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Information technology

Where is the wisdom that is lost in knowledge?
And where is the knowledge that is lost in information?
T S Eliot *The Rock I*, 1934[1].

Definitions

No claim for scholarly insight is made in the following attempts to give working definitions of terms used in Information Technology (IT). There is no agreement amongst scholars and I do not have the expertise to judge between them.

Information comprises **data** that have been organized and communicated and which reduce uncertainty in the receiver. If I tell you your birthdate, I am probably not "informing" you; you know it already. A person is always attempting to reduce uncertainty in order to act effectively. For instance, one needs information about the options open to one and one needs information about the benefits and disbenefits of the options. This is what is called an operational definition of information. Several other sorts of definition could be formulated for other purposes.

Information technology is the acquisition, processing, storage, dissemination and use of vocal, pictorial, textual and numerical data or information by computers and telecommunications.

Writers about Information Technology often slide imperceptibly from a discussion of information to a discussion of **knowledge**. According to Fritz Machlup[2] knowledge is an organized body of information that is acquired by **thinking** while information is acquired by being told. Theodore Roszak explains that he uses the term "ideas" in exactly the same way that Machlup uses "knowledge" and he goes on to say "The mind thinks with ideas, not with information"[3]. One task of thinking is to add context[4] to the information so that multiply ambiguous messages are correctly interpreted. Harold Innis expressed the opinion that the printing press and the radio had enormously increased the difficulties of thought. I think this is because they tend to strip the message of context. The operational test of knowledge is our ability to act effectively.

A different perspective on knowledge is offered by the Knowledge Science Institute, centred in Calgary, part of whose mandate (1985) is reproduced here:

> The Institute will facilitate the development of multi-disciplinary studies of knowledge science and technology.
>
> The Institute will undertake system development and application projects involving knowledge-based systems, and train and support others to undertake such projects.
>
> Knowledge has become a major component of the economy on a par with raw materials and manufactured goods. The production and dissemination of knowledge now accounts for over 50% of the GNP in North America.
>
> Understanding the nature of knowledge and its social and economic impacts is vital to the development of our industries and our society.
>
> The study of knowledge is essentially multi-disciplinary and involves all scientific disciplines, the professions and humanities.

> The computer technologies underlying the knowledge economy have advanced at a rate that is so high and has been sustained over such a period that it forms a series of revolutions rather than technology evolution.
>
> The explosive growth of computer technology from the 1940's may be seen not as a cause of the knowledge society but rather as providing a necessary infrastructure through which to support it.
>
> The fifth and sixth generation computing thrusts initiated by the Japanese are based on a shift from information to knowledge technologies together with major improvements in human-computer interaction.
>
> The new generation computing systems will provide knowledge bases that are accessible by people with no specialist computer skills and are integrated into all aspects of the operation of society.
>
> We are already seeing the effect of this shift in the development of an expert systems industry taking scarce human skills and encoding them for delivery through computer systems.
>
> A country such as Canada that is rich in resources and able to afford innovation in applications can play a major role in the transition to a knowledge society.

The tacit assumption behind this programme is that the "thinking" activities described above can be incorporated into computer programs called "expert systems". It is the contention of sceptics that this project will founder on the rock of context.

In direct interpersonal communication the **media** are the organs of sound production, body language and olfactory sensation, vision, and audition. Problems of comprehension result from semantic noise or confusion. Technology inserts some device or technological system into the path of communication and thus opens the way for an engineering noise source to be added to the semantic noise. The refraction of meaning referred to by Ellul is a product of the total noise.

Economics

Information technology is now the largest single industry in the world. It comprises numerous sectors including:

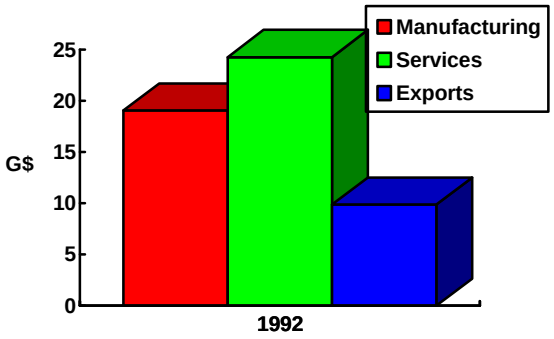
- manufacture of devices and connectivity --communications media.
- intermediate products such as software and databases used in manufacture and business
- final products, information and entertainment (which dominates the field at present)-- referred to generically as "content".

