"This digital *Origin of Species* turns out to be a sequel to *The Odyssey*"
Wired

the soft edge

a natural history and future of the information revolution

PAUL LEVINSON

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To Donald T.Campbell,
1916–1996

CONTENTS

PREFACE

The Soft Edge is about the difference that communications media make in our lives. The edge is soft because information is intangible. But it is pervasive and advantageous inasmuch as we cannot do without information, and because those who possess certain kinds of information —and more effective means of processing it—usually have an upper hand. For those unaware of this power of media, the edge can also be a precipice.

All life, indeed, operates on information. What characterizes human life is that we presumably are aware of information and its various modes of conveyance— yet so ubiquitous is this information, like the very air around us, that we often take no notice of its most profound consequences, the ones that arise when the currents of conveyance change. This book is thus a voyage of discovery, of a history and present we already know and a future under way, with an eye toward explaining how information technology helped bring them all into being.

We begin in Chapter 1 with some general principles. To say that the printing press engendered the modern world, radio the totalitarian audience, computers a new hybrid of author and reader, is not to claim that the media created and imposed these ways of living upon us, but rather that they provided crucial conditions in which new worlds could and did emerge, pathways in which human penchants long in quiet residence could now find larger expression. Part of this process is out of our control, since inventions so often have unintended consequences. But, as we'll also see, media have impact because we select them for survival over their competitors, as we did with the alphabet over hieroglyphics, talkies over silent movies, computers over typewriters. And we frequently invent and deliberately apply media to specific remedial tasks, as with the home video recorder, which gives television the means of recall and anticipation.

Stocked with these and related navigational guides, we start our tour of history. Our first stop, in Chapter 2, is the ancient world. Here we find the Egyptian heretic Pharaoh, Ikhnaton, who more than three millennia ago decreed a new monotheistic religion—whose practice in Egypt barely survived his lifetime. In contrast, the monotheism of Moses just a century later took permanent root and went on in its Christian and Islamic transformations to convert most of the world. Could the difference have been that Moses used an alphabet, in effect a digital medium whose capacity to easily describe an omnipotent, omnipresent but essentially invisible deity was lacking in the Pharaoh's picture-based, "analogic" hieroglyphics?

Our next port of call, the Europe of Gutenberg in the late fifteenth century, picks up the story of media and religion, with the proposition that the printing press made the Protestant Reformation possible by making available the Bibles that Luther said people should read for themselves. But Chapter 3 also explores the mutually catalytic relationship of the Reformation, the Scientific Revolution, the rise of national states, public education, and capitalism—each running to some extent on print, each also coaxing the others into action. The information revolution as an elicitor of human patterns already present can be seen nowhere more clearly than in the Age of Discovery, one of the prime engines of the rise of national states. The Vikings reached the New World some five hundred years before Columbus; what made Columbus different is that word of his discovery was printed and distributed throughout Europe.

Chapters 4–10 introduce us to the photochemical-electronic rounds of the revolution with photography and telegraphy in the first half of the nineteenth century, and follow their development and surprising results through the telephone, electric lighting, radio, and television to the doorstep of the computer age just a little more than a decade ago. The phonograph and motion pictures of course also figure in this recent natural history, but in this rendition they play supporting rather than leading roles, appearing within and between, rather than on top of, chapters in starring title credits. This brings to the fore an important point about our narrative from here on in: the pace of invention became so quick in the nineteenth and twentieth centuries that I have focused only on those media whose presence was clearly decisive in shaping our world prior to computers. Indeed, they still shape our world today, as do the alphabet and printing press. These selective dispatches from the information revolution describe critical junctures, some often remarked upon, others less obvious, sometimes arising from the same invention.

Electricity serves not only as a distraction from reading when powering television but as the book's nighttime accomplice when providing light. Radio not only convened the world's first simultaneous mass audiences but has flourished in an age of television because it is an incomplete medium that gives us sounds with no images, allowing us to do other things while we hear it.

