Chapter 1

The Basis of Computing

The computer is both a product and a tool of technology, so an understanding of computers and their uses can only follow from an understanding of what technology is.

Technology in its broad sense means "the scientific study of the practical or industrial arts" but may be applied to "[a] particular practical or industrial art" (*The Oxford English Dictionary*, second edition, 1989). The word is related to the word *technique*, which means "*loosely*, a skilful or efficient means of achieving a purpose" (*ibidem*).

These definitions make plain several important points. Firstly, technology is something people do or use. Secondly, technology is used practically or industrially. Thirdly, technology is used by people to achieve their purposes.

The distinction between people and machines is thus a very basic one, and very important. Computers are tools that people use. A failure to make this distinction provoked the first essay in this chapter, "What Can Computers Do?" (essay 1.1, p. 8).

Technology

Many animals have techniques and use tools. Birds build nests, dolphins use sponges to protect their snouts, platypuses dig burrows, orcas bait birds with regurgitated fish, otters use rocks to break shellfish open, beavers build dams, gorillas use walking sticks, and so on, and so on.

Humans are different only in degree, in their accumulation of techniques that has produced technologies. In prehistoric societies, before *homo sapiens* even, people were using tools and techniques for providing food, clothing and shelter. In later societies, technologies were used to exploit and develop plants and animals to support human activities and supply human needs.

The degree to which the human race has developed its technology is way beyond that of other species, however. Why is this?

The basic reason is that humans have developed a metatechnology, that is, a technology for passing on and improving tools and techniques.

What is easy to overlook is that *metatechnology* is simply a fancy way of referring to the essence of modern society itself. Without technology there would be no society as we know it, and the development of technologies by our society is what has made a society like ours possible. And this is not just true today, but has been true for many millennia.

Another reason, one that follows from the first, is that the development of technologies has made possible the enlargement of world society through higher food production and lower death rates. More people means technology can be developed faster, provided social conditions allow this.

Our appreciation of technology is quite subjective. Simply by talking about it in isolation from its social context, particularly when we use terms such as *hi-tech* and *nanotechnology*, we put it on a pedestal as something to be admired if not worshipped. A proper appreciation of technology is often blocked by its jargon, and by those who jabber about it unthinkingly.

But in a quite fundamental way, human society is what it is because of technology, and technology in turn is what it is because of human society. The two are inseparable.

Some of the general social aspects of technology are brought out in the second essay of this chapter, "Revising the Principles of Technorealism" (essay 1.2, p. 10).

Digital Technology

What is this metatechnology that enables humans to exploit and systematically improve their technologies? It's simply our language.

What is language? Early language was a system of signals, perhaps both vocal and gestural, used to convey ideas. More recently relatively permanent symbols have been used to represent spoken language visibly or magnetically.

Signalling, by voice or gesture, is not peculiar to humans. Many creatures practise systematic signalling: bees by dancing, birds by whistling, whales by singing. Many primates use signalling systems, vervet monkeys having more than a dozen distinct signals, for instance.

What makes human language, and maybe dolphin and some other animal languages, different is its combinatoriality. Whereas vervet monkeys can only signal as many ideas as they have different signals, we can put sounds together to make words, words together to make phrases, phrases to make sentences, and sentences to make poems and speeches, laws and plays, and essays and books. Our words and sentences and books can be used to instruct beginners in the use of technologies and engineers and scientists in the development of technologies.

Having only a finite number of distinct signals, or symbols, is the basis of digital technology. With just twelve different signals—ten digits plus a decimal point and a negative sign—we can write down any decimal number we can think of. Internally, modern digital computers use only two symbols, zero and one, but combinations of these *binary* symbols can be used to represent any numbers or words we need to have processed.

Digital computers can process our language in various ways because of the digitality of language, but its own digitality limits what the machinery can do. We use language for a special mode of communication and thought that we have built on top of the richness of the perceptions and feelings that make up our daily life.

When language is represented digitally, we call that representation *data*. When people extract facts and ideas from data, we call those facts and ideas *information*. Or we SHOULD do so, which is why "The Great Term Robbery" (essay 1.3, p. 16) explains that the definitions of these two terms come from the formally accepted international standard vocabulary of the computing world.

The point to be emphasized is that computers can only process data, while only people can process information. Only people have knowledge and ideas, computers only have representations of them.

People and Computers

The definitions of the standard vocabulary do not by themselves justify the very important principle that computers only process data while only people process information. To compare the basic nature of people and computers is much more revealing.

Digital computers and their associated equipment encode everything they process as binary digits (called *bits* for short) or, rarely nowadays, as digits of other kinds. The glory of bits is that, though they are imperfectly stored and retrieved, and imperfectly sent and received, any particular bit must be very thoroughly imperfect before automatic machinery will fail to distinguish which of the only two possible values is encoded.

Furthermore, if a digital storage or transmission medium is known to be unreliable in particular ways, then extra bits can be added systematically to every record or message to allow automatic machinery to detect and even to correct errors. In this way a medium can be made as reliable as it is worthwhile to make it.

The corollary to this is that what goes in, and only what goes in or can be computed therefrom, can come out. Two compatible computers running the same program on the same data will give exactly the same result, unless there is a malfunction. Digital computers are determinate.

In contrast, anything anyone says can convey many kinds of information to a listener beyond, and to a degree independently of, the specific words used, information about the speaker's feelings and intentions, for example, or about the speaker's age, gender and background.

Further, although a listener can memorize a speech and even mimic its pronunciation, the information got out of the actual words themselves will depend on the listener's background and state of mind. The information got from speech equates to the thoughts provoked in the listener's mind by that speech, and the associations triggered by those thoughts. Those associations depend on the peculiarities of mind working on memories imperfectly laid down.

No two listeners are identical in background and state of mind, not even identical twins. Thus the information conveyed by the spoken word will not be identical for any two listeners, and will typically be quite different. Similarly, though to a lesser degree, different readers will acquire different information from reading the same text.

In this variety lies the richness of society, a richness that only fades when a person's perceptions fade, as for example in sleep or starvation, or are so swamped that background and personality become largely irrelevant, as for example when watching television.

Thus any conflating of people and machines is totally unjustified, a point examined further in "The Myth of the Intelligent Computer" (essay 1.4, p. 21).

Computers and People

Our society is based on our metatechnology of language. Our language is a social construct. We learn it from our parents and other companions, and our community maintains and develops the language we use.

Although our bodies and our brains have changed little over hundreds of millennia, our societies have changed enormously. We have changed our physical environment through farming and industry, and we have changed our systems of interpersonal relationships through wars and laws.

All these changes have been made possible by our social development of language, firstly spoken language, then written language, and most recently by the application of machinery to language.

The changes seem to be accelerating, partly and importantly because we have begun using complex machinery to process our language, going from printing machinery to electronic computers in only a few centuries. Indeed for several decades now we have been completely dependent on the use of digital computers to develop cheaper and more capable digital computers and telecommunications, a kind of positive feedback.

However, our society is developing digital computers of ever-increasing complexity while we, the individual members of society, are not developing at all, in the sense that a baby born today has the same innate potentiality as a baby born millennia ago.