Central to the whole issue of Information Technology and its social impact is the rapidly falling cost of acquiring, storing, transmitting and processing a bit of information. This has been compared to the Gutenberg revolution.[5]

Canada and IT

As the result of the vastness of our territory in relation to its comparatively small population, Canada has evolved as a communications-intensive nation[6]. This has never been more true than to-day when Information Technology contributes about 6% of GNP and has been growing since 1988 at about 7.4% a year.[7]

The chart shows the contributions of various sectors in the year 1992.

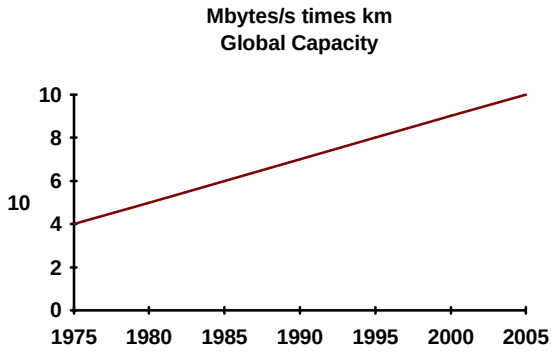


Technological changes in the media

The industry is in a ferment owing to the concurrent introduction of numerous very important technological changes in the media.

1. Synergistic merging or **convergence** of the computer and other items of office equipment (recorders, copiers) with communications devices;
2. Proliferation of channels of communication. The long-established telephone lines and cable TV channels have been joined by optical fibre and wireless transmission from satellites at various levels above the earth. This has resulted in the potential **ubiquity** of service; this "means that people are increasingly able to -- and expect to -- communicate by voice, data, image and video anywhere, anytime."[8]
3. The threat to ground-based systems of the "**death stars**"--or "direct-to-home broadcasters".
4. **Digitization** of all data, making possible the use of compression algorithms and the resulting explosion of the "bandwidth" or information transmission capacity. In addition to compression, the introduction of Asynchronous Transfer Mode (ASTM) has broadened the effective bandwidth of telephone lines.

World communication capacity measured by the product of the rate of flow and the distance covered had a value of about 10 000 km.Mbytes/s in 1975 and is doubling every two years. It should be 10 billion in 2005.



5. The result of these changes is to provide the potential, and in some cases the actuality, of transmitting voice, data, video and images simultaneously which is referred to as **multimedia.** Also in making the communication interactive - that is to say, allowing the receiver or customer to send messages and commands to the sender or service provider.

6. These phenomena have called forth a huge industry in complementary products to supply "content", i.e., the information, advertising and entertainment to fill, and pay for, the newly opened channels. This is clearly a **technology-driven** project.

Reverse salient

One reverse salient or bottleneck is obviously the acoustic modem which is limited to a few dozen kilobits per second.
To transmit a two minute video at 28.8 kbs modem takes 5 h to download.
On ISDN (Integrated Services Digital Network) it takes an hour.
On a device hooked up to coaxial cable it takes 1 min in the lab but much longer on shared cables which are like the old party line telephones. We shall soon see, because Shaw Cable have announced the availability of the WAVE system[9] using a new generation of cable modems from Motorola Inc. capable of delivering up to 30 Mbps at a price of 50 $CAN/mo plus an installation cost of $150. Wiring office towers for cable might cost 100,000$US per site.
Telephone lines using ISDN run 64 kbs but cost $500 for the adapter and additional line charges of up to $120/mo. With data compression they can achieve 600 kbs.
ADSL (Asymmetrical Digital Subscriber Line) is being offered by CADVision in Calrary at a rate of 2Mbps for 70$CAN/mo. VDSL (Very-high rate Digital Subscriber Line) is capable of 55 Mbs and will be available later.

What about wireless via satellite? Bill Gates and Craig McCaw would place 840 satellites in low earth orbits.

The big problem for the immediate future is agreement on standards.

Issues

These technological changes have raised a number of issues that are not primarily technological. They can be divided into problems about how to make money out of the technology on the one hand and how to achieve societal goals (and avoid societal harm) on the other hand. The two sets of goals cannot be completely separated.

Profit making from IT

This problematique has two main areas of concern: ownership of the channels and ownership of the service providers.

