COMPUTER, USA	Computers	14,755
34	THOMSON, France	Electronics	14,396
35	L.M. ERICSSON, Sweden	Telecommunications	13,961
36	TELEFONICA DE ESPANA, Spain	Telecommunications	13,960
37	DIGITAL EQUIPMENT, USA	Computers	13,813
38	BERTELSMANN, Germany	Publishing/printing	13,747
39	SPRINT, USA	Telecommunications	13,600
40	BELL ATLANTIC, USA	Telecommunications	13,430
41	AMERITECH, USA	Telecommunications	13,428
42	NYNEX, USA	Telecommunications	13,407
43	TEXAS INSTRUMENTS, USA	Electronics	13,128
44	ROCKWELL INTL., USA	Electronics	13,009
45	DAI NIPPON PRINTING, Japan	Publishing/printing	12,902
46	SBC COMMUNICATIONS, USA	Telecommunications	12,670
47	PTT SUISSE, Switzerland	Telecommunications	12,473
48	TOPPAN PRINTING, Japan	Publishing/printing	12,294
49	LG ELECTRONICS, South Korea	Electronics	12,234
50	ROYAL PTT NEDERLAND, Netherlands	Telecommunications	12,187

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Rank	Company	Industry	1995 Revenue (million US$)
51	WALT DISNEY, USA	Entertainment	12,112
52	MATSUSHITA ELEC. WKS., Japan	Electronics	11,933
53	SCHNEIDER, France	Electronics	11,910
54	VIACOM, USA	Entertainment	11,780
55	US WEST, USA	Telecommunications	11,746
56	RAYTHEON, USA	Electronics	11,716
57	RICOH, Japan	Computers	11,532
58	APPLE COMPUTER, USA	Computers	11,062
59	LAGARDERE GROUPE, France	Publishing/printing	10,539
60	EMERSON ELECTRIC, USA	Electronics	10,013

(Sources: **Fortune**, **Business Week**, company reports)

The struggle to control the world's most dynamic economic sector is far from over. The world's largest companies are increasingly demanding broad, affordable, reliable and flexible electronic highways around the globe. Only a worldwide digital grid can meet such demands. The latter will be expected to transport all signals that can be digitized, from the human voice to high definition television imagery. This will require the replacement of conventional carriers, such as the copper wires traditionally used in telephone systems, with optical fibre cables and new satellite systems. It will also mean developing new switches and new software to manage the unprecedentedly large flows of information across borders.

Digital technologies, in particular, thus raise difficult questions in the realm of political economy, centring on such issues as access, control and expense. Who will have access to the emerging digital grids? At what price? Who will control the networks? Where will the intelligence that guides the network be stored and who will own it: the network operator or the end user? Who will meet the enormous expenses implied by the process of digital conversion of conventional telecommunication networks?

Digital Technologies and Moral Issues

The adoption of digital technologies reduces and practically eliminates the constraints that previously controlled and disciplined "information conduct". Without these constraints, it is now possible to insult a million people instantaneously, monitor their daily activities around the clock, store information about their misdemeanours forever, and re-create their experiences through digital manipulation.

In part, the moral challenges posed by digital technologies are rooted in conventional questions (such as those revolving around intellectual property and privacy) made more urgent in the context of a digital world. With more information available in digital form, there will also be more information that people would prefer to have censored: the transnational nature of digital networks creates situations in which information is illicit in the sending country and perfectly acceptable in the receiving country, or vice versa. Although this has always been the case to some extent, the sheer velocity and flexibility of information transmission now make border controls less realistic than ever before.

Digital technologies also obscure earlier dividing lines between "broadcasting " (e.g., the mass media) in the public realm and "narrowcasting" (e.g., telephone reception) in the private sphere. In fact, this convenient division between regulatory domains is disappearing. Private e-mail can be broadcast to a million receivers, most of whom never asked to receive the message.

In addition, digital technologies have made the manipulation of data, images and sound so easy that it is possible to use and reuse all sorts of materials without consulting the initial author-owner. Rules against piracy activities cannot always be legally enforced, and a large grey area of contested intellectual ownership emerges. It is precisely for this reason that individuals must make moral decisions about what they judge to be defensible behaviour. A similar problem occurs with regard to the protection of privacy.

In the digital age, rapidly increasing volumes of personal information are collected, stored and sold through vast electronic systems. And the new technologies enormously expand the capacity to respond to the specific data needs of particular users. For example, it is now possible to map an individual's movements precisely through the "electronic trace" left behind as we use credit cards, rent cars, buy airline tickets and purchase items in department stores. The precise pattern of communication between any individual network user and the rest of the system can also be recreated.[2] This creates the potential for a monumental invasion of people's privacy.

Another illustration of a troubling violation of privacy is the growing trend to engage in the electronic monitoring of employees. This phenomenon can encompass secret video and audiotaping, the opening of electronic mail, the monitoring of video display terminals to check employee performance, and the widespread bugging of telephones.

"Home-telematics" also increases the risk of privacy infringement. The dangers involved in teleworking are particularly illustrative. "Because the teleworker is beyond the range of the employer's physical supervision, the necessary supervision of the execution of the work will take place via the on-line telecommunication connection with the worker's terminal. Consequently, the worker is subject to the possibility of continuous supervision by an invisible employer. Moreover, the fact that the worker's terminal is located at home means that the employer can also monitor certain aspects of the worker's daily routine" (de Vries, 1990:202).

Since the market for home-telematics services is increasingly international and the workers themselves may be scattered across many countries, the multilateral agenda will have to address concerns about security and privacy protection across borders, developing flexible policy responses that combine legal guarantees and forms of industry self-regulation.

An additional, very recent, threat to privacy involves the use of medical and biological information. The collection of sensitive personal data through

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[2]In order to connect nodes in a network there must be data exchange, and advanced telecommunication systems have an intelligent signalling system, separate from the voice-network, that facilitates data communication between the exchanges. This creates a Call Detail Record for all users, providing precise information about the pattern of network use by individual subscribers.

diagnostic techniques like genetic screening is becoming a reality; and these techniques can generate information about future diseases. The potential for exclusion of "high-risk" persons from employment or health insurance is great under such circumstances. A real prospect looms that firms may sell genetic profiles to insurers and employers.

The violation of privacy will follow the spread of advanced digital technology around the world. Admittedly, people have very different conceptions of privacy. In most Western societies there is a much stronger emphasis on the protected individualistic life-world than in many Third World societies. Yet people throughout the world know that information about them can be used for harmful ends and that surveillance by power holders is a development about which one should be very suspicious.

The protection of privacy is important not only for individual citizens but also for nations. Digital technology creates transparent societies, "glass-house" countries very vulnerable to external forces that can undermine their sovereignty.

Not only do digital technologies magnify old moral concerns, but they also raise completely new moral issues that are intimately related to specific features of these new technologies. Questions arise, for example, in connection with the (contested) reliability of the technologies at a time when more and more people depend upon them. Digital technology involves risks. If the technology is tampered with, airline passengers may die in a crash, patients may be seriously injured, or companies may go bust. And if digital systems do indeed fail and cause great social and personal harm, the moral responsibility of the different actors involved (e.g. hardware manufacturers, software designers, users) must be defined. This becomes especially complex, however, when in the course of events decisions are taken by electronic agents, smart robots, or other intelligent software, or when decisions are based upon the information provided by expert systems.

Increased vulnerability to technology failure in many aspects of life is reinforced by the unreliability of digital computers. Forester and Morrison argue that computers are inherently unreliable as "they are prone to catastrophic failure; and second, their very complexity ensures that they cannot be thoroughly tested before use" (Forester and Morrison, 1990:468). In contrast to analog devices, digital systems can suddenly fail totally or behave erratically. This is the case because digital systems are "discrete state" devices: they can be in an infinite number of states, and the correct execution of tasks in each state depends upon an earlier state. The magnitude of possible discontinuities is mind-boggling. Software bugs and errors, systems malfunction, computer crime and hacking can cause over-billing or false arrest, cost millions of dollars, and even imply grave injury or loss of life.