Utopians see this contrast in development rates as leading to a society where all the work is done by machinery and everyone lives a life of leisure and luxury. Luddites see this contrast as foreshadowing a takeover of our world by "silicon-based lifeforms," such as extremely capable androids able to manufacture and develop their own kind.

Obviously, utopians are either extremely naïve or inhabit another world. Anyone who follows, however intermittently, the sequence of annual reports from the United Nations Development Programme[23] will understand this, as will anyone who has any familiarity with the history of the industrial world.

Luddites are in turn extremely naïve about the nature of the human mind and of human society.

Digital computers are a very long way from having a consciousness or a mind like ours. In the first place they are fundamentally different in kind, and in the second place they are still much less complex and adaptable, as explored in "Having a Mind to Computing" (essay 1.5, p. 23).

Digital computers, even when linked by the Internet, have nothing like our sociality and mobility and little prospect of ever attaining these. Even collectively, they are simply and fundamentally different. They are inanimate tools, we are their users.

The Law and Property

One of the most obvious differences between people and machinery is in the way they function, in their behavior.

When we blithely talk of machines such as cars or digital computers as behaving or misbehaving, we are referring to what they do as we use them. What we can get them to do depends firstly on what they were designed to be able to do, and secondly on the knowledge and skill we can apply to our use of the machinery. If we cannot get them to carry out some task then it is either because they can't do it (from design or malfunction) or because we don't know how to get them to do it.

When we talk about people behaving or misbehaving then we are talking about the effect of what they are doing on themselves and on other people. People behave or misbehave in that they cause emotions in each other.

Machines "behave" or "misbehave" in that they cause emotions in *us* by their mechanistic operation.

What machinery does is mechanical and functional. What people do is social and intentional.

Much social interaction is linguistic, and is typically activity intended to affect or control other people's behavior. Of course humans are not the only social animals. By developing our language we have simply extended social behavior like the grooming of monkeys, and indeed some linguists see our language as having a gestural origin.

Behavioral control is of two kinds, though the kinds overlap.

People use language to control interpersonal relationships, typically in a hierarchy of some kind. Hierarchies exist in other animal communities and signalling of various kinds is used to uphold the structure and control its lower members. But the complexity of human communities, even of entirely oral communities, is arguably made possible only by the use of language.

As language is developed social hierarchies become more complex and more extensive. The use of written language coincides with, and is certainly related to, the growth in the size of human hierarchies, witness the historical importance of documents in religion and the law. Today digital technology has become the basis of the global community.

People also use language to control the behavior of other people in respect of objects and entities other than humans.

Within a community of hunters or gatherers the provision of shelter, food and clothing involves negotiation or command, in particular when children are concerned, so that the community can survive or prosper. Commodities are owned by the community insofar as their possession and use is controlled by the community.

The combination of ownership and hierarchy has led to the development of the formal idea of property. Interestingly, since its first use well over five thousand years ago, written language beyond isolated symbols has been used primarily for the administration of society and property. Literature and science have been very minor sideshows, and universal literacy is a very recent ideal.

Property is about ownership and its rights, and has, at least in the British tradition of law, been of two kinds—realty and personalty.

Realty is land, and structures fixed to the land, and ownership is asserted either by battle or title. Title is established by documentation. Ownership is not quite the same as possession because a leaseholder can have rights of possession, again established by documentation.

Personalty is of three kinds—–leasehold interests, tangible property, and intangible property. Leasehold interests relate closely to realty.

Ownership of tangible property has to do with the possession of material objects. These are often physically marked to identify their real owner in case of disputes. Interestingly, the seals used to identify sometimes the owner and sometimes the maker (like a modern trademark) of goods in the Middle East well over five millennia ago were possibly the very first examples of a printing technique used for language.

The ownership of intangible property (formally *choses in action*) such as shareholdings, debts and trademarks, is more complex. Rights in intangible property can only be claimed or enforced by legal action, action that depends almost entirely on documentation.

As society and its various uses of language have been developing, so too have the significance and the use of intangible property. For example, money was once valuable in its own right and thus relatively free of inflation, but now it is purely symbolic almost everywhere in the world.

The development of intangible property has become very rapid indeed with recent advances in digital technology. Digital machinery processes data, and data are intangible. Further, programs for computers are also intangible, and both programs and digital recordings have come to the forefront as items of commerce.

Some of the implications of this are discussed in "Data and Information as Property" (essay 1.6, p. 28).

1.1 What Can Computers Do?

(1997 May)

Marty Leisner answers his own question "Do Computers Make Us Fools?,"[13] with the statement: "It seems that computers make people incapable of independent thought." On the other hand, he concludes that "reliance on them . . . might make us fools," and this, together with many of his other comments, answers quite a different question and answers it well. But it seems to me that neither question is the real question—the basic question.

So what is the real question? What is the basic problem? The context is that computers are seen as underpinning social change. The mistake is that computers are seen as causing social change. Let me illustrate one relevant social change.

Computer as Scapegoat

In 1970 I returned to Australia after living for awhile in the Hudson River Valley, where there was fairly widespread use of computers and punched cards. The state of New York had a very simple and effective drivers' license system based on stub cards, which required only that you send back the stub with your payment each year; the remainder of the card was your license.

When I went to get a license in Canberra, I was given a three-part form. The form not only asked for many more personal details than New York ever required, it required them to be written three times. When I mildly criticized the form design at the counter, I was solemnly informed that the design was as it was because of The Computer. I left it at that, but my later inquiries revealed that the department had neither a computer nor any plans to get one.

This incident alerted me to the most important social role of the computer, then as now: universal scapegoat. I have seen nothing since to change my mind on this, and indeed I have seen much to confirm it. The social change here is that people seem to be eager to use computers to avoid personal responsibility. Computers are being used to replace personal values with impersonal ones, like the ultimate abstraction—money.

Computer as Tool

Computers are merely tools. They are not members of society; they are not even pseudomembers, like corporations and governments. They are not independent agents. Like cars and telephones, they only do things if and when someone uses them. They can neither be blamed for what they do (are used for), nor given credit for what they do (are used for). If there is blame or credit then it belongs to the users, or to the owners, or to the designers, or to the manufacturers, or to the researchers, or to the financiers, never to the computer itself.

Computers cannot make us fools—they can only allow us to be foolish faster. And they can be used by others to make fools of us, for profit or power.

This is not understood by everyone because the computer industry and the computing profession seem to be saying otherwise. We seem to be saying that computers are like people; that they have memory, intelligence, understanding, and knowledge; that they are even friendly. How foolish ! How ignorant ! How impressive ! How profitable !

Attitudes to Computers

Those in the industry who warned against anthropomorphic language have been ignored. The people who put together the first standard vocabularies for the industry urged people to call the devices where data are put "stores" or "storage," not "memories." To suggest there is any likeness between the computer storage and the memories a human might reconstruct is farcical, if not insulting.

Those in the industry who urged that people be distinguished from machines have been ignored. The people who put together the first standard vocabulary for the industry installed such a distinction in its very first two definitions. In brief, they defined "data" as representations of facts or ideas, and they defined "information" as the meaning that people give to data. Only people can process information; machines can process only data. Embodying this fundamental distinction in the definition of the two most basic computing terms was a complete waste of ink.