The personal computer and its extensions is a medium *par excellence* for facilitating both reading and multi-tasking, or doing many things at once. Chapters 11–15 consider five aspects of this revolution before our eyes: word processing, online publishing, hypertext, its implementation on the Web, and the role of icons and images in these processes. An advantage of looking at such innovations so close at hand is that their emergence is in abundant evidence all around us, and often subject to our direct, personal experience. I have no hesitation about citing my own pleasure with word processing, and the freedom it gives from frustrating negotiations with the typewritten pages that once were required for every correction—or the lessons I have found about online communication in Connected Education, which has been offering university courses through personal computer and modem under the supervision of my wife and me for more than a decade. Of course, a drawback to studying a transformation newly in progress is that we cannot be as clear about its outcome as we can about inventions and consequences that first appeared three thousand, five hundred, or even a few years ago. As recently as 1994, surveys estimated that the average American watched 1,560 hours per year of television and spent 3 hours on the Internet and other online services; by the middle of 1996, a different kind of measurement shows television still reaching more than 250 million Americans in contrast to estimates ranging from 9 to more than 40 million Americans on the Internet (see Dizard, 1997, and Kantor and Neubarth, 1996, for details); all that we know for sure about the extent of online patronage is that it is growing rapidly, yet is still a fraction of that enjoyed by older media.

In the concluding four chapters of the book, we embark almost entirely into the future, the hard evidence of which is in even shorter supply. In Chapter 16, we weigh the prospects of a medium to which we and our words have been remarkably attached since the printing press: paper. In Chapter 17, which may be the most important practical section of this book, I argue for stronger, not weaker, provisions for intellectual property in the digital age, and make an explicit proposal for a new kind of "smart" patent number, an electronic watermark embedded in every technology, which would provide people with a

ready listing of its inventors, and therein heighten the profile of authorship and the products of intellectual labor. I offer this proposal in the hope that it will be seriously considered and then implemented.

Chapter 18 shifts from the practical to the ethical, and indeed more than any other stage of this excursion enters the "what if?" realm of science fiction. What if we developed computers that were more than adjuncts and auxiliaries of our intelligence—the extensions and enhancements of cognition that they are today and will continue to be, at least in part, in the future—and were truly autonomous intelligences? The very posing of the question presumes that we do not yet have anything like that, and I elaborate at length as to why I think that is the case, yet need not always be. Our popular culture has worried that such AI entities might destroy us—but if we did develop machines with intelligence that truly rivalled our own, would we be right to treat them like slaves?

We round out the voyage in Chapter 19—in a sense return home—with a look at what is, in effect, the other side of the AI question: are there some aspects of being human which, absent a modification of our genome which would make us a different species, can never be satisfied by any information technology? Investigation of this issue brings into play the fundamental contrasts of information versus physical reality, remote robotic versus in-person acquisitions of knowledge, representations versus originals that reside in the very heart of all information technology, and its continuing evolution which is the subject of this book. The ultimate limits of what can be done in cyberspace, or by any conceivable medium of communication, are the limits of the information revolution, and of *The Soft Edge*.

In addition to the expectations about the evolution of media with which we began, we will encounter throughout our journey a recurring set of characters, issues, and theories waiting to greet us almost each time we step ashore.

The first is what I call the Greek chorus of critics. Actually, only one, Socrates —and/or Plato—is Greek. And in most ways the chorus is not at all uniform, ranging from Socrates to Hitler in benefit and damage its members have otherwise bequeathed to the world. But both were vehement in their denunciation of the written word (Socrates in *Phaedrus,* Hitler in *Mein Kampf*), as are Karl Jaspers and Jacques Ellul in their attacks on the technological enterprise itself, Lewis Mumford and Neil Postman on electronic media, Gore Vidal and others on personal computers. What makes such criticism worthy of special attention is not that it is criticism—like Karl Popper, I believe that criticism is the

essential operating system of knowledge—but that it targets certain media, or fundamental human activities like technology itself, as the root of all evil in a given society, or as lethally incompatible with certain modes of thought and discourse. We will find in this volume that the first is never the case, and the second very rarely. Moreover, inasmuch as many in the scholarly world apparently take such media pessimism as obligatory (see, for example, the brief summary by Lohr, 1995), and assume that any optimism about media can only arise in people ignorant of such critiques, I make a point of highlighting its refutation by reality throughout this book, and the optimism that stands not ignorant of but after its defeated arguments. Socrates' claim that writing is incompatible with dialogue was battered by the printing press, and thoroughly put to rest by the advent of electronic text —a development that similarly contradicts Postman's contention that electronic media are incompatible with rational discourse, unwarranted even when first lodged against television.