Finally, new moral issues are raised by the possibility of combining human beings and electronic systems in cybernetic organisms (cyborgs). The dividing lines between humans and non-human systems begin to blur, and questions arise about the moral quality of this new existence (Schroeder, 1994). What are the implications of creating software robots that might permit a — digital — resurrection of the dead? Their personality could be recreated to such an extent that question and answer sessions might be held with the deceased: say Mahatma Gandhi, or Martin Luther King or Marilyn Monroe. What enormous power does this bestow upon those who can create such personality constructs? And how can this power be socially controlled?

Future Trends

The ICT industry resounds with great expectations for a profitable all-digital future and an exponential increase in consumer purchases of digital devices. Chipmakers (such as Intel, in particular) predict enormous growth in the market for digital consumer electronics: digital set-top boxes and decoders for satellite and cable television; video-game consoles; digital video discs and small-size dishes for direct digital broadcast television.

It has already been noted that in hardware, the most important trends of the recent past have been increasing speed, miniaturization, more efficient energy use, greater capacity and lower costs. These tendencies may continue. But in addition there may well be completely new developments, such as the optical computer that processes information through light waves instead of electrical pulses. Universal digital fibre optic networks may combine with wireless networks to expand communications capacity enormously. Mainframe computers may disappear altogether, as high-capacity processors can be built into wrist watches.

Meanwhile, one of the latest developments in digital convergence is the symbiosis of television sets and personal computers that creates new forms of interactive television. To further this goal, a powerful new alliance is currently in the making between content producers (NBC, Viacom, Time-Warner), computer manufacturers (Compaq and Apple), chip makers (Intel), software giants (Microsoft), and consumer electronics companies (General Electric, Philips and Sony). The industry expectation is that within 10 years consumers will want the television to act as a personal computer and will demand a great deal of interactivity.

In software, there are still enormous problems to be resolved. Computers need to become far more user-friendly. Their current interfaces (mouse, keyboard) should be modified to allow for more sophisticated ways of communicating with the system, for example through speech or touch.

Improvements are expected in the areas of natural language processing and computer graphics (virtual reality technology). Intelligent agents might be developed that respond to questions posed by users — and themselves pose questions to users. Agents might surf through information networks on behalf of users and deliver the information they need. The currently operational knowledge robots ("knowbots") of the US Corporation for National Research Initiatives can already communicate with each other, work together and clone themselves. Smart technology is increasingly used in the production of flexible robots that can perform many of the manual labour functions that human workers execute.

The development of parallel processing — multiple processors that work on several tasks simultaneously — promises innovations in automatic speech recognition, optical character recognition, and image analysis. Particularly important is the development of so-called neural networks — parallel computing systems that emulate the structure of the human brain. These systems learn to recognize patterns in trial and error processes. They are operational in situations that require recognizing patterns in enormous quantities of data.

In spite of the application of smart technology in such tools as telephones that think for themselves, current ICTs are still very much more difficult to operate than common household appliances. The really simple, easy-to-use information appliance is still in the laboratory. As **Business Week** states: “The great information-appliance race is on. The goal is to create electronic gadgets that are as simple as the TV set but can instantly make the connection to the digital world” (24 June 1996:42). “Armies of engineers are busy developing radically new products, from wristwatch data phones to slimmed-down personal computers for cruising the Internet. All of these intense efforts are aimed at bringing the unwired masses into the Information Age” (ibid.). Their efforts are oriented toward an enormous potential market: 60 per cent of US consumers and 90 per cent of all households worldwide are today unwired — that is, they have no access to the Internet and are disconnected from cyberspace.

Obviously, not all developments in digital technology will be equally successful. As Verity writes: “An abundance of cheap computing power and human imagination are fuelling an explosion of new digital species. Which of these myriad creations will make it from laboratory to market and then into people’s lives? Nobody can say” (Verity, 1996:61).

Digital Technologies and Development

During the 1950s, many developing countries began to take an interest in strengthening their information and communications capabilities, particularly in the fields of printing and broadcasting, telephone and telex. It was assumed that the technologies which had lifted the advanced industrial countries to unprecedented heights of material wealth could be used to accomplish the same results in the developing world.

Since technological progress had been accomplished through laborious and expensive trial-and-error processes, it seemed a well-advised policy for those who came late to exploit the most recent state of the art. “Rarely did the countries at each stage of the decision-making process raise basic questions such as: Does the country have the technology? Can it develop the technology? Can it adapt imported technology? How long will it take? What resources will be needed? What are the trade-offs between importing technology now and waiting to develop it at home? Why not import now, but plan in such a fashion that there will be no more repetitive imports in the future?” (UNCTAD, 1985:162).

By and large, policy makers in the developing countries were concerned with the availability of technological products, rather than with the more complex problems associated with their political, economic and cultural integration. Thus little or no attention was given to meeting the infrastructural requirements for a productive assimilation of imported science and technology in the recipient countries. The process of technology choice also tended to be undemocratic. Very seldom was there a comprehensive analysis of needs and alternative choices to meet those needs, nor was there usually any public consultation on alternatives. The state of most policy-making was characterized by an emphasis more on operational choices (procurement and deployment) than on strategic choice (the direction of technological development).

When, in the course of the 1960s, the volume of transferred technology increased considerably, many recipient countries became aware of the fact that the transfer usually consisted of end-products rather than of technology per se, that much of the transfer took place as intra-firm movements, that the conditions under which transfer took place were often disadvantageous for them, and that much of the technology was inappropriate, obsolete, over-priced, or all of these together.

By the 1970s, the introduction of ICTs such as telephony, educational television and satellite communications began to show a specific pattern of social benefits in most developing countries. Various studies suggested that the primary beneficiaries were the companies that provided the equipment (for example telephone companies), the banking consortia providing the funding, and the local administrative élites who used the new technology. Often unforeseen negative secondary effects occurred, such as serious balance of payments problems associated with the capital intensity of the new technologies (Clippinger, 1976).

All this gave rise to spirited debate within UNESCO and the United Nations General Assembly, and eventually to a proposal for a New Information and Communications Order. When the dust of this debate subsided, many developing countries — adverse experiences notwithstanding — expressed a strong interest in receiving foreign aid to develop their information and communication infrastructures. Aid programmes were established in the fields of mass media and telecommunications development.

In 1980 the UNESCO General Conference initiated, with the unanimous support of all member states, the International Programme for the Development of Communication. Shortly thereafter, the International Telecommunication Union (ITU) Plenipotentiary Conference of 1982 established an independent commission to study the problems of worldwide telecommunications development. And in 1985, the Maitland Commission produced a report entitled **The Missing Link**, recommending more investment in telecommunications in developing countries and more resources for training and transfer of technology. Among its principal conclusions were the following (Maitland, 1992):

- it was urgent to grant higher priority to investment in telecommunications;
- the effectiveness of existing systems had to be improved;
- the scarcity of foreign exchange in developing countries required new methods of financing; and
- the ITU itself should play a more effective role in ICT development.

The Maitland Report concluded not only that ICTs are critical to economic development, but also that they unleash forces transforming education, enriching national cultures and reinforcing social cohesion (Independent Commission, 1985:13).

In the 1980s, Third World leaders came to share the expectation within industrial nations that innovations in telecommunications and computer technologies could markedly improve industrial performance and increase economic productivity. Furthermore, there was a common belief that ICTs in fact enable developing economies to leapfrog over industrialization into a post-industrial society. With this hope, developing countries began to launch policies and programmes to acquire a share in international satellite communications and transborder data flow networks.

In many developing countries, however, there was also anxiety concerning the possibility that ICTs might imply serious social risks. People were concerned about issues like the potential for cultural colonialism, the replacement of jobs by machines, and the erosion of individual privacy and national sovereignty. Towards the end of the 1980s these fears seemed to have abated, and the general view on the relation between ICTs and development entered a third and current phase.