As long as we allow people to think of computers as anything else than machines to be owned and used, powerful people and institutions will be able to use computers as scapegoats and avoid blame for the social inequities they are able to bring about for their own benefit by using computers.

An endnote referred readers with concerns about computers and social inequities, in particular through the global financial market, to George Soros, "The Capitalist Threat."[20]

1.2 Revising the Principles of Technorealism

(2003 January)

While preparing a talk for the Victorian Section of IEEE, I stumbled on the home page of the technorealists.[19] The overview proclaims that technorealists "seek to expand the fertile middle ground between techno-utopianism and neo-Luddism." Their goal is "neither to champion nor dismiss technology, but rather to understand it and apply it in a manner more consistent with basic human values." Although these statements show the technorealists' hearts to be in the right place, the eight principles that follow suggest that their minds have drifted way off course. The principles smack more of popular journalism than realism.

My misgivings grew stronger when further Web wandering brought me to Harvey Blume's comment in *Atlantic Unbound* that the technorealist movement seemed by 2000 "to have faded away . . . because the initial statement of technorealistic principles was simply too noncontroversial."[3]

That the technorealists little understand technology is unfortunate; that their mistaken ideas should be deemed uncontroversial is a revelation of the prevalent misunderstanding of technology that makes us tragically prone to be its slaves instead of its masters. These thoughts prompted me to suggest in my talk that engineers have a professional responsibility to bring realism to technorealism.

Technologies

The first technorealist principle asserts that

> *Technologies are not neutral.*

This principle derives from the statement that "Technologies come loaded with both intended and unintended social, political, and economic leanings." Yet technologies do not simply come—loaded or otherwise—technologists develop them. Further, technologists—not the technology itself—supply any intended or unintended leanings these technologies might have.

In digital technology's case, technologists do not yet know themselves. The workers in more traditional technological areas distinguish between technicians, who know a trade and build and repair things, and professional engineers, who exercise professional judgment to develop and design the things the technicians use, build, and repair. By nature, technicians must answer to their employers and customers. Professionals, theoretically at least, hold a privileged place in the community because their education and experience qualify them to exercise judgment in their use of technology—which the public assumes will be exercised for the community's benefit. People expect professionals to be beyond the command of employers and clients in matters that concern the public good.

Digital technologists, at least in the computing field, seem mostly to be technicians who do their own designing and who seek distinction in arcane specialties. As technicians, they have little incentive or inclination to look past their employer's interests and leanings. The first principle should be that

Technology is *neutral.*

The Internet

The second technorealist principle maintains that

The Internet is revolutionary, but not Utopian.

All the technorealist principles suffer from a misplaced preoccupation with digital technology, but it's especially strong here. Digital technology provides only a secondary tool, one that supports primary technologies such as genetic manipulation, medical imaging, and integrated-circuit manufacture.

The Internet is thus neither "an extraordinary communications tool" nor "revolutionary." It simply represents the current stage in the development of human capabilities through written language, which itself derived from the spoken form. Europe had an Internet two centuries ago: a semaphore system connecting Spain, Italy, France, Germany, and the Low Countries. Internets have developed in fits and starts since then, and will go on doing so.

So far, the main impersonal uses of the Internet and other digital technologies have been conservative, reinforcing and extending the existing social structure. This process has been good for some, bad for many, not because of the technology but because of how people use it.

The personal use of the Internet represents nothing more than a continuing evolution that has taken us from post to telegraph to telephone and beyond. The second principle should be that

The Internet is the present stage in
the evolution of the technology that underpins human civilization.

Cyberspace

The third technorealist principle observes that

Government has an important role to play on the electronic frontier.

In their explanation, the technorealists equate the electronic frontier to "cyberspace [which] is not formally a place or jurisdiction separate from Earth." For them, "the state has the right and the responsibility to help integrate cyberspace and conventional society."

Cyberspace, one of technobabble's more ludicrous coinings, seems to be anything but a place or jurisdiction. Margaret Wertheim sees it as "a repackaging of the old idea of Heaven but in a secular, technologically sanctioned format."[24]

If cyberspace refers to anything, it refers to the ubiquitous storage and transmission of digital data. The third principle should be that

Government has an important role to play in bringing
the benefits of digital technology to the community.

Information

The fourth technorealist principle states that

Information is not knowledge.

The technorealists explain their reasoning with a welter of pompous banality for which, unfortunately, the computing profession must bear responsibility.

Nearly 50 years ago, wise pioneers persuaded the profession to officially adopt clear and unambiguous definitions for the two most important words in our professional vocabulary: *data* and *information*. In brief, *data* refers to the conventional representation of facts or ideas, while *information* refers to the meaning people give to data. The profession has ignored this vitally important distinction, allowing the two terms to become almost synonymous, and has thus supported confusion and obfuscation in public discussion of digital technology [see also essay 1.3, p.16].

If the profession would only re-adopt these two standard definitions and promote them to the public, the difference between machines and people would always be clearly visible. The fourth principle should be that

Only people process information, machines only process data.

Schools Versus Education

The fifth technorealist principle states that

Wiring the schools will not save them.

Two assertions underpin this principle:

- "The problems with ... public schools ... have almost nothing to do with [digital] technology," and
- "The art of teaching cannot be replicated by computers, the Net, or by 'distance learning.'"

Despite the truth of these assertions, the resulting principle is much too weak. Its weakness lies in aiming at *schooling* rather than *education*, for only through education can children become full participants in society. Anything less than education for all children perpetrates a gross injustice.

Why is schooling secondary to education? Because the other members of a child's family constitute the child's first society and thus provide his or her main educators. If the family fails, the community must step in. If a family or community cannot educate its children, school will be unlikely to succeed where they have not. A misfit in the family usually becomes a misfit everywhere else.

Therefore, before they worry about schools, professional technologists should be concerned with the effect their technology has on families and communities. So should the government. The fifth principle should be that

Education is a basic human right, but it must come
from the family and the community, not from schools or machines.

Intellectual Property

The sixth technorealist principle claims that

Information wants to be protected.

The motivation behind this absurdly worded principle is "that cyberspace ... [is] challenging our copyright laws and frameworks for intellectual property." The technorealists' solution to this perceived problem calls for updating the old laws in pursuit of an old goal: "to give authors ... an incentive to create."

They have their background wrong. Intellectual property rights are monopoly rights and as such have been regarded with extreme disfavor by democratic legislators. Coming late on the intellectual property scene, the drafters of the US Constitution—wary of the bad effects such property law had caused in Europe—stood strongly against monopolies of any kind.[21] Only with great reluctance did they give to Congress, in Article I Section 8, "the Power ...

To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

Viewed in this light, much intellectual property law has run off the rails and could even be viewed as unconstitutional in the US. Lawmakers stretch copyright to allow commercial profit from any expression of any idea and for its each and every use. Patent holders use their rights to aggressively discourage innovation and competition.

Jefferson and Madison would regard what is happening as a contemptible perversion of their work. Both copyrights and patents should be dropped, and only intellectual property monopolies such as trademarks and industrial designs should be granted—and then only to promote fair trade [more in essay 1.6, p. 28]. The sixth principle should be that

Facts and ideas must be used for the public good.