Second, there is what might be called, in its best light, a political expression of the above concern about the negative impact of media. In its worst light, it is plainly an abrogation of the First Amendment to the US Constitution, and its guarantee that "Congress shall make no law… abridging the freedom of speech, or of the press." That fundamental safeguard of free expression received a grievous blow in the 1934 Federal Telecommunication Act, its establishment of the Federal Communications Commission in America, and subsequent legislation and Supreme Court rulings which held that broadcast media are a special kind of press whose speech can be abridged, to the point of censorship, by government. Print media also have been put under government pressure in this century—the worst instance being Richard Nixon's attempt to prevent *The New York Times* and *The Washington Post* from publishing the "Pentagon Papers" in 1971—but they generally stayed clear of legislated interference, until the new Telecommunication Act of 1996 and its prohibition of "indecent" written material on the Internet was passed by Congress and signed into law by Bill Clinton. Against these and frequent other occasions in history for government attempts to control the flow of information, I argue along with Milton, Jefferson, and Mill for the inherent rationality of people, our capacity to separate truth from falsity, identify garbage and teach our children about its dangers. We perform these tasks imperfectly, but far less so than government, which not only always fails in its high-minded intentions, but in the trying runs the risk of impairing the vehicles of free expression which are the best hope for improvement. This, indeed, is the real

threat, not only to rational discourse and freedom, but to the process of media evolution itself. If this book does nothing else, I hope it calls attention to the uselessness and peril of the Communications Decency Act (the section of the Telecom Act that applied to the Internet; see Chapter 14 in this volume). It not only deserved to be found unconstitutional; it never should have been enacted in the first place.

And, speaking of the evolution of media, this narrative comes woven with a theory of media evolution that I developed some two decades ago in my doctoral dissertation, "Human replay" (1979). As that title may suggest, the theory is simply this: All media eventually become more human in their performance—that is, they facilitate communication that is increasingly like the ways humans process information "naturally," or prior to the advent of given media. Voices on the telephone replace the dots-and-dashes of telegraph; color photography replaces black-and-white; and the fluid online written dialogue, more like speech in some respects than print, now is beginning to compete with older, paper media. That the older forms—telegraph, black-and-white photography, print on paper—were developed in the first place was due to the enormous extension across space and/or time, beyond our biological means of perception, that they provided. We were willing to put up with their tradeoffs, with their sacrifice of essential components of human communication, as long as we had no other way of communicating across such vast reaches. But the pressure remained for media that extended beyond biological barriers without dispensing with the voices and colors and immediacy of the natural world, and slowly the best of both is being obtained. This, of course, flies in the face of critics of the technological age in yet another way, by showing that "artificiality" is but a waning, early, condition of media. The reader will find this "anthropotropic" theory—evolution of media towards human performance—and its applications cropping up throughout our natural history of information technology, especially in Chapter 9, where we use it to explain why some media survive and others fail in their competition for human attention.

Like all works, this one makes use of the work of many others. Rather than thanking all of their authors here, I list them in the Bibliography.

But there are four people whose work has made a preeminent contribution to this volume—whom, moreover, I have personally known—and I therefore want to say a few words about each of them.

Marshall McLuhan (1911–1980), more than any other writer in history, created the very field of study of "media effects" and how they

make a difference. His observations and speculations light up nearly every chapter of this book—even those concerning personal computers, which came of age after his death —and who knows how many insights I picked up from him in the wonderful conversations we had around his home in Wychwood Park in 1977.

Donald T.Campbell (1916–1996) wrote articles rather than books, but they were more than enough to establish the discipline of "evolutionary epistemology" —the continuities and analogies between the evolution of biological organisms and the evolution of human knowledge that are the sails and sea winds of this voyage. I wrote "Human replay" and its Darwinian theory of media evolution just prior to reading Campbell's work, but I remember how thrilled I was to come upon Campbell's much larger, stronger, schema, and how pleased I was, sixteen years later in 1995, when he wrote of my then-new book, *Learning Cyberspace,* about "Levinson's career as an evolutionary epistemologist and exponent of Karl Popper's philosophy. Alone among us, he has extrapolated this philosophic framework to display the implications of the new information technologies." *The Soft Edge* is an attempt to further fulfill the challenge of that blurb.