This phase is driven by a very strong fear of being left behind and cut off from the emerging global digital highway. The general belief seems to be that, without adequate access to the system, developing countries cannot hope to be economically competitive. Therefore, in many developing countries the "digital rush" is on to create and broaden links with electronic networks in the fields of trade, finance, transport and science. Such a position is inspired by recognition of the obvious benefits that digital information and communication technologies have to offer (at least in principle) in a number of concrete areas.

Educational facilities, for example, can be improved through using ICTs to facilitate distance learning and on-line library access. In this regard, there are very promising pilot projects in countries such as Canada, where over 10,000 schools have been linked electronically for the provision of a host of on-line services. Electronic networking has also been used in the improvement of the quality of health services, since ICTs permit remote access to the best diagnostic and healing practices and, in the process, cut costs (Durant, 1996:18-21). Digital technologies for remote resource sensing can provide early warning to sites vulnerable to seismic disturbances, and they can identify suitable land for crop cultivation.

In addition, computer technology can assist in the development of flexible, decentralized, small-scale industrial production, thus improving the competitive position of local manufacturing and service industries. In a number of countries (Singapore, Brazil, Hong Kong) the introduction of computer-aided manufacturing (CAM) technologies in small-scale industries has been very successful. There is also an environmental advantage in such developments. As the World Commission on Environment and Development noted in its report **Our Common Future**, decentralization of industry reduces levels of pollution and other impacts on the local environment (1987:215).

Another important benefit to be gained from currently available computer-communication technologies is the ease with which one can create a public sphere in "cyberspace". Through the use of personal computers, modems and telephone lines, new global communities are being established. Increasingly, Third World organizations are integrated into these webs of horizontal, non-hierarchical exchange that have already proved themselves able to counter censorship and disinformation. Members of ecological movements and women's organizations, human rights activists, senior citizens and many other groups have made impressive use of new communications networks.[3]

[3]"One of the important tools of the Zapatista movement [in the jungles of southern Mexico] has been the Internet." The movement's leader, Subcomandante Marcos, carries a small computer, through

Combining telecommunication technologies with desktop publishing software creates new opportunities for even the smallest action group to disseminate its messages across the globe with relative ease and at minimal expense. By way of illustration, part of a letter sent by a member of a women's organization in Mexico to the computer network PeaceNet could be cited.

> Until last year we had to ride 24 hours on the bus every 2-3 months to San Antonio, where another Mujer to Mujer member lives, so that we could make marathon phone calls to catch up mutually with our key US contacts, plan tours, conferences etc. Long distance phone calls from Mexico have always been prohibitively expensive, and international mail is too slow and undependable.

Or a letter from a community-based health project in Nicaragua:

> PeaceNet has enabled us to maintain contact with our people, even when there was not any reliable mail service. It has also provided us with a means of exchanging ideas, information and urgent communications with other organizations which share our aims (cited in Lewis, 1993:124).

The growing ICT demand in developing countries finds expression in long waiting lists for telephone connections, growing use of cellular systems and rapidly expanding numbers of Internet users. To meet this demand, consideration of information and communications technologies is increasingly becoming an integral part of national development agendas. In fact, there is currently a phone frenzy in the developing world. The planned increase in telephone lines within the Third World for the next five years will require some US$ 200 billion in investments. This is expected to be achieved largely through a massive inflow of foreign capital. And to encourage the latter, countries are deregulating and opening their markets for equipment manufacturers and service providers. A rapidly increasing number of developing countries are scheduling the privatization of their telephone companies.[4]

Looking quickly at this phenomenon by region, it can be noted that in Asia, **India** inaugurated its first digital information network in 1994 and now wants to superimpose on this net its ambitious information highway: a network that brings together optical fibre and coaxial cables, microwave links and satellite connections. Between 1994 and 1995, the network grew almost 23 per cent. India also plans to expand its telephone service from its current level of 0.77 per 100 inhabitants to 1.52 by the year 2000.

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which "he has been able to communicate with the rest of the world in a form which is not so easily controlled by the government. In fact, individuals can even find a way on the Internet to send a message to the Subcomandante. And communication is vital, because for the [rebel movement] to succeed, it needs involvement from oppressed people all over, not just from Chiapas". Source: http://www.coa.edu/HEJourney/polcom/arsenault/zap.html

[4]Examples include Bolivia, Cape Verde, Côte d'Ivoire, India, Indonesia, Sri Lanka, Thailand, Uganda, Ghana, Guinea, New Guinea, Nicaragua, Panama, Paraguay, Zambia, El Salvador and Honduras.

By the turn of the century, **China** intends to install 100 million digital lines at a cost of US$ 40 billion. This represents an expansion of telephone service from 0.98 per 100 inhabitants to 3.50. **Indonesia** opened its telecom market in 1995 to foreign competition for the installation of 5 million phone lines in the next 3 to 4 years. The Minister of Tourism, Post and Telecommunications announced at a conference in Jakarta in April 1996 that his country places great emphasis on ICTs to achieve economic and social development. They are seen as "enabling technologies which can bring information from the grassroots level to the capital, help manage the transport of goods across unforgiving terrain, disseminate life-saving medical know-how to underskilled practitioners, and process commercial transactions and capital flows in accordance with world best practices" (I-Ways, 1996:26).

Korea's Ministry of Information and Communication has announced a blueprint for that country's new information society. The Ministry wants to establish a full-scale information highway project by extending the National Information Superhighway into 80 cities across the country. To implement its policies, the government will provide some US$ 80 million for the development of software technology, set up industrial complexes for multimedia industries, and increase investment in research and development.

Malaysia has established the National Information Technology Council "with the vision of creating an information-rich society in line with the aspirations of Vision 2020" (the official Malaysian government plan for the development of ICTs). Furthermore, on 29 August 1995 the Prime Minister announced the establishment of Malaysia's Multimedia Super Corridor — an area of 15 by 40 kilometres, close to the capital Kuala Lumpur, in which transnational multimedia corporations will be invited to establish business and research units and to serve regional and world markets with multimedia products produced in the corridor.

In Latin America there is also growing support from private and public institutions for developing national and regional information infrastructures. The countries of the region are privatizing quickly and developing very sophisticated networks. The Plan of Action approved at the summit of the Organization of American States in December 1994 shows a strong commitment to the development of ICT infrastructures. And in **The Americas Blue Book: Telecommunications Policies for the Americas Region** (released in April 1996 by the Telecommunications Development Bureau of the ITU and the CITEL of the Organization of American States) much emphasis is placed on the joint development of telecommunications policy and the expansion of telecommunication services.

A country-by-country survey shows that the **Brazilian** National Congress voted in August 1995 to allow privatization of the state monopoly Telebras, to begin in 1997, and plans an expansion of the telephone network from the current level of 6.83 to 9.49 lines per 100 inhabitants in the year 2000. **Chile** plans a telephone expansion from 8.92 per 100 inhabitants to 19.71, and **Mexico** from 7.54 to 12.49.

The African regional interest in the ICTs was very prominently displayed in 1995 during the First African Regional Symposium on Telematics for Development, as well as during the 21st session of the Conference of African Ministers responsible for Economic, Social and Development Planning. During the same year, the Workshop on the Role and Impact of Information and Communication

Technologies in Development (held in Cairo) concluded that "without proper national information and communication policies, strategies and implementation plans, countries will not be able to partake fully in the global information society".

Also indicative of the African interest in ICT development is Resolution 795, "Building Africa's Information Highway", adopted on 2 May 1995 by the Conference of Ministers of the United Nations Economic Commission for Africa (ECA). African ministers for economic and social development requested in the resolution that the ECA set up a high-level working group on information and communication technologies, made up of African technical experts, with a view to preparing a plan of action in this field.