Controlling the Airwaves

The seventh technorealist principle argues that

The public owns the airwaves; the public should benefit from their use.

This strangely worded principle springs from the Gilbertian antics of governments and telecommunications companies during the feeding frenzy that third-generation mobile-telephone technology prompted. Although the frenzy seems to have subsided, some points remain to be made.

The radio spectrum cannot be owned. Clearly, a government can grant or deny the right to emit electromagnetic radiation, just as it can grant or deny the right to fly or otherwise drive vehicles. The point of a democratic government is that it should use its power over rights to serve the greatest public good. In matters of public good, the community's welfare, not the economy's, provides the main criterion. The seventh principle should be that

Electromagnetic radiation cannot be owned,
but the community must control its use for the public good.

Understanding

Curiously, the eighth technorealist principle proclaims that

Understanding technology should be an essential component of global citizenship.

The technorealists pin this requirement's necessity on "a world driven by the flow of information," as though the world of humans hasn't always been thus. They define *global citizenship* as involvement in understanding "interfaces" and creating better tools.

Citizenship is more a matter of understanding society than of understanding digital technology. Further, the only understanding we need of any particular technology is how to control and exploit it. I need to know how to drive my car, but I get a mechanic to maintain it. Trying to make a technologist out of everyone is silly.

The idea of global citizenship does raise the important issue of public good on a global scale. Simply getting everyone to use digital technology is tragically impractical in a world where two billion people exist on less than one or two dollars a day. Surely, we should marshal technologies of all kinds to reduce this shameful inequality. The eighth principle should be that

Using technology to reduce inequity should be an aim of global citizenship.

Techno-utopianism, the belief that advancing technology will automatically bring global prosperity, is as ridiculous as neo-Luddism, the belief that global prosperity can be achieved only by rejecting technology. Although technology is inherent in all human civilizations, *people* develop it.

Yet the nature of any civilization depends on how it uses technology. Low technology used well might better serve a community than high technology used poorly. To prosper, any community must include professionals who use their expert judgment to guide the development and use of technology to the community's greater benefit. In today's world, digital technology clearly holds great importance, not only for its role in supporting human interactions and everyday activities, but for supporting the development and use of other technologies as well.

Technorealism should be based on the idea that people are more important than technologies. Before we can properly develop and use technology, we must first understand how people interact and coexist. Computing professionals can play an important role in guiding the future development of our global civilization, but their view of digital technology and the people they help must be realistic.

1.3 The Great Term Robbery

(2001 May)

In *Computer*'s January Letters to the Editor column, a reader responding to my November 2000 column (appendix, p. 285) described my suggestion that the phrase "coding scheme" would be less misleading than "programming language" as the onset of a Newspeak campaign aimed at undermining the computing profession.[10] His concerns about a real-life Newspeak are only too well founded, but computing Newspeak is long established rather than a mere threat, despite the computing profession's official adoption decades ago of a standard terminology.

As George Orwell saw and foresaw it, Newspeak aims to reduce if not remove meaning from language, thereby making political control of the masses easier. Although Orwell coined the term and wrote much on the topic, the slogans of *1984*'s Inner Party display Newspeak's character most clearly: "War Is Peace," "Freedom Is Slavery," "Ignorance Is Strength."

Although the régimes Orwell depicted have yet to appear in their full glory, at least in the world's advanced nations, Newspeak is with us nevertheless. Orwell's scornful bluntness prompted him to depict a blunt Newspeak, but a subtle version harbors more subtle dangers.

Modern Newspeak

That we already have a form of Newspeak became clear to me last December when I wandered into a bookshop dominated by several tables of books on sale, labeled bestsellers, at what the signs declared to be "lowest prices." Most of these "bestsellers" simply bore a sticker declaring that status, although others received further qualification, such as "best-selling horror story" or "bestselling war story."

The hovering sales assistant noticed my bemusement and offered her help. When I told her I somehow expected a bestseller to be unique, she brightly reassured me that they all were. My pedantry received a further jolt when I got home and noticed that the front cover of my current favorite, *The Surgeon of Crowthorne*,[25] bore the phrase "The Number One Bestseller."

Modern Newspeak hastens the decline of literacy in countries where, until a few decades ago, government schools had sustained universal literacy for most of the twentieth century. Now, the inability and disinclination to read have reached proportions that hark back to the nineteenth century. Present-day marketing does not need literate consumers—it needs an unthinking, unquestioning audience, able to be swayed by image and assertion, by repetition and hyperbole. Our ignorance is their strength.

The Computing Industry

The computing industry has also suffered from marketing hyperbole—christening data diskettes "floppy disks" provides but one example. Clothes flop, dough flops, dot-coms flop, but diskettes don't. Even the earliest versions, which lacked rigid covers, merely flexed. So why call them floppies?

To better distribute microprogram code, IBM developed the diskette drive in the late 1960s. In the 1970s, when this storage medium became widely used, marketers must have found the sober name "diskette" too bland, and so coined "floppy" to jazz it up.

Why not "flexy"? Well, by the 1970s marketers within the computing industry had drained all meaning from the word "flexible" by dubbing *everything* flexible: programs, computers, controllers, tape drives, card readers, printers, application programs, suppliers, even customers. Marketers routinely suffer from such naming exuberance. In the 1980s, "user friendly" dominated; in the 1990s, "intelligent" took pride of place; and in the 2000s, "e–" appears to lead the pack.

The computing industry and its profession require a certain amount of jargon. Our use of mnemonic initialisms and acronyms for the many transient technicalities makes technical discussion and education easier, although the practice bewilders neophytes and the public.

A responsible profession can less easily justify jargon that distorts ordinary language, either in meaning or grammar. The computing profession, for instance, uses the verb *to sort* to mean *to order* or *to sequence*. The dictionary defines *sort* as "to arrange according to sort, kind, or class"—a meaning too useful to lose, surely.

This distortion has an historical foundation, however: When data processors kept data on punched cards, they used repetitive sorting—in the true sense of the word—to put a card file in any desired sequence. Thus, sequencing on a five-digit ID number would take five passes of the card file through a sorter, moving from low-order digit tor high-order digit. Unfortunately, when magnetic tape replaced punched cards, the term "sorting" assumed the meaning "sequencing," even though the process no longer involved sorting, but rather progressive merging of subsequences. When using four tape drives, a tape "sort" would typically halve the number of subsequences with each merge pass, then stop when it arrived at a single sequence.

Grammatical distortion has its comical aspects. Computing professionals who would never think of inputting sugar into their coffee, or outputting their dog at night, unashamedly commit these grammatical atrocities on data. When jargon distorts ordinary language, it becomes harmful. A profession has a responsibility to the public to use ordinary language whenever it's possible and convenient to do so.

Terminology Standards

A profession also has a responsibility, both to the public and its members, to develop and employ a vocabulary for expressing the fundamental concepts on which its discipline is based. The example of the American Psychiatric Association shows that such a standard vocabulary can greatly hasten a profession's maturity. The APA's *Diagnostic and Statistical Manual*[1] has been of enormous benefit, as its adoption internationally attests.