The philosophy of Karl Popper (1902–1992) indeed plays a central role in this natural history too. More than any other thinker in the twentieth century, he systematically argued that our response to dogmatism need not be an anything-goes relativism, but rather a recognition of both the fallibility of our knowledge and its capacity for improvement via criticism and testing in reality. As a champion of reason in an alternately fanatical and cynical age, Popper's political contribution puts him in a league with Jefferson and Mill. As an epistemologist, he worked the same evolutionary fields as Campbell and laid the groundwork for my own extension of this approach to media, since technologies survive only to the degree that they embody some accurate knowledge of reality. In fact, I first came upon Campbell's work when researching *In Pursuit of Truth,* the *Festschrift* for Popper I edited in 1982.

The Foreword that I commissioned from Isaac Asimov (1920–1992) for *In Pursuit of Truth* constitutes the main evidence of our intersection prior to this book, but I have known his work far longer than any of the others, ever since I read his science fiction about robots when I was 10 years old. If this voyage were just one of history, Asimov would still be a relevant guide, since he is throughout his work a staunch advocate of human reason and its application in technology as the best means of our improvement. But when we turn to the future, Asimov's science fiction becomes an indispensable preamble. More so than any formal

philosopher of artificial intelligence, his stories about robots bring to life the hypothetical question of what we might do with these ultimate information technologies—and, indeed, after our history of what media have done, what remains in *The Soft Edge* and after is what that edge might do, which in turn is mostly a question of how we decide to use it.

Professors routinely thank their students, but in this case the tour of history and the future conducted here has been in motion since the "Intro to Mass Media" courses I taught at Fairleigh Dickinson University in the 1970s and 1980s, and indeed in the "History and Development of Mass Media" course I currently teach at Hofstra University. In between, courses in "Artificial Intelligence and Real Life" and "Popular Culture and the Media" I developed and taught at the New School for Social Research provided many occasions for refinement of some of the ideas presented in this book. Discussion of theories in classrooms and seminars provides uniquely useful clues for improvement, and I am grateful to all of my students over the years for helping in that process.

Special thanks go to my Editor, Adrian Driscoll, and the top-notch staff at Routledge.

The three people in this world with whom I have no doubt discussed the ideas in this book more than with any others are my wife, Tina, and our children, Simon and Molly. Innumerable dinners, breakfasts, walks on the beach, around the block, trips in the car, sprawlings in front of the television have been punctuated by some thought about media raised by me, or one of my family, and the conversations that ensued. If, in addition to the soft edge of the information revolution, there is a soft edge—a human awareness and dimension—in the way this book has been written, the credit belongs to my family.

Paul Levinson
White Plains, NY
May 1997

1
INTRODUCTION

"Natural histories" abound in scholarship and popular treatments of human affairs —a recently re-issued, not entirely inapt, example being Tabori's *The Natural History of Stupidity* (1993).

So why risk the danger of adding to Tabori's volume with a natural history of information technology?

The association is more than attractive, provocative packaging. Information and the structures that disseminate, preserve, and thus shape it are, in their very origin, natural: what else is DNA, and the living structures that it both shapes and is shaped by, if not a system of information technology *par excellence*? As the pioneer cyberneticist Norbert Wiener recognized—and clearly articulated (1948) —a half-century ago, biological and technological systems both run on patterns of information dispersal, including feedback, which was Wiener's greatest interest.

We should not be surprised, then, to find in the history of information technology, and in its current configurations and future projections as well, an evolutionary dynamic in many respects very much like that of the literally natural, organic world. This complex process of media evolution, of course different from as well as similar to the evolution of living things, will be the backdrop against which we will consider each of the episodes of information technology and its impact on the world in this book. Each of the episodes will be probed, in other words, not only in terms of its influence in its immediate human environment, but as an expression, clarification, on occasion refutation, of a larger theory of technological evolution also being developed in this book.

We begin, in this Introduction, with a brief description of some of the evolutionary dynamics of information technology.