After meetings in Cairo, Addis Ababa and Dakar, this working group produced "Africa's Information Society Initiative: An Action Framework to Build Africa's Information and Communications Infrastructure". In early May 1996 the Conference of Ministers authorized implementation of the plan. The Conference on Information Society and Development in South Africa, in May 1996, was the venue for launching the African Information Society initiative. By 2010 this initiative foresees an information society for Africa in which

> Every man and woman, schoolchild, village, government office, and business can access information through computers and telecommunications; information systems are used to support decision making in all the major sectors of each nation's economy; access is available throughout the region to international, regional and national 'information highways'; a vibrant private sector exhibits strong leadership in growing information-based economies; African information resources are accessible globally, reflecting content on tourism, trade, education, culture, energy, health, transport and natural-resource management; and information and knowledge empower all sectors of society (Cogburn, 1996:32).

On a world level there is also a clear expectation that the new ICTs will contribute to development. Strong support for the construction of a Global Information Infrastructure (GII) was expressed by the leaders of the G-7 countries (the United States, Japan, the United Kingdom, France, Germany, Italy and Canada) as well as top management from the private sector, during a summit held in February 1995 in Brussels. The Final Declaration of the summit stated that the development of a global information society is expected to enrich people worldwide.

Nevertheless, there were serious concerns about the existing disparity between the information-rich and the information-poor countries. Therefore, the G-7 governments committed themselves to "promoting universal service to ensure opportunities for all to participate" and "encouraging dialogue on worldwide co-operation", so that industrialized countries would work toward the participation of developing countries in the Global Information Infrastructure. The main initiator of the GII project, US Vice-President Al Gore, stated in his speech at the conference of the International Telecommunications Union in Buenos Aires (March 1994) that the creation of a Global Information Infrastructure is in fact "an essential prerequisite to sustainable development for all members of the human family".

Digital Disparity

Concern about information disparities between rich and poor countries is well founded. There seems to be general agreement in the scientific literature and in public policy statements that the ICT-gap between the developed and developing nations is widening and that this hinders the integration of all countries into the Global Information Society.

The seriousness of the ICT-gap is clearly demonstrated by figures on the world distribution of telephony. There are 1 billion telephones in the world today and approximately 5.7 billion people. Some 15 per cent of the latter have access to 71 per cent of the world's main telephone lines. At the same time, more than 50 per cent of the world's people have never even used a telephone. Put differently, low income countries (where 55 per cent of the population of the planet is to be found) have less than 5 per cent of the world share of telephone lines. And while high income countries have 50 telephone lines per 100 inhabitants, many low income countries have less than one telephone line per 100. This ranges from Cambodia with 0.06 to China with 0.98 in 1992 (according to figures provided by the ITU/BDT Telecommunication Indicator Database).

The reality of the widening gap in telecommunications capacity raises serious questions about whether the poorer countries will be able to overcome the financial and technical obstacles that hamper their access to digital technologies. Since reducing the ICT gap requires a major financial effort, one central concern is whether the international community is ready to provide the massive investments needed for the renovation, upgrading and expansion of networks in developing countries. To understand the magnitude of the challenge, it is useful to remember that it would take some US$ 12 billion to assure 50 per cent of the population of the Philippines access to the Internet (Berendt, 1996:4).

A number of public and private institutions are working toward reduction of digital disparity. The World Bank, for example, established the Information for Development Program in early 1995, with the brief to assist developing countries with their integration into the global information economy. In the same year, the International Telecommunications Union established WorldTel — an ambitious project to generate private investment in basic infrastructure. WorldTel aims to provide some 40 million telephone connections in developing countries in the next 10 years and to create an investment fund of at least one billion dollars.

In the private sector, the Africa One project of ATT plans to have a fully operational optical fibre cable around the entire African continent by 1999, providing connections for all the major coastal cities. Siemens and Alcatel also have designs (called Afrilink and Atlantis-2, respectively) to provide telecom connections, especially to West Africa. Meanwhile, both the International Satellite Organization (IntelSat) and the Regional African Satellite Organization are actively promoting the expansion of electronic mail services for the continent.

These international initiatives coincide with continuing concern about the appropriateness of the technologies being transferred and the capacity of recipient countries to gain control over them. In fact, there is at present no convincing evidence that the owners of advanced technologies will change their attitudes and policies towards the international transfer of technology. Throughout the past decades, the prevailing international policies in this field have erected formidable obstacles to the reduction of North-South technology gaps. There is no indication that the current restrictive business practices, constraints on the ownership of knowledge, and rules on intellectual property rights that are adverse to developing country interests are radically changing. And in this case, there are no realistic prospects that the relations between ICT-rich and ICT-poor countries will change in the near future.

Furthermore, the key actors in international ICT policy-making have expressed a clear preference for leaving the construction of the Global Information Infrastructure to "the forces of the free market", and there is room for doubt about whether the institutional arrangements of a corporate-capitalist market economy allow for the development of an equitable information society.

At any rate, it is important to think carefully about whether, given the realities of the existing international economic order, there can be any serious reduction in existing ICT disparities. It may well be an illusion to think that ICT-poor countries can "catch up" or keep pace with advances in the most technologically advanced societies. In the North the rate of technological development is very high and is supported by enormous resources. This is certainly not to say that poor countries should not try to upgrade their ICT systems. But they should not do so in the unrealistic expectation that those who are ahead will wait for them. The situation may improve for poorer countries, but the disparity between North and South is not likely to go away.

Unfortunately, in most countries concern about access to digital technologies is met by public policies that tend largely to react to an already defined technological environment — in part because the capacity to identify appropriate digital technologies is not locally available. This postpones necessary efforts to consider the kinds of digital technologies that might be appropriate for their specific development trajectory. The problem is compounded by the fact that, in many cases, Third World states "seem to have no disinterested non-governmental organizations to advise them on telecommunication technology and on the social objectives of regulation, in order to safeguard those interests that private profit will not protect" (Mody et al., 1993:270). "Without adequate regulatory intervention to ensure accountability to the general public, market forces responding to [the needs of] groups with purchasing power are bound to generate unequal development" (ibid.). And to make matters worse, there is also a critical absence of co-ordination of "digital" policies among the developing countries themselves.

It is essential for all societies around the world to understand that planning for the adoption and deployment of digital technologies can no longer be a local affair. Global negotiations such as the recent Uruguay Round on multilateral trade, and international institutions like the World Trade Organization, have enormous impact on national technology plans. Therefore, developing countries must participate more forcefully and effectively in these institutions, basing their actions on greater policy co-ordination. But "the G-77 lacks a research facility or a permanent secretariat, and is unable to carry out long-term planning or strategizing for international meetings and negotiations" (Khor, 1995:18). Without policy co-ordination, "many developing countries do not obtain a fair share of the benefits of globalization, and some actually suffer net losses" (Khor, 1995:16).

In addition to asking critical questions about reactive public policy-making, as well as about the lack of assessment capacity and cross-border co-ordination within the Third World, one must also consider whether the current worldwide emphasis on deregulatory policies can contribute to reducing digital disparity between North and South. The policies and programmes launched by many of the developing countries now seem to focus almost exclusively on the creation of favourable conditions for commercial operators in the ICT market. As the UNESCO **World Science Report** acknowledges, “there has been a new shift in favour of indirect measures such as deregulation and reinforcement of market mechanisms at national and international levels” (1996:277). But is this shift from direct public intervention to more indirect (deregulatory) policies adequate to enhance the potential for social development inherent in the digital technologies?

Cultural Globalization

Even if the developing countries are integrated into the global digital grid, there is concern in many quarters that the growth of transnational cultural industries, as well as liberalization policies pursued by such bodies as the World Trade Organization, may reinforce current patterns of cultural colonialism. In fact, technological innovations, the enormous growth of international trade and a very supportive liberal political climate have facilitated the rapid transnational proliferation of mass-market advertising and electronic entertainment produced by a handful of mega-conglomerates. A uniform consumer lifestyle is being aggressively marketed across the globe.