Computing professionals, too, have a standard vocabulary. In 1961, the International Federation for Information Processing set up a Terminology Committee in conjunction, later, with the International Computation Centre. The committee published an international standard vocabulary in 1966[22] that remains, with some modifications, an ISO/IEC standard.[12]

This heroic and noble work deserved a better fate than oblivion. Yet dictionary makers and—far worse—most computing professionals have largely ignored the international standard vocabulary. No computing textbooks seem to adhere to the standard, nor do the multitude of specialist computing dictionaries that flood bookstores and the Web.

The common neglect of the standard's two most fundamental definitions, which are listed first in that work, best reveal this lack of observance. In their original form, these definitions read as follows:

- **Data.** A representation of facts or ideas in a formalized manner capable of being communicated or manipulated by some process.
- **Information.** In automatic data processing the meaning that a human assigns to data by means of the known conventions used in its representation.

These two clear and distinctive definitions conform reasonably with traditional usage. Contrast them with the corresponding definitions from *The New International Webster's Pocket Computer Dictionary of the English Language*[17]:

- **Data.** (*sing.* datum) Information, as that processed by a computer.
- **Information.** Any data that can be stored, retrieved, and manipulated by a computer.

These latter definitions are even murkier than the book's title. Completely confused, they conflict with the words' traditional usage. Although the worse dictionaries typically maul these definitions, the better dictionaries treat them almost as roughly.

We cannot really blame the dictionary makers for this nonsense, however. The confusion of specialist dictionaries and textbooks mirrors the terminological confusion and irresponsibility of our so very immature profession.

The Robbery

Professionals carefully and thoughtfully drew up the definitions of *data* and *information* in the standard, giving them pride of place as words that describe the computing professional's two most important concepts. Thus, the profession's dismissal of these definitions implies a profound dereliction of duty.

This neglect leaves us with two terms used more or less interchangeably for meanings so wide and indefinite as to surpass "flexible" and "intelligent" in uselessness to the profession and the public at large. Further, the profession and the public have been robbed of computing's two most important concepts, as defined and contrasted by some of the profession's wiser pioneers.

Specifically, we have been robbed of the ability to simply and consistently distinguish between people and machines. What do these two standard definitions tell us? That only people can process information, while machines can only process data. No more important distinction can be made in the field of computing.

By not making this distinction strongly, we hide from people their natural status and rights in respect to computers and their users, allow unscrupulous people to bewilder and confuse the public as to the proper role of digital technology in our society and its government, and allow our fellows to drift unconsciously from being citizens of our nations to being subjects of our economies. In effect, we support a fourth Inner Party slogan: "People Are Machines."

By not making this distinction strongly, we also rob ourselves of an important classification within digital technology. If people serve an important role in a given digital system, it is an *information* system and must be based on *information technology*. If people do not play such a role, it is a *data* system and must be based on *data technology*. Information technology should be based on cognitive science, data technology on computer and communications sciences.

The Restitution

The computing profession must review and extend the standard vocabulary in the spirit of the pioneers who did the original work, as Ian Gould described in "In Pursuit of Terminology."[9] We must pay particular attention to arriving at definitions of phrasal terms that contain either *data* or *information* to ensure that we preserve and even reinforce the humanistic distinction.

This restitution cannot happen speedily, as the linguistic habits of the community change only slowly. But we must bring the distinction between people and machines into everyday conversation. The profession must press both specialist and general dictionary makers to adopt the standard vocabulary and must persuade editors and authors of technical articles and texts to conform to the standard.

Further, the Computer Society, jointly with other professional computing societies, must make the standard vocabulary conveniently and prominently available online, for public use and for professional comment regarding the standard's concepts and their definitions.

The computing profession's most important responsibility is to plainly and consistently define the role that digital technology plays in its community. To accomplish this task, the community must distinguish between itself and its machines, and our terminology must support, not hinder, this distinction.

1.4 The Myth of the Intelligent Computer

(1997 July)

When I awoke to the radio announcement that Deep Blue had beaten world chess champion Garry Kasparov, I was at first bemused and then dismayed. I was bemused because I had just written a column (essay 1.1, p. 8) that clearly explained why it would actually be Deep Blue's designers, programmers, and builders who had beaten Kasparov, not the machine itself.

I was dismayed because—as surely as night follows day—the radio, television, and newspapers would unleash a torrent of utter claptrap about the Intelligent Computer, and some would even forecast the imminent takeover of the world by silicon-based life forms.

That this is complete twaddle is easily demonstrated. That it will be widely believed is a condemnation of our education system, which should be giving our children truth and self-respect, and of our own industry, which actively promotes the myth of intelligent machinery.

Intelligence is social

To imagine that intelligence can be equated with skill at chess playing is to completely misunderstand what intelligence is. Chess playing is to logic and calculation what intelligence is to relationships and negotiation. Chess is abstract; intelligence is social.

Intelligence is not only displayed socially, it is induced socially. Not only intelligence, but the ability to become intelligent, comes from social stimulation and interaction. People exhibit their intelligence as they learn it, entirely by the richness and versatility of their behavior with others. Did you see Deep Blue on television? Any behavior at all was only implied, and even this implied behavior was anything but rich and versatile.

Intelligence is multidimensional

In *Frames of Mind*[8] the celebrated and respected Howard Gardner distinguished seven dimensions of intelligence: linguistic, logico-mathematical, spatial, musical, kinesthetic, intrapersonal, and interpersonal. Even more have been identified since then.

To hold that a written test that takes 30 minutes or so to complete can be used to measure intelligence must be the greatest educational con job of all time. Although individuals will differ from one another (and from themselves from time to time) in their skills in these various dimensions, all normal individuals will have a modicum of skills in each—otherwise they are subnormal.

In how many of these dimensions does the Deep Blue program have any capability at all? Only one, logico-mathematical, and here its capability is quite inhuman, both in kind and degree.

Who needs androids?

Of course, in 50 or 100 years' time we may be able to build machines that can simulate, even perhaps possess, skills in all these dimensions. But by then these machines will no longer be computers. Science fiction writers have long called such machines androids. Isaac Asimov, in particular, wrote many of his stories about the problems of fitting androids into human society. Asimov's stories raised many moral and philosophical issues, most memorably "*The Caves of Steel*,"[2] which featured an android detective called Daneel Olivaw.

It may be that we will eventually make such machines. But it is hard to see why. The people who are able to own such special-purpose machines as Deep Blue will get much more benefit, at least in the short term, from their very special-purposeness.

Consider the effectiveness of the highly specialized network of computers that runs the international financial market. Many eminent economists consider that this machine is so effective that national governments no longer have any control over the economies of their countries. As one scholar put it, "The policy role of government has . . . been reduced to one of obedience to financial and foreign exchange markets."[15]

The result is an accelerating gap between rich and poor people and between rich and poor nations. As one observer sardonically points out, there are more than six million people in the world worth more than $1 million and more than 1,000 people who die every day of diseases that would cost at most $1 a day to treat.

With special-purpose machines as effective as the world's financial engine, who needs androids?

This essay appeared in the column Open Channel, *edited by Will Tracz.*

1.5 Having a Mind to Computing

Originally *Would a Digital Brain Have a Mind ?*

(2002 May)

Certain recent events caused me to doubt whether I know my own mind or not. Let me explain.