Ownership of the channels

The concern is both with the ownership of the channels of communication and with the degree of monopoly that can be exercised over them. Although all entrepreneurs praise the virtues of competition, they spend a great deal of time and money trying to kill it. The fight is between the telephone companies, cable companies, cellular telephone companies with ground-based repeater stations, cellular telephone consortia with (0-100) high altitude satellites, projects with from 60 to 840 low altitude satellites (that is at about 800 km above the earth) and projects for 12 satellites at medium altitudes (about 10 000 km above the earth. These satellite consortia include Bill Gates's Teledesic Project, which is still in the planning stage and

the other communications consortia such as the Iridium, Odyssey, and Globalstar systems which have received the go-ahead. The immediate focus is on Direct Broadcast Satellite systems for entertainment, channels sometimes referred to as DTH (Direct To Home) or DeathStar systems because of their threat to conventional cable systems.

On the ground, the fight is over the nature of the house connection. Will it be:
• Two channels into each residence, as there are now? The cable companies would probably prefer the status quo with a monopoly of multimedia given to them by government regulation.

• A twisted wire input, supplied by the telephone companies, using ASTM, linked to an optic fibre along the street. This is the preferred solution of the telephone company consortium known as Stentor.

• Optic fibre into every home within 5 years as foreseen by Nicholas Negroponte, founder of the MIT Media Lab.

Since the outcome of these battles is unknown and the stakes are enormous, the companies involved are busy hedging their bets with strategic alliances and cross-ownership. Fortunes will be lost and made.

How will the content providers profit?

The proliferation of physical media has been described as a set of solutions searching for a problem. Nobody knows exactly what can be sold on the network that will begin to repay the billions of dollars of installation costs and give a profit to the investors. Two methods are being used to find out: expressed preference and revealed preference.

Expressed preference

This is established by conducting surveys. The Angus Reid poll conducted in February 1995 found that more Canadians expressed a preference for educational programs than for any of the other choices offered. The following table shows the percentage of people expressing "great interest" in these electronic highway offerings.[10]

Education programmes	56
Banking	50
Tax filing	37
News	36
Community information	34
Video on demand	33
Show tickets and information	31
Classified	29
Software buying	24
Travel planning	22
Unemployment insurance	21
Investing	20

Local shopping	19
Sports tickets and information	19
Long-distance shopping	16
Video games	14
Real estate shopping	13

Bearing in mind the fate of the Ford Edsel, one is permitted a certain scepticism about the real significance of these findings.

Revealed preference

There is considered to be insufficient history to establish a revealed preference, although some costly experience has been obtained e.g. J.C.Penny's computerized video shopping catalogue that lost millions before it was axed[11]. The Canadian government's TELIDON experiment with interactive TV in the 1970s was perhaps a victim of prematurity. Therefore, some authorities are sponsoring large-scale trials in an attempt to find how people would use the services if they were provided. Paul Hoffert, director of York University, Cultech Collaborative Research Centre, says the important questions are: how people will use the proffered services; what benefits they expect; and how much they are willing to pay. Small business and home business need efficient business services, not movies. Workers need access to courses. Intercom Ontario is attempting a full simulation of an interactive community (not just the "early adopters"). New homes in the study area will have remote access to security monitoring etc. The researchers will attempt to discover the pattern of demand over a period of 4 years. Because of the considerable cultural differences between Ontario and Alberta, I believe it would be an excellent project for the Alberta Science and Research authority in partnership with business. As professors Wellman and Buxton (U of T) say, we need field studies of how people use the information highway in real world situations rather than laboratory studies of people in artificial situations.

Social Problems

The problems centred around profit concern only a few rich people. The social problems concerns us all. There are several aspects:

- **who** will have access the network of services and communications which the press calls the information highway;
- **what** will get onto the highway; and
- **how** will a person normally access it.

The prospect of an information society has led many to expect a great increase in democracy. Knowledge is power, they tell us. And if we all have access to knowledge we shall be empowered. I doubt it. The knowledge that brings power is the knowledge that others do not have. The outcome of the battle of Waterloo was brought to London by Rothschild's carrier pigeons and it was that exclusive knowledge that enabled him to found a fortune in a few hours. For an idealistic vision of what the Information Society might bring I recommend Yoneji Masuda's *The Information Society as Post-Industrial Society* (1980).

If electronic information is to be provided free or at a nominal cost to the public in the same way that printed information is provided through libraries -- as an essential

building block of the infrastructure in an information based economy - then some form of taxation will have to be invented to pay for it.

> Arthur Cordell has proposed a bit tax. Every digital bit of information flowing along the electronic highways would be taxed at an amount of, say, O.000 001 cents per bit. Since all information is rapidly becoming digitized, the tax would take a minuscule chunk of revenue out of every piece of data. The tax would be automatically calculated by the trunk carriers and remitted to the appropriate national tax-collecting agency.