Pop culture is America’s hottest export item today. US movies, music, TV programming and home video now create an US$ 8 billion trade surplus in this sector. Top sellers are Mickey Mouse, Madonna, Michael Jackson, McDonald’s burgers, Levi’s jeans and Coca Cola. In the past five years the overseas revenues of Hollywood studios have doubled. The US$ 20 billion music industry earns approximately 70 per cent of its revenues outside the United States. Clearly, there is a worldwide trend towards increasing demand for American entertainment.

The global proliferation of standardized food, clothing, music and television drama, as well as Anglo Saxon business style and linguistic convention, contribute to an unprecedented cultural homogenization. (The Disney amusement parks, whether on the East or West coast of the United States, Tokyo or Paris, are a lively expression of this cultural globalization.) In addition, such cultural conquest has important implications for patterns of economic development and may create serious obstacles to self-reliant strategies. Furthermore it promotes a consumerist, resource-intensive lifestyle that the world’s natural environment can ill afford.

Aggressive around-the-clock marketing, controlled information flows that do not confront people with the long-term effects of an ecologically detrimental lifestyle, aggressive exercise of competitive advantage against local cultural providers — all encourage a reduction of local cultural space. This is not to say that there is now a uniform, global culture. Obviously local culture is very strong, even to the point of fomenting manifold inter-ethnic conflicts. And non-Western values are by no means extinct. Furthermore, one could claim that the project of a global culture is inherently weak, since culture is bound to time and space, while transnational consumer products are a-historical and spatially non-located.

But even if “global culture” is not an adequate category of analysis, a process of “cultural globalization” is undoubtedly under way. As information and communications technologies open new markets, Dutch, German or Japanese firms join American transnationals in selling consumerism across the globe. Maintaining American style and production values, media products have now become “the generic material for all transnationals, whatever their ownership base”. Fusing different sources of capital, the global transnational information and cultural producers are “turning the world into a shopping mall for those with sufficient disposable income” (Schiller, 1993:29 and 40).

In the process, global operators have understood that adaptations of generic products to local tastes can improve their likelihood of success. The performance of MTV, the music television station, in Asian markets is a good case in point. MTV beams its signals to Asian audiences through one of the channels on Satellite Television Asian Region (STAR TV). This Hong Kong-based satellite operator reaches some 3.75 million households in Asian countries. With many Asian youngsters ready to spend on global pop culture, this is clearly a promising market for MTV advertisers. In order to accommodate local tastes, some 20 per cent of MTV programming is Asian. This includes the promotion of Thai and Chinese pop stars, as well as Mando-Rock music sung in Mandarin.

Although MTV products may be regionally customized, the effort is primarily oriented toward offering advertisers a profitable market for consumer products and luring consumers — particularly young ones — into watching its programmes. The process plays a role in changing their tastes, lifestyles and moral values.

Cultural adaptation is also a concern of companies (like Turner Broadcasting, ESPN, NBC, MTV Latino, and Murdoch’s Fox Latin America channel) that are trying to cash in on the expansion of pay television markets in Latin America. Although pay TV only reaches a limited proportion of Latin American households, the latter provide an affluent and growing market for advertisers. In order to make generic programming more acceptable to local audiences, it is given a “Latin look”.

Opinions differ regarding the effect of cultural globalization. In the Asian region, for example, one finds optimistic positions like the following: “We in Asia have a particular advantage . . . nobody has yet moulded us. . . . Even in the most economically advanced Asian societies, we are a very tradition-minded people” (Joseph Wang, advertising expert from Hong Kong quoted in Menon, 1993:31). But one can also find less optimistic positions: “Thai society today is indeed in a state of confusion and expedient Westernization. McDonald’s, Burger King, Dunkin Donuts. Fast foods and fast profits. . . . Thai culture and traditions are becoming obsolete and irrelevant, if not outright obstacles to modernization and Westernization” (Yos Santasombat, an anthropologist from Thailand, quoted in Menon, 1993:31).

Environmental Sustainability

The possible proliferation of digital technologies throughout the world raises another important question concerning whether ICTs can be applied in environmentally sustainable ways. If, as a result of the deployment of ICTs, economic productivity increases, does this imply also that levels of consumption increase? And is this an acceptable course from the perspective of sustainable development? It would seem naïve to assume that the mere deployment of ICTs implies that the society involved can engage in sustainable development.

Both environmentally positive and environmentally negative scenarios can be elaborated. In the positive scenario, information replaces tangible goods; and production processes with lower levels of environmental pollution are developed. Also, of course, the application of ICTs in environmental warning systems (for example, global satellite mapping to save tropical rain forests) promotes environmental protection.

In the negative scenario, growth in economic productivity (even assuming this could be accomplished with lower pollution levels per unit of output) implies the strong likelihood that more industrial production leads to higher levels of consumption and therefore in the end to more pollution (Jokinen, 1996). For example, if one assumes that digital technologies improve the productivity of the automobile industry, then (even if cars were manufactured with lower levels of pollution) the overall increase in car purchase and use would probably lead to higher pollution levels (Malley, 1996). In this scenario, the evidence points to the likelihood that the "information society" will be a "consumer society" and consequently exercise enormous pressure on natural resources.

In addition, the global use of ICTs may increase the emission of carbon dioxide (by printers, copiers and computers) to environmentally untenable levels. The production of a single personal computer requires approximately as much energy as the average electricity consumption of a mid-European household per year. And to manufacture a four-pound lap top requires utilization of 40,000 pounds of resources. After three to four years, when the equipment is obsolete, the PC will be dumped on the growing heap of electronic scrap, containing toxic waste such as cadmium (in batteries) and lead (in screens) (Malley, 1996).

In all scenarios, the core problem with a more equal global access to ICTs is that this will increase the level of energy use (per capita) in the developing countries to the average levels of the rich countries, without reducing the latter at all. As Makridakis (1995:800) suggests, ". . . it is doubtful that the climatic equilibrium of earth can be sustained" if this happens. Furthermore, the phenomenon has to be seen in the light of a rapidly growing world population, which could reach over 12 billion people by the middle of the twenty-first century. For policy makers, this may be one of the toughest questions: can a global digital grid — accessible to all — be combined with environmentally sustainable development?

Digital Technologies: Choices for Social Development

Given the growing demand for digital technologies, policy makers will have to take decisions that adjust technological potential to the requirements of social development. Yet the "digital landscape" is kaleidoscopic. On the one hand, there are strong expectations that digital technologies will create a bright future. On the other hand, there are very pessimistic projections that point to serious social and economic problems. And empirical reality completely supports neither the utopians nor the dystopians. The question in this confusing situation is thus how one can arrive at defensible policy choices.

The techno-centric perspective

In much utopian writing, ICTs represent a revolutionary force that can fundamentally transform societies and individual lives. In this perspective, the imperatives of technological development determine social arrangements: technological potential drives history (see, among others, Hiltz and Turoff, 1978; Toffler, 1980; Beniger, 1986; Zuboff, 1988).

Furthermore, the techno-centric perspective holds that the "digital revolution" definitively marks the passage of world history into a post-industrial stage. The emerging global information society is characterized by positive features: there will be more effective health care, better education, more information and diversity of culture. New digital technologies create more choice for people in education, shopping, entertainment, news media and travel.

From this perspective, there is no reason to put technology itself on the public agenda, since the technological process is accepted as inevitable. For the protagonists of the "digital revolution" it is not conceivable that people would decide not to adopt these innovations.

The gravest problem with the techno-centric perspective is that it ignores the social origins of information and communication technologies. It suggests that they originate in a socio-economic vacuum, and fails to see the specific interests that generate them. Guided by this perspective, policy makers find it very difficult to accept that technological innovations do not, in and of themselves, create the institutional arrangements within which they function; and thus they fail to see that whether the potential of technologies will be realized in positive rather than negative ways depends much more on their institutional organization than on the features of their technical performance.

If the technological environment is accepted as given, then options of decision makers are limited to reactive policies and programmes, "designed to cope with, or adapt to, the consequences of technical change, rather than anticipating (and so influencing) these consequences" (Edge, 1995:26). Unless we understand what problems the major stakeholders want to see resolved and what technical systems they select, policy makers cannot anticipate the consequences of these systems and thus make a concerted attempt to influence their design in socially beneficial ways.