Last week, the first of our academic year, all first-year students in our degree program underwent a supervised test in which they pull an old computer to pieces and put it back together again. We give this test to put a healthy disrespect for digital circuitry—which is, at heart, only carefully polluted sand—into each student's mind as early as possible. We intend this disrespect to counter the superstition, held both by naïve students and by members of the public susceptible to media persuasion, that digital machinery has much in common with the human brain.

Yesterday, I went to a lunchtime philosophy club lecture titled "Why the Body Is the Mind." Because some of the discussion related to consciousness, I recalled Giorgio Buttazzo's article, "Artificial Consciousness: Utopia or Real Possibility?."[5] The juxtaposition suggested a strange contrast between computing people, who see mental capabilities in machines because they do not appreciate how complex the human brain is, and philosophers, who see complexities in the human mind because they do not appreciate that the brain and the computer share some simple and fundamental properties.

However, not being a philosopher, I find it difficult to be confident that I understand them when they discuss the mind. This uncertainty leaves at least three possibilities:

- either I understand the basic nature of my mind and the philosophers don't,
- vice versa, or
- we share the same understanding
  but express it in mutually incomprehensible language.

Later, I read Bob Colwell's provocative essay "Engineering, Science, and Quantum Mechanics."[6] Toward his essay's end, Colwell reported of entanglement theory that "the [photon's] wave function's actual point of collapse is when a conscious mind perceives the results" and that the collapse was caused by "the synapses of our brains, acting in concert to form our minds, at the instant we detected the photon."

Suddenly, I felt alone, isolated, out of my depth, and fearfully vulnerable. What follows is meant to enlist your sympathy and rebuild my confidence.

The Mind as Process

According to my *Macquarie Dictionary*, the principal meaning of *mind* is "that which thinks, feels, and wills, exercises perception, judgment, reflection, etc., as in a human or other conscious being: *the processes of the mind*." The principal definition of *process* is "a systematic series of actions directed to some end."

An action requires an actor, presumably the mind in this case. Why not the brain? The Macquarie defines the *brain* as "the . . . nerve substance that fills the cranium of man and other vertebrates; centre of sensation, body coordination, thought, emotion, etc." Why so coy? Where is the mind in this brain?

The computer works like the mind–as–actor in that it functions as a device that processes data—conventional representations of facts or ideas. The circuits carry out the computer's processing by copying, transmitting, and transforming these data.

The mind, given the Macquarie definition, processes thoughts, feelings, intentions, perceptions, judgments, reflections, and so on. Neurons and glial cells process neural and hormonal representations of sensations past and present.

Although the idea of the mind as distinct from the brain has a natural appeal, defining the mind as an actor distinct from the brain invokes an unnecessary, even deceptive, dualism. Our mind thinks, feels, perceives, and so on, whereas our brain merely exists between our ears. The distinction can be useful and productive.

The problem lies in defining the mind as an *actor* rather than an *action*. If we regard the mind as the thinking *process*, it becomes distinct from the brain and becomes the systematic series of actions the brain takes as it processes sensations and reconstructs memories.

We can thus view the brain as substance, the mind as process. Likewise, we can view the computer as substance and its computations as process. The brain exists materially, while the mind arises as a property of changes within the brain. Similarly, the computer exists materially, while computation occurs as a property of changes within the computer. So far, so simple.

Source of Confusion

Consciousness seems to be the confusing factor. We associate self–awareness and identity with consciousness. Buttazzo writes, "Because we cannot enter another being's mind, we cannot be sure about its consciousness." This theme recurs in writings on the philosophy of the mind. But if a mind *is* a process, it's meaningless to talk about anything entering it.

Processes can only be perceived, thus inferring the operation of another mind from such perception must surely be sufficient. If anyone argues that we need certainty, we can counter that no one can be certain of anything, as the "brain in a vat" argument shows.[4]

Cycle time versus data rate

In speculating about the effect of cycle time on artificial consciousness, Buttazzo poses a curious question, "If consciousness emerges in an artificial machine, what will time perception be like to a simulated brain that thinks millions of times faster than a human brain?" What does "be like" mean here? In any case, the question confuses cycle time with data rate—the stupendous parallelism of the brain makes the cycle time of our present digital computers irrelevant.

However, Buttazzo speculates that the world might seem to slow down for a simulated brain as perhaps it does for a fly, "thus giving the fly plenty of time to glide out of the way" of a swatting hand.

The fly and I have much the same kind of neural signaling system. The average local fly measures about 10 mm, and I am roughly 200 times that length. My reaction time is about one-tenth of a second. A submillisecond reaction time for a fly is thus not at all mysterious, nor would much shorter reaction times in a digital computer be in any way puzzling. Where then is consciousness in all this?

Whence consciousness?

Is a fly conscious? Well, it's aware to the extent it can often dodge a swat—its perceptual neural system alerts it to the swatting hand so that it can dart out of harm's way. But what part of the fly's nervous processing is aware, and thus to some degree conscious?

Awareness must emerge at least from the transformation of perception into the intent or neglect of an action. The transformation of sensation into perception can be unconscious because it can be automatic: We remain, for example, cheerfully oblivious to the dramatic data compression our retinas carry out. The transformation of intention into motion can similarly be unconscious: We do not consciously stimulate each individual muscle in our mouth, throat, and chest as we speak.

For the fly, we might imagine that its nervous system functions like a computer system: Its central processor "consciously" forms intentions on the basis of perceptions that its peripheral sensory system "unconsciously" produces, then its peripheral motor system "unconsciously" puts those intentions into effect.

Cache as cache can

We can transfer this analogy to the human nervous system to explain how consciousness arises from it, except that we have a more complex central processor than does a fly and much more occupies our minds than mere perceptions and intentions. We have extensive memory traces from which neural processes can reconstruct pseudoperceptions that pass through our consciousness. Intentions cannot be based practically on reconstructing all our possible memories at once. Part of our brain processes perceptions together with relevant pseudoperceptions to derive intentions. The processing of this area within the forebrain must be closely allied to our consciousness.

Human consciousness therefore strongly resembles the processing that a digital computer's central processor and its associated main store cache carry out. The cache brings relevant data close to where the current computation can use them. In this sense, then, our present-day computers are conscious, if their CPU has a cache.

Vive la Différence

Observing that "The human brain has about 10^{12} neurons, and ... 10^{15} synapses," Buttazzo calculates that, using artificial neural networks, "Simulating the human brain requires 5 million Gigabytes" of data storage. Moore's law suggests that digital computers will have main stores of that capacity by 2029, although Buttazzo carefully qualifies this observation by adding that it "refers only to a necessary but not sufficient condition for the development of an artificial consciousness."

Using a digital computer to simulate an artificial neural network that simulates the human brain does not seem the best approach. Given the neural parallelism to be modeled, using analog circuits to directly implement neural networks would seem a better alternative, one that might bring the feasibility date well forward, if research could divert the circuit manufacturing industry to this cause. But this begs the question of whether artificial neural networks can be made comparable with real ones.