Time

Debates about the sustainability of natural resources are seldom conclusive; the optimists can always dream up another source of supply. But in communications we are dealing with a very obviously limited resource -**time**. A person has only so many hours a day in which to absorb information or be entertained. And unless time is set aside for action (purchase of goods and services, voting for the sponsoring party, using acquired skills in the productive economy) the only incentive for the suppliers of content would be social pacification through the provision of an opiate. It would seem, therefore, that the 1000-channel universe might be self-defeating unless entirely new time-management tools are invented to deal with it.

In fact, the social problems on the immediate horizon concern not the plethora of information but the extreme inequality of access to it.

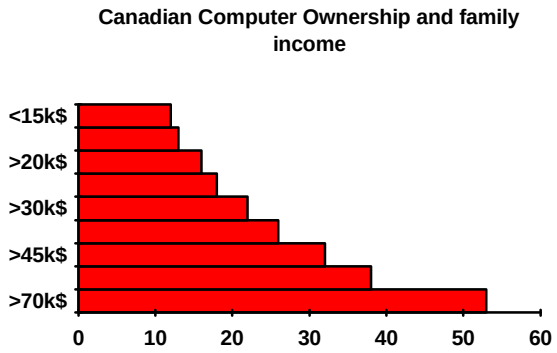
Accessibility

There is widespread concern amongst those studying the social issues that, far from expanding democracy, the information highway will exacerbate the existing dichotomy in society between the haves and the have-nots by making a further division between those end users with ready access to the information highway and its supposed treasures and those who are denied access: i.e., between the information-rich and the information-poor. Every new technology "designs out" some potential users.[12]

Affordability

The first handicap is likely to be simply financial. Even those who already have access to cable television and a telephone may find themselves excluded by a process similar to the gentrification of old neighbourhoods that will take place as the cable and telephone companies, together or in competition, upgrade their communications networks to handle multimedia and interactivity.

Most corporate groups involved in building the information highway are looking at tollways, not freeways, even though hefty user fees will inhibit extensive use of information.[13] Already, in Europe, high per-minute charges for local phone calls have greatly limited the use and development of the Internet.[14] Already, on-line government statistical data in Canada are too expensive for any individual without university affiliation or private means although analogous data about the United States are readily available either free or for a nominal sum.



Greg Ip of the Financial Post writes airily that "For less than $10 a month, anyone can join an on-line service and access the Internet." This ignores the capital investment and the connection charges; it also ignores the fact that the most valuable data bases make a substantial charge for use.

Fortunately, the capital investment for Internet access is plummeting thanks to the development of connection boxes whose application software is held in the server and is called up by the end user on demand. Notional prices from about $500 to $1000 have been suggested, but a device using a television monitor is being offered on the Calgary campus for only $250. (November 1996)

Cognitive access

Further barriers may be erected as interactivity demands a level of skill in language and dexterity not possessed by certain social groups. Wellman and Buxton say that we should invest less in hardware and more "in developing the usefulness and controls of what will pass through it"

In the meantime, the route for those with limited funds or skills must continue to be the Public Library System, which risks being pushed aside by the more glamorous InfoHighway.

Concept of a common carrier

A second aspect of accessibility concerns the service providers themselves. It may be assumed that the major networks of service providers will be linked to the communications networks by mutually profitable business agreements. In the last few years Microsoft has moved to acquire ownership of the world's Museum and Gallery reproduction rights. What of the small service providers, independent film makers, community organizations, special interest groups and so forth who, even if they could afford the fare, might be denied the use of the highway? As a matter of public policy it seems essential to secure the information highway as a common carrier as was done with the road system and with the major pipelines in the early days of building an infrastructure for the oil industry.

Content

Information networks have been around for at least three decades[15]. Modern financial instruments such as derivatives depend entirely on an effective global communications system. The entire mutual funds industry owes its success to cheap computing power which enables it to value thousands of securities daily, process thousands of buy and sell orders and keep clients up to date on their investments. The airlines reservations systems such as American Airlines SABRE owe their existence to

communications technology. Sabre links 20 000 agents in 64 countries through a proprietary network that is accessed 150 million times a day. Note that this is a proprietary network and that these major financial and business institutions do not necessarily have any interest in the public information highway.

There are several socially important aspects to content. Problems of **national culture** have concerned us as Canadians since Confederation. Harold Innis has written about it. The CRTC has tried to regulate it. The difficulty of doing so can only get worse. The very aggressive American insistence on domination of the entertainment media will intensify as NAFTA expands its influence and as Death Stars fill the sky.