The perspective of discontinuity

The techno-centric perspective is characterized by a strong emphasis upon the discontinuity of historical processes. Its analytical approach is based upon the notion that a technological discontinuity (the "digital revolution") causes a social discontinuity (a "Third Wave civilization", in the words of Toffler, 1980). In its fascination with "revolutions", the perspective overlooks the fact that technological processes are only rarely revolutionary and most often proceed in gradual ways over longer periods of time.

Technological developments can hardly ever be described as radical breakthroughs. Studies on technological inventions usually demonstrate that innovations have (often long) pre-histories of conceptual and technical development. Thus today's ICTs evolve quite logically from earlier technological generations. Size diminishes, speed increases and capacity expands — but this is hardly revolutionary. Almost all developments today are just further refinements of what was there already.

This observation does not imply that there are no significant technological breakthroughs in the application of digital technologies or that these could not create new concepts and methods of information handling which might interact with social processes in ways radically different from past experiences. The point is that it is often too early and too facile to label current processes as revolutions, since it may take quite some time before new concepts and methods translate into new patterns of social behaviour, new lifestyles, political and economic structures, and viable virtual communities.

A serious problem with the concept of technological revolution is that, when such a term is used, it becomes harder for policy makers to see that technological innovations come in different layers of "newness". Developments such as the Internet are not monolithic. They have various dimensions, ranging from techniques that are only slightly different from previous ICTs (such as e-mail in comparison to "snail" mail) to techniques that show less and less resemblance to earlier modes of information handling (such as newsgroups, Internet Relay Chats, and three-dimensional graphical presentations in virtual reality).

In general, the process of social transformation resulting from the interaction between socio-economic variables and technological innovation is most adequately analysed in terms of gradual change. Two hundred years ago, in some parts of the world, mechanical techniques began increasingly to be used in the production and distribution of industrial goods. This mechanization process, largely motivated by considerations of cost efficiency, logically evolved through several stages of upgrading, such as rationalization (Taylorism) and conveyor belt automation (Fordism). Technical developments, such as those in the field of energy utilization, contributed to this process of refinement. Mechanical techniques, however, require capital-intensive energy in the form of manual labour or fossil fuel. The logic of cost efficiency supported their replacement by semi-independent systems that have minimal energy requirements and yield better cost-benefit ratios. Thus electronic systems, utilizing information rather than energy input, came to substitute for machines.

Electro-mechanical techniques have been increasingly replaced by ICTs in the production and distribution of industrial goods. On the surface, this suggests that there has been a transition to a totally new type of economy: the service economy in which industry will rapidly disappear. It is certainly true that today, in many developed countries (as well as in some of the developing countries), the service sector makes a considerable contribution to the national economy. However, many services are integrally related to industrial production and distribution and could not survive in a de-industrialized economy.

In fact, there is little indication that industrial production is fundamentally withering away (Webster, 1995:41). "In most countries the proportion of industrial workers has hovered around one-third during the twentieth century. And growth in the 'service' sector dates right from the beginnings of industrialism" (Lyon, 1988:47). American data show that industry accounted for 32 per cent of GDP in 1947 and 22.8 per cent in 1990. Services went up from 55 to 73.3 per cent, but most services were related to manufacturing. The significant change came in the sector of agriculture (see **American Economic Review**, May 1996)

In the process, the manufacturing output of industrial societies did not fundamentally change, it shifted to the manufacture of service products.[5] As Webster concludes: "Undeniably, information and knowledge — and all the technological systems that accompany the 'information explosion' — have quantitatively expanded. It can also be readily admitted that these have become central to the day-to-day conduct of life in contemporary societies. Nonetheless, what cannot be seen is any convincing evidence or argument for the view that all this signals a new type of society, 'post-industrialism', which distinguishes the present sharply from the past" (Webster, 1995:50).

The post-industrial thesis (such as that proposed by Bell, 1976) suggests that the number of so-called "information workers" has dramatically increased. Apart from the problem of measuring this increase, it can be questioned whether, even if there are more information workers, this implies a social revolution. One could ask, for example, what kind of transformation the employment of more "information workers" has implied for women or for the ethnic minority work force? As Webster concludes from the empirical evidence: ". . . more service sector employment, more white collar work, and even more professional occupations . . . do not announce a 'post-industrial' epoch" (Webster, 1995:46).

However, even if one is sceptical concerning the supposed discontinuity between industrial and information ages, one cannot ignore the fact that the proliferation of ICTs, as well as the increased social and economic importance of information handling, have an impact on existing social structures. There are undeniably important social processes at play in relation to the application of ICTs. But it is not certain that these processes usher in a totally new society. It is not yet obvious that societies around the world are moving beyond corporate capitalism, for example, or replacing male-dominated social institutions.

Meanwhile, overemphasis on historical discontinuity makes it difficult, if not impossible, to deal in any realistic way with the empirical finding that in most societies actually-existing processes of social change lag far behind visionary predictions. Thus the discontinuity perspective is not very helpful in dealing with what has been called the "computer paradox". Computers are applied by some 50 per cent of the work force in the industrial nations, and their processing capacity doubles every two years. Of the world's total investment in capital goods, 50 per

[5]As Gershuny demonstrated (as early as 1978) with massive documentation: "Instead of buying services, households seem increasingly to be buying — in effect investing in — durable goods which allow consumers to produce services for themselves" (Gershuny, 1978:8).

cent goes to computers and peripherals. Yet expected growth in productivity has not materialized. White collar productivity remained stagnant during the 1970s and 1980s at some 0.9 per cent per year and improved in the early 1990s to 1.3 per cent — a low figure despite the announcement by **Fortune** magazine that “the productivity payoff arrives” (**Fortune**, 27 June 1994:35-9).

To many observers it is unclear what causes this “computer paradox” (see Makridakis, 1995:800; UNESCO, 1996:276; and **American Economic Review**, May 1996). It could be, however, that one cause is the phenomenon of “social inertia” (Postmes, 1996:142). “Thus while technology has invaded aspects of everyday life to a degree believed impossible by technological experts until the 1980s . . . the dramatic changes in social relations that were prophesied have not materialized” (ibid.).

Aside from questioning the historical correctness of labelling technological and social developments as “revolutionary”, there is yet another problem with this perspective. Since it binds technological and social discontinuities so strongly together, it ignores the option of a technologically discontinuous process without a social revolution. This position — taken by Armand Mattelart (1985), among others — accepts the reality of a technological revolution and argues that there is no empirical evidence of a social revolution. Finally, one could argue that there is no way of telling which way any deep process of social change may go: the adoption of digital technologies might, for example, reinforce the pyramidal shape of social power relations; or the pyramid might flatten out, or turn upside down. No one can predict this. The essential questions thus become how we want social relations to be shaped in the future, and how digital technologies should themselves be shaped to realize this goal.

Utopian versus dystopian perspectives

Most current discussions on digital technologies are couched in terms of optimistic versus pessimistic perspectives. On one side of the debate are utopians such as John Naisbitt, Bill Gates, Nicholas Negroponte, Pamela McCorduck, Yoneji Masuda, Alvin Toffler, Kevin Kelley, Howard Rheingold and George Gilder. Utopian scenarios are put forward in the myriad business folders that announce the billion-, if not trillion-, dollar investment opportunities in the new global electronic markets.

Among the critics of these technophiles, most of whom belong to the academic community, one finds authors like Herbert I. Schiller, Ian Reinecke, Frank Webster, Kevin Robins, Joseph Weizenbaum, Neil Postman, Theodore Roszak and Mark Dery. It is important to understand the suppositions underlying these two schools of thought.