In an artificial neural network, each node, or neuron, has an activation value that the network passes forward to other nodes through connections, or synapses. The synapse to each forward node has an associated weight that modulates the incoming activation value's effect on the forward node's activation. The weights can be adjusted in various ways likened to "learning." An artificial neural network's nodes mimic the classical neuron—but very roughly—with an axon down which the repetition rate of an action potential, the *spike*, passes an analog value, dependent on the activation of the neuron's main body.

Disregarding as a mere production problem attaining 10^{12} neurons and 10^{15} synapses in analog circuitry, where do artificial neural networks fall short of the real thing?

• The activation of a classical neuron is not an arithmetic sum of the synaptic effects. Rather, a complex process involving the intervals between action potentials at individual synapses and their relative timings between synapses determines the activation. The more neurons are studied the more such complexity is revealed.

• The human nervous system contains many different kinds of neurons and many kinds of glial cells. The glial cells provide more than support because they signal and have synapses just as neurons do.

• Action potentials alone do not control nervous signaling. Graded potentials and hormonal signaling also play a part, as does the great variety of different neurotransmitters and hormones.

Creating an artificial consciousness does not require simulating these complexities. But human consciousness lies far beyond any presently contemplated artificial one. We have, for example, developed a highly complex and utterly human consciousness of our physical bodies. Likewise, we have a highly developed consciousness of other people and of our society, whose collective consciousness shapes our development as humans.

Obvious parallels exist between the brain and digital computers. To fulfill their responsibility to themselves, and to others who might be misled by journalistic hyperbole, computing professionals should have well-founded opinions about the extent of these parallels. The profession should refrain from applying humanistic names to its mechanistic endeavors, and it must be conscious always of the essential differences between people and computers.

Perhaps in 50 or 100 years, our machines will acquire a humanlike consciousness and intelligence. But such machines will be utterly different from the puerile imitations we now have or can realistically design. Getting to such machines will raise professional and philosophical issues quite different from those that reflect on the nature of what human and machine consciousness can generate.

And what about the mind and entanglement theory? If a CPU and its cache possess consciousness, we could leave looking at photons to them. In any case, I've now put entanglement theory into the back of my mind under the shade of the tree in Bishop Berkeley's quad![16]

1.6 Data and Information as Property

(2004 May)

Digital technologists concern themselves with data—conventional representations of facts or ideas–and with machines for storing, transforming, and transmitting it. Although computing professionals also concern themselves with digital technology, they focus primarily on people and information—the meaning that people give to data.

The use of data to convey information is vitally important to our social systems. This is underlined by recent research showing that dogs are much more able to get meaning from data than chimpanzees,[7] which probably explains why dogs make better pets.

The sharing of meaning has been the foundation of social development. The different data technologies have been used both to empower and to constrain members of our society as technology and society have evolved together. Computing professionals should thus always be sensitive to the social uses of data and information. They should also be alert to legal developments related to using data and to digital technology's role in producing data.

Data's Evolution

Spoken language was the first digital technology. Many oral societies were quite extensive and persistent, although oral data is short-lived and only persists through memory. The rulers of successful oral societies depended on respect for oral tradition as reflecting acceptable past behavior.

Written language was the second digital technology. Writing gave a permanent and copyable *aide memoire* to the institutions in control of literate societies, making the written word law. Literacy remained the exclusive province of the élite until late in the development of printing.

Electromagnetic media underpin the third digital technology. Not only has the capture, storage, manipulation, transmission, and display of electromagnetic data gone far beyond that possible with the old kinds of written language that developed and developing societies use, it has also given the leaders of those societies much greater scope for controlling and exploiting the people under their leadership.

The use of digital technology now encompasses and facilitates not only written and spoken language, but also the production and delivery of goods and services. Abstract goods and services such as pictures, speech, and music—which have in the past been relatively awkward to deal with as analog data—have, through digital technology, become easy to produce and reproduce.

Intellectual Property

In the affluent fraction of the world at least, digital data has become more bureaucratically and commercially significant than any other product. In particular, its commercial significance has led to the rapid expansion and extension of so-called intellectual property (IP) law. The World Intellectual Property Organization (WIPO) and the international Trade Related Aspects of Intellectual Property Rights Agreement have extended such laws around the globe.

IP rights figure importantly, but remain almost unnoticed publicly, in so-called free-trade agreements such as the recently negotiated but not yet [but since] ratified agreement between Australia and the US.

The 1967 WIPO convention[26] defines intellectual property to include those rights relating to:

- literary, artistic, and scientific works;
- performances of performing artists, phonograms, and broadcasts;
- inventions in all fields of human endeavor;
- scientific discoveries;
- industrial designs;
- trademarks, service marks, and commercial names and designations; and
- protection against unfair competition.

WIPO's definition of IP also includes all other rights resulting from intellectual activity in the industrial, scientific, literary, or artistic fields.

Calling such rights *intellectual* property is a misnomer, and the definition is both a chimera and a hydra. The misnomer is because many of the rights do not result primarily from intellectual activity, especially when computers are used. The chimera is because it cobbles together quite different kinds of rights with quite independent and distinct histories. The hydra is because the definition's specific items go far beyond precedent, and a rapacious ambit claim follows them.

There are, or were, three kinds of property covered here: commercial identifications intended to provide for fair competition, novel ideas of use to industry, and original creations of interest to the public at large. Until recently, the first two kinds were usually called industrial property, for obvious reasons. Digital technology has great significance for all three kinds of property, which is why all computing professionals should take an active interest in IP law.

Commercial identification

The rights relating to industrial designs—and to trademarks, service marks, commercial names, and designations—are rights to produce goods with an appearance or with labeling or markings that identify the goods' origin.

Industrial design rights relate only to the visual appearance of goods. First introduced in England in 1787 in support of the textile industry, these rights provide a distinct industrial form of copyright. There has been much discussion of the overlap between appearance and function, but patents of invention rightly cover novel function. Provided this separation remains, using a computer to produce a design should not affect rights that a registration process ensuring distinctness of design establishes.

Trademark registration granted a monopoly that extended the protection of the tort of passing off, and it is nowadays supplemented legislatively by various trade practices, laws, and regulations intended to prevent unfair trading. However, the use of trademarks to identify the origin of goods is disappearing as they increasingly become the lynchpin of modern marketing, which uses them to condition purchasing behavior through advertising.

Information as property

The second kind of IP rights, monopoly in information, involves ideas as ideas, such as the rights established under patent law.

Nations began granting monopolies for inventions in Europe in the 15th century. England's Queen Elizabeth enthusiastically adopted the idea of such grants in the 16th century for a variety of monopolies, the official document of grant being called a letter patent.

Gross overuse of letters patent in England led to legislation in the 17th century that rendered all patent monopolies invalid except for patents that protected the "sole working or making of any manner of new manufacture." Governments granted these to inventors, a term which then included importers of technology.

The English tradition of patent law developed from this legislation. Several aspects of this tradition are important:

- Patents sought to encourage innovation for the good of the nation. An exception to the rule against monopolies, they were not primarily granted to reward the inventor, but to discourage the use of trade secrets that hamper innovation.
- Rights targeted innovation in manufacturing and excluded a "mere scheme or plan." The present extension into business processes and beyond is questionable.
- Novelty, a requirement, excludes any development that would be obvious to one skilled in the prior art. The plethora of patents being granted currently

implies the scarcity of true novelty.