INFORMATION TECHNOLOGIES COUNT

In the natural world, information not only counts on the genetic level in the ordering of proteins to form living structures, but on the environmental level, where living organisms daily face life-and-death encounters with all that surrounds them. Information about those surrounds is clearly crucial: the amoeba that lacks information about a noxious element in its vicinity may well embrace it and die.

Donald T.Campbell (e.g., 1974a) has shown how various modes of perception that have arisen in the organic world—touch, taste, smell, hearing, and vision— each provide a means of vicarious interaction with the environment, a knowledge which in some way allows the organism to encounter the environment from a distance, to embrace it without the possible payoff of immediate death. Two cardinal characteristics of this vicariousness, which will be considered extensively in our discussion of information technology in this volume, are that (1) it always entails some loss in accuracy of information, some potential for error, in comparison to the mere total embracing of any object in the environment (amoebas do not suffer from optical illusions), and (2) the particular sensory modes favored by the specific perceptual apparatus of any organism are crucial determinants of what the organism is, and how it functions in the world (sightless organisms live in a very different realm from those with vision, and indeed look very different, as well as differently).

In human beings, the vicarious mechanism of abstract thought and language works in all of the above ways. We, its possessors, have a palpable survival advantage over similar organisms that do not. To tell a group of hominids that there may be a lion a few hills away gives that group an edge not enjoyed by an otherwise equivalent group of chimps, whose only information about the possible lion comes from a member of its troupe frantically pointing and gesturing. Of course, abstract thought and language—facilitating the capacity to communicate about things not immediately present—also opens up large possibilities for lying. And these two consequences, the amplification of our survival as well as our capacity for error, are a fair shorthand for what we are as a species.

No information technology developed by humans since our emergence as thinking-speaking beings has come close to equalling, let alone exceeding or in any way replacing, the centrality of language as the essence of our species. But these technologies have had nonetheless, in more limited ways, a profound impact on our existence. We turn now to one useful means of categorizing that impact.

MEDIA DETERMINISM : HARD AND SOFT

The origins of speech and thought are so deeply entwined with our very emergence as a species that questions of which came first—abstract words or abstract thought—are very difficult to settle, as are issues of to what extent we were meaningfully human prior to our capacity for abstract language in its external and internal ramifications. I have argued for years (e.g., Levinson, 1979, 1988) that abstract thought at very least presupposes a capacity for its communication via abstract speech. Absent an ability to communicate abstractions, they provide limited evolutionary advantage: thinking a lion may be over the next hill the next day is hardly as effective, in terms of group/species survival, as speaking that thought to neighbors who can understand it.

The question of what role the powerful co-evolutionary combination of abstract speech and abstract thought may have played in determining our human existence is probably a bit easier to answer, though by no means uncomplicated. Clearly, abstract language (comprising speech and thought) is a necessary condition of our humanity: we could not be human without it. Whether language is a sufficient condition—meaning that its emergence made our humanity inevitable—is not as clear. Certainly other aspects, including bipedality and digital opposability, played crucial roles.

To the extent that an information system has an inevitable, irresistible social (or other) effect, media theorists refer to that relationship as "hard" media determinism. The relationship of abstract language to humanity comes closest to that extreme or ideal; the fact that it does not fully achieve it highlights a very profound point about information technologies and their impact on human beings, to wit, that media rarely, if ever, have absolute, unavoidable social consequences. Rather, they make events possible—events whose shape and impact are the result of factors other than the information technology at hand. Media theorists refer to this type of determinism as "soft."

To appreciate the difference between hard and soft determinism, consider the operation of information technology in creating organic structures and systems on the genetic level. Here the relationship of genotype to phenotype is not close to 100 per cent either—other factors like catalysts for the operation of DNA are significant—but there are clear pathways of cause-and-effect between DNA and organisms lacking (other than in metaphor) in the relationship of information technologies and social structures. Genes determine the colors of eyes in far less soft a manner than telescopes and microscopes applied to those eyes determine

the scientific revolutions that may ensue. Indeed, though neither relationship is absolute, or "hard," which means that each is actually a variant of soft determinism, we may reasonably call the genetic hard and the social soft.

Soft determinism, then, will be the *modus operandi* of all the social consequences of information technology we will be considering in this book. It is a system of making things possible—of the result not being able to occur without the technology—rather than the technology inevitably and unalterably creating that result. It is a