The “utopian” perspective

This scenario couches its support for the deployment of ICTs in such terms as “new civilization”, “information revolution” or “knowledge society”, and thus subscribes to the theory of historical discontinuity discussed above. An array of positive developments are associated with the emerging information age. New social values will evolve, new social relations will develop, and widespread access to the crucial resource known as information will bring the "zero sum society" to a definitive end.

The scenario forecasts radical changes in economics, politics and culture. In the **economy**, ICTs will expand productivity and improve employment opportunities, and will also upgrade the quality of work in many occupations. Moreover, they will offer a great many opportunities for small-scale, independent and decentralized forms of production. In **politics**, decentralized and increased access to unprecedented volumes of information will improve the democratic process, and all people will ultimately be empowered to participate in public decision-making. Finally, in the realm of **culture**, new and creative lifestyles will emerge, as well as vastly increased opportunities for different cultures to meet and understand each other. New virtual communities will be created that easily transcend all the traditional borderlines and barriers of age, gender, race and religion.

The "dystopian" perspective

Critical analysts reject the idea of discontinuity and stress the likelihood that ICT deployment will simply reinforce historical trends toward socio-economic disparities, inequality in political power and gaps between knowledge élites and the knowledge-disenfranchised. On the **economic** level this scenario forecasts a perpetuation of the capitalist mode of production, with a further refinement of managerial control over production processes. In most countries, it foresees massive job displacement and de-skilling.

In **politics** the expectation is that a pseudo-democracy will emerge, allowing people to participate in marginal decisions only. ICTs will enable governments to exercise surveillance over their citizens more effectively than before. The proliferation of ICTs in the home will individualize information consumption to a degree that makes the formation of a democratic, public opinion no more than an illusion.

And finally, **cultural** developments will be characterized by the play of antagonistic tendencies: one toward a forceful cultural "globalization" (homogenizing all ways of life in the mould of global McDonaldization), and another toward an aggressive cultural "tribalization" (fragmenting cultural communities into fundamentalist cells with little or no understanding of different "tribes").

The debate between utopians and dystopians is not very helpful in designing policies and programmes that are intended to realize the development potential of digital technologies. The most important flaw in both perspectives is their failure to recognize the fundamental impossibility of foreseeing the future social and economic implications of technological innovations. Since there are no valid scientific instruments to predict future social impact, it is necessary **to make social choices about the future under conditions of uncertainty**.

The validity of our projections into the future is obviously dependent upon the robustness of the tools of inference on which we rely. Prospective technology assessment (PTA) is one of these, which is clearly seriously flawed. It is based on the supposition that harmful effects of the introduction of particular technologies can be forecast in extensive studies and consequently avoided.

Prospective evaluation can be criticized for several reasons, including the fact that it tends to show a technological bias, i.e., it takes technology as a given and tends to focus on the control of negative impact. Prospective evaluation is also **inductivist**: it is guided by the assumption that one makes statements about the future on the basis of a limited number of observations in the past. Against inductivism, David Hume (1739) proposed as early as the eighteenth century that there is no logical argument for supposing that phenomena about which we have no knowledge would resemble those we know. Inductivism has to assume an inherent continuity of the historical process. It requires accepting the existence of unalterable laws of historical destiny.

Such laws may be formulated by the physical sciences for regularities in the physical environment, but there is no empirical indication that similar regularities are valid in the social environment. There are certainly trends to be observed in human social history, but these are distinct from natural laws that determine the movement of a society and thus provide a valid prediction about society's future. Trends depend upon the specific configuration of historical conditions which themselves are not unequivocally determined. It is possible to establish correlations between trends and historical conditions, but these cannot in any way guarantee that a prediction based upon them is valid.

This is related to another flaw in technology forecasting: **the poverty of social scientific theory**. It is possible to provide a theoretical explanation for the relationship between certain trends and certain historical conditions. However, if one refuses to accept the notion of unyielding laws in the historical process, any explanation can be contested. In fact, it is characteristic of social scientific theories that they are "underdetermined": there are always several theoretical perspectives that concur with a single empirical observation of social reality. This implies that empirical observation does not provide a way definitively to prove or disprove divergent social theories.

The explanatory poverty of social scientific theory invalidates technology forecasting, since this is based upon the assumption that a valid explanation of the modes of interaction between technology and society is possible. There is no theoretical perspective on technology and society that could provide the basis for a solid prediction about their future interaction. Given the essential contestability of theory in the social sciences, neither is there a prospect that such a prediction will emerge shortly. This fact may be disguised by the sophisticated nature of some forecasting techniques, but in the last analysis their very basic flaws make them no better than ancient astrology.

Since the available tools of inference show serious shortcomings in their capacity to predict the future outcomes and consequences of ICTs, we must always live with imperfect information. Perhaps even the notion of imperfect information is too generous; it seems more appropriate to accept a state of ignorance.

Given this situation, the choice for a utopian or dystopian scenario cannot be made on the basis of unequivocal information. With regard to the development of integrated digital networks, for example, it is equally possible to project positive effects as negative ones. The optimistic forecast sees more productivity, more employment, consumer convenience, more access and participation, and protection of vital information. The pessimistic forecast sees greater social disparity, more unemployment, more central control, more invasion of privacy and more social immobility. But neither utopian nor dystopian perspectives — both based upon a flawed assumption about predicting future impact — can guide the search for defensible social choices as these are related to the design and deployment of digital technologies.

The conclusion, then, is that it is imperative to move away from analytical perspectives that are techno-centric and determinist, that focus on historical discontinuity, and that make unwarranted claims about future impacts.

To correct these deficiencies, an approach focusing on the "social shaping of technology" has been developed (MacKenzie and Wajcman, 1985). This approach does not ignore the possibility of social impact, but stresses the dynamic interaction between social forces that shape technological development and technological innovations that affect social relations. In contrast to technological determinists, those who concentrate on the "social shaping of technology" are particularly concerned with "the social forces which give rise to particular technologies" (Mackay, 1995:41). Among the factors shaping ICTs are socio-economic, political, cultural, and gender variables, geography and market forces.

It is imperative for those who want to influence the course of change in information and communications technology, in directions that might support social development, to understand what forces shape the evolution of ICTs, and how these forces interact (for a good illustration of this approach, see Flichy, 1995). This makes pro-active policies and programmes possible and allows for conscious social choice.

The question immediately arises as to how policy makers can make such choices if it is impossible to predict future impact. The answer is that pro-active policy-making rests upon the design of visions for a preferred future. The inability to foresee future social impact should not stop policy makers from designing alternative future courses and deciding about their desirability. Then technological solutions must be shaped to match these future visions.

In this way, policy-making can move beyond the unproductive battle between optimists and pessimists. These bands would argue, for example, about whether investments in digital technologies will or will not lead to greater economic productivity. A third position would propose that a scenario for a desirable, environmentally sustainable, economic future should include a definition of the social and institutional changes that seem to be required before digital technologies can contribute to achieving this vision.

Relying upon utopian or dystopian perspectives, the debate will get stuck between the empirical evidence that automation eliminates jobs (Howell, 1985:297-310) and the evidence that automation creates new jobs (Peitchinis, 1983). What remains — inevitably — unclear is what the eventual balance will be.

One could, however, move beyond the debate on more or less unemployment, and make a social choice for the creation of **full employment**. This choice could be inspired by the observation that “Large scale unemployment is the main source of growing social inequality in OECD countries” (Freeman, 1995:21).

> Mass unemployment is an unmitigated social disaster. . . . Just as unemployment alone cannot be blamed for the rise in crime and drug-taking, so too it cannot be regarded as the sole cause of ethnic conflicts and the rise of fascist-type movements. But one would have to be blind indeed not to observe the connections between unemployment and these phenomena, whether in the 1930s or the 1980s and 1990s (ibid.).

If policy makers share this vision, they should design those social and institutional instruments that seem required to adjust the potential of digital technologies to a full-employment future.