• Innovation excludes scientific discoveries. In the English tradition, such discoveries belong in the public domain—invention relates solely to the industrial exploitation of discoveries. Thus, while a new substance is not patentable, processes for making or exploiting that substance are.

Some indirect aspects are also important. For example, patent holders all too often use their rights to prevent innovation, which they do easily by blocking any innovation that extends their invention. Also, modern inventions typically have a much shorter useful life than a patent, denying the public any residual benefit.

Software patents are indefensible in principle.[11] Most importantly, disputes over patents incur great expense and have notoriously unpredictable outcomes. Patent holders can thus easily use litigation to discourage competition.

These aspects of the patent system are particularly relevant to computing professionals now that so many patents involve digital technology.

Data as property

The third kind of IP rights confers a monopoly in data—representations of facts or ideas, such as rights established under copyright law. In England, the Stationers' Company established a monopoly in printing, and its members held exclusive control over the importation and publication of books. Because copyright holders came to use the monopoly extortionately, Parliament passed the Statute of Anne, an "Act for the Encouragement of Learning . . . ," in 1709. After an immense legal and political battle, it replaced the earlier and much wider monopoly. Originally covering books only, rights were gradually extended to artistic, dramatic, and musical works.

In general, copyright lets the owner control the copying of works, although extensions over the past few decades to cover modern works such as broadcasts and computer programs have made copyrights much more complicated. In essence, copyright pertains to the representation of a fact or idea, not the fact or idea itself. The work need not be novel, but it must be original, and until recently it had to be in material form.

The idea of copyright monopoly arose with the introduction of printing, but technology has made copyright grotesque.[18] The first stage of the copyright farce came when photocopiers replaced spirit duplicators and Roneo machines, which led to absurd fee-collection systems. The farce continues today in the recorded music industry.

The Future

Digital technology has been universally adopted in the commercial world, so data is becoming the main and often only source of revenue for many enterprises. The importance of data to business enterprises has led to the extension of IP rights in scope, duration, and severity—and geographically through WIPO. Extension of existing legislation and legislation for entirely new rights—such as those for circuit layouts and software patents—widens the scope of rights even further. The duration of both copyrights and patents of invention is being greatly extended. Large companies, unable to protect their own intellectual property through the traditional civil courts, are persuading legislators to make crimes of what have always been torts, so that governments must enforce commercial property rights. Extended IP rights are being propagated internationally by, for example, so-called free trade agreements.

Because IP rights are of tremendous significance to computing professionals, we must be well informed about them. We have a clear duty to counter the persistently uttered falsehood that they are intended to reward the inventor or author who is, in fact, rarely the main beneficiary. Indeed, it seems likely that in the future, inventors and authors will often be computers.

Personal views on IP rights range widely. Identification rights are in principle necessary as a basis for fair trading in goods, but data and information have become goods in themselves. Given that capitalism is based on extending property rights to artificial entities, it would seem logical to extend the property rights themselves as far as capitalism requires. In contrast, since property rights are monopolies, and monopolies act in restraint of trade, free-market principles would outlaw copyright, patent, and related rights.

I believe that the expansion in scope and duration of these rights should be greatly and promptly reversed. Eliminating copyright and patents altogether would be interesting and certainly different, possibly more beneficial, but impractical.

As computing professionals, our views should be well founded, wherever in the spectrum they might lie. We should also be prompt to speak out against obvious absurdities, such as the push to bring deep linking under copyright law. If this push were to succeed, its logic would make it illegal for someone to cite this essay other than by giving its title, my name, and the name of this publication. Giving the date, volume and issue, and pages would be illegal and possibly criminal.

Much of the background information in this essay was gleaned from Intellectual Property in Australia.[14]

1.7 Notions

The notions are given here partly as a rough summary, but more particularly as topics and issues for students to study and debate. They are in the sequence of their *key word* or *phrase*. The page number to the right of each notion points to its context.

1. Machines *"behave"* or "misbehave" only in that they cause emotions in us by their mechanistic operation 5
2. That digital machinery has much in common with the human *brain* is a superstition 23
3. The Internet is the present stage in the evolution of the technology that underpins human *civilization* 11
4. Electromagnetic radiation cannot be owned, but the *community* must control its use for the public good 14
5. Only what goes into a computer, or can be *computed* therefrom, can come out 3
6. Digital computers are a very long way from having a *consciousness* or a mind like ours 5
7. Human *consciousness* lies far beyond any presently contemplated artificial one 27
8. *Copyright* monopoly arose with the introduction of printing, but technology has made copyright grotesque 31
9. *Cyberspace* is a repackaging of the old idea of Heaven but in a secular, technologically sanctioned format 12
10. *Education* is a basic human right, but it should come first from the family and the community, not from schools or machines 13
11. To hold that a written test that takes 30 minutes or so to complete can be used to measure intelligence must be the greatest *educational* con job of all time 22
12. A misfit in a proper *family* is usually a misfit everywhere else 13
13. With special-purpose machines as effective as the world's *financial* engine, who needs androids? 22
14. Computers cannot make us *fools*— they can only allow us to be foolish faster 9

15. *Government* has an important role to play
in bringing the benefits of digital technology to the community 12
16. Using technology to reduce *inequity*
should be an aim of global citizenship 15
17. Different readers will acquire different *information*
from reading the same text 4
18. Only people process *information*, machines only process data 12
19. Intellectual property is a misnomer because
many of the rights do not result primarily from
intellectual activity, especially when computers are used 29
20. Chess playing is to logic and calculation
what relationships and negotiation are to *intelligence* 21
21. Modern *inventions* typically have a much shorter useful life
than a patent, denying the public any residual benefit 31
22. Only people have *knowledge* and ideas,
computers only have representations of them 3
23. A profession has a responsibility to the public to use ordinary
language whenever it's possible and convenient to do so 18
24. Modern *marketing* needs an unthinking, unquestioning audience,
able to be swayed by image and assertion, repetition and hyperbole 17
25. The sharing of *meaning* has been
the foundation of social development 28
26. The brain exists materially,
while the *mind* arises as a property of changes within the brain 24
27. Technology is *neutral* 11
28. The use of trademarks to identify the *origin of goods*
is disappearing as modern marketing increasingly uses them
to condition purchasing behavior by advertising 30
29. *Patent* holders can easily use litigation to discourage competition 31
30. Specifically, we have been robbed of the ability to simply
and consistently distinguish between *people* and machines 19
31. The transformation of sensation into *perception*
can be unconscious because it can be automatic 25
32. The combination of ownership and hierarchy
has led to the development of the formal idea of *property* 6
33. Rights in intangible *property* can only be claimed or enforced by
legal action, action that depends almost entirely on documentation 6

1.8 Bibliography

The entries are in order of the first or only author's name. Where no personal author is known, as for popular news items, an indicative name is used. Where there is a page number or two in *italics* at the beginning of the annotation, they point back to where the item was cited. Where some of the annotation is given in quotes it has been taken from the item itself or from some of its publicity.

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