> "Digital technology is the solvent leaching the glue out of the nation state as we know it." Paul Saffo, Director, Institute for the Future (Globe and Mail 3 Feb. 96)

Censorship is another concern both for those who believe in freedom of speech and for those who are nauseated by what they bump into on the highway. Those who rejoice in the triumph of bad taste forget that the Internet depends on a very costly infrastructure largely built and still partly paid for by the US military. That situation might not continue.

Discussions of access usually concentrate on the ability to **retrieve** information from the net. Equally important is the ability to **post** information (or misinformation) to the net. How can that be secured?

A matter of enormous importance to the future of Work is the nature of the activity performed by people working at home.. There are three basic ways in which the computer has been used to move work into the home[16]. They are:

telework
telecommuting
telepreneurship.

Telework is work of a routine nature performed at home under contract to a company. It is mainly repetitive work or work governed by strict performance codes held in the computer and monitored by the computer. It is paid for on a piece-work basis.
Telecommuting is the activity performed at home during part of their working time by regular company employees. It is no different from the work they would have been doing in their company offices but it saves the company overhead andit saves them travel costs.
Telepreneurship is the running of a complete business out of the home with the use of a computer.
The social dynamics of these activities will be discussed in the lectures devoted to Work.

Intellectual property rights

Intellectual property rights are dead[17]. Long live intellectual property rights! As someone said, what incentive is there to produce new media creations if they end up as swag on the saddle of an Infohighwayman?. It has been demonstrated that legislation cannot handle the problem in spite of the occasional successful prosecution of a hacker or a software pirate. "The infinite malleability of digital forms of

expression melts down all the old distinctions on which copyright is based." It is not just a question of economic rights. What about the moral rights of an artist whose work is altered? The law intervenes only at the point where the work of the intellect is fixed in some tangible form. A live broadcast is not protected. Neither is a principle of management. In an interactive work, even the distinction between artist and audience, producer and consumer, starts to blur. The technical answer may lie in encryption but for software protection the best answer lies in linking software support and updates to proof of purchase.

Software developers face the same problem with patents. The small developer cannot afford to protect his invention and simply has to move fast before he is plagiarized.

Canadian Government Policy

The government established an Information Highway Advisory Council under the chairmanship of David Johnston, formerly principal of McGill[18].

Johnston says that the three governing principles of the Council were:

- job creation
- reinforcement of Canadian cultural identity
- universal access at a reasonable cost.

The Report of the Council was published in 1995 and is available at the Council's Web site.

Review Questions

1. Explain what is meant by bandwidth and describe one way in which an increase in bandwidth is being achieved.
2. What is meant by multimedia in the context of communications technology?
3. How might you find out what people will be willing to buy on the Information Highway?
4. What do you see as the main problems for various social groups in gaining access to the Information Highway.
5. What issues in Intellectual Property Rights have been brought into focus as a result of the Information Highway.
6. The chairman of the Information Highway Advisory Council says that one of the governing principles of the Council is "job creation". What constructive suggestions would you make to him?

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[1]T. S. Eliot *Collected Poems 1909-1962*. New York: Harcourt Brace & World Inc. p.147.
[2]Machlup, F. & Mansfield *The study of information* cited by Theodore Roszak (1986) *The cult of information*. New York: Pantheon., p.93
[3]Roszak, Theodore (1986) *The cult of information*. New York: Pantheon.
[4]See Dan Sperber and Deirdre Wilson's *Relevance: Communication and cognition.* Oxford: Blackwell, 1986.
[5]"The iron laws of information" rewriting public policy." Francis McIerney and Sean White. *Policy Options*, May 1993.
[6]David Johnston, 1994 p.3

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[7]Alberta Science and Research Authority Nov 1994.
[8]BCE Annual Report 1995.
[9]Web site www.wave.ca. See also Mel Duval "Life in the fast lane" Calgary Herald 13 Nov. 1996.
[10]*Globe and Mail* 2 Feb 1995.
[11]Wellman and Buxton, Policy Options, Sep. 1994
[12]Norman Ball of the U of Waterloo
[13]Wellman and Buxton, ibid.
[14]Wellman and Buxton p.16
[15]Greg Ip, Policy Options, Sep. 1994 p.8
[16]Menzies, Heather (1995) Whose Brave New World: The Information Highway and the New Economy. Toronto: Between the Lines.
[17]Andrew Coyne, G&M 1 Oct 1994.
[18]"Toward 2000: Public policy and the Information Highway. Policy Options, Sept. 1994.