Social and Institutional Frameworks

If one assumes that the institutional formats surrounding the deployment of technologies are more important in shaping their consequences than technological potential by itself, it becomes imperative to inquire what kind of institutional arrangements will direct digital technologies towards social development. But policy makers tend to confront a situation in which digital technologies are adopted within the social and institutional (conceptual and organizational) frameworks and routines of yesterday. This problem is especially visible when considering issues of economic productivity and democratic participation.

Looking first at productivity, it is obvious that digital technologies offer unprecedented opportunities for the integration of different components of industrial manufacturing. Rather than just substituting electronics for a component of the production process, digital technologies can link industrial design, manufacturing, testing, marketing, distribution, repair and innovation. This facilitates new modes of custom-tailored and on-demand industrial production. As the UNESCO **World Science Report** argues:

> The benefits expected to accrue from these developments are enormous. New forms of management have already made it possible to shorten manufacturing lead times for existing and new products while reducing the volume of stock and improving the organization and performance of services. At the same time, the management and use made of equipment are becoming more efficient, as is the control of both production and quality. All these improvements can lead to reductions in overhead costs (1996:272).

Nevertheless, if the organizational structures of industrial companies deploying digital technologies are not adapted, this potential cannot be realized.

> The integrated application of I(nformation) T(echnology) by business firms requires a radical reorganization of their working methods, as most organizations still apply a highly specialized and differentiated division of labour with the de-skilling of many tasks, inflexible production procedures and controls, a many-tiered, hierarchical management structure based on bureaucratic decision-making procedures and a mechanistic approach to performance (UNESCO, 1996:273).

Furthermore, the current shift toward the pervasive application of digital technologies spawns a wide array of new industries, such as software production, processing services, time-sharing facilities, semiconductor manufacturing, database management, and electronic publishing. This potential for new economic productivity requires an educational infrastructure that provides the knowledge and skills required for ICT-related occupations. Although there has been a considerable increase in ICT teaching in many schools and universities around the world, new multimedia tools are still widely underused or used only as support for conventional teaching methods.

There is also a dearth of solid and creative training materials catering to the specific needs of developing countries. “The need for appropriate technologies geared to the special circumstances of the poorer countries has long been recognized in development economics, and nowhere is this more relevant than in the context of education and training materials” (Freeman, 1995:14). Without the adjustment of teaching methods and learning materials, the potential of digital technologies to provide new forms of employment is not likely to be realized.

A similar argument can be made in relation to the democratic, political potential of digital technologies. There can be — technologically — little doubt that political decision-making procedures can be opened to more extended participation of citizens through the adoption of digital information and communication technologies. A variety of current experiments with so-called digital cities demonstrate a clear potential for improved decision-making, exchange of information and debate (Schalken et al., 1996:47-54). These digital cities are electronic meeting places that form virtual communities where people communicate with each other, as in real cities, but digitally. In the Netherlands, for example, digital cities are operational in Amersfoort, Amsterdam, Eindhoven, Utrecht, Delft, Leiden and in the regions of Limburg, Friesland and Twente. Local governments use these digital cities for discussions with citizens and for the provision of information.

However, it is not yet clear how this potential can be optimally exploited. ICTs can create ways to consult citizens about political choices, but it remains uncertain whether the political system will use this facility, when it will use it, and what it will do with the data it collects. A critical question is whether the potential can be realized within the framework of the institutions prevailing in modern-day political democracies, based most frequently upon the notion of “representation”. At the core of the system, one finds not the active citizen but the elected representative who decides on behalf of the citizen. It is hard to see how the participatory potential of new forms of direct democracy can be realized within the institutional setting of representative democracy.

This is also true at the level of world politics. When a global digital highway is indeed constructed and access to it is affordable to people around the world, there are unprecedented opportunities for direct electronic referenda on decisions which affect people’s lives. At least on the technical level, these possibilities for global participatory democracy are feasible options. Nevertheless, the realization of this technological potential would require that the institutions of world politics become more democratic, including a more democratic structure for the United Nations, as the conferences of the Citizens Association for a More Democratic UN (CAMDUN) have repeatedly argued.

Additionally, of course, there is the problem that access to digital technologies may well remain restricted to only a part of the world population. Current digital demographics are not very promising on this score.

When considering the democratic potential of digital technologies, issues of control also arise on at least two levels. First, there is the question of whether the social forces controlling emerging digital networks will be the same that control today's major information media. If these same commercial interests supervise the digital highways, what are the chances of restoring the public political discourse that is currently in rapid decline all over the world? Will digital technologies be used for the creation of open, not-for-profit, public service spheres or for the transformation of public space into electronic shopping malls? The social and institutional arrangements that are currently proposed for the construction of a Global Information Highway do not support the public service model. They are to be privately funded, corporately controlled and market oriented. (In passing, it should be noted here that even the common metaphor for the global digital grid — a "highway" — reflects the tendency to deploy the technologies within a conventional conceptual framework.)

Second, an important element in democratic political systems is the secrecy of their voting procedures; and this creates a serious problem in a "digital democracy". Most local networks imply a fair amount of control over their users, for instance by the institutional systems operators ("sysops") who can secretly access user messages and even stop e-mail traffic (on the illusion of e-mail privacy, see Brown, 1997:35). Today's international networks, such as the Internet, are not very secure systems either. They are very vulnerable to forms of surveillance and intrusion. This problem cannot be solved by mere technological improvements, such as privacy enhancing software (like the software package "Pretty Good Privacy" that Philip Zimmerman began to make available through the Internet in 1991). Although these encryption techniques offer a certain amount of protection against governmental and private snoopers, they only deal with the symptoms of a much more serious, underlying social problem: surveillance.

Digital technologies will not by themselves change existing institutional settings. This will need processes of political decision-making that are guided by the genuine aspiration to bring about sustainable and democratic social development. The matter is urgent: the UNESCO **World Science Report** warns that the use of ICTs within conventional social and institutional frameworks may not only hamper the realization of possible benefits, but may also reinforce the possible social risks (UNESCO, 1996:273).

Areas for Future Action and Research

The argument presented in the preceding sections would suggest that a number of issues require new research, conducted within an action-oriented framework. The main purpose of further study and debate would be to provide policy makers in developing countries with analytical perspectives and empirical data that create a better match between technological potential and preferred futures. It is assumed that these futures should be both sustainable and democratic.

The first area could be concerned with **the design of democratic and pro-active policies and programmes that make it possible to realize the social development potential of digital technologies**. Among other things, this entails studying

- the roles that public and private sectors should play in the design and execution of these policies and programmes;
- the forms of public intervention that are conducive to shaping technological change in accordance with desirable social goals; and
- the establishment of new and more democratic relations between producers and consumers of ICTs, so that technological progress becomes much more responsive to social needs.

A second area of concern is centred around **the definition of those social and institutional changes that are required to maximize the social benefits and to minimize the social risks associated with the adoption and deployment of digital technologies**. This entails considering

- various ways of adjusting the organizational structures that are relevant for economic productivity, political participation, and cultural diversity in line with preferred social scenarios; and
- the (cultural) appropriateness of educational methods and training materials required for the realization of the technological potential.

Third, it is important to discuss **the design and adoption of digital technologies that strengthen sustainable processes of social development**. This involves creating digital technologies that reduce the use of energy-intensive resources and encouraging environmentally sustainable applications of digital technologies.

Since conditions in different countries vary, no global solutions can be proposed in any of these issue areas. Country studies are needed in order to explore the specific policies, programmes and technological solutions likely to be effective in specific social and economic conditions.

A final area of research and action-oriented debate should no doubt involve **studying the "social shaping of technology"** in concrete situations. It is essential for those who want to use ICT development to further social goals to understand what forces shape technological changes and how these forces interact. This understanding would allow policy makers to anticipate social consequences better and to construct those institutional arrangements that orient technological change towards socially desirable ends. Here one must look at

- relationships among variables affecting technological development, be they socio-economic, political, cultural or gender variables, geographical locations or market forces. Too little is known about how these factors interact at micro, meso and macro levels;
- the strategies through which those affected by technological development can (re)shape this development in socially beneficial ways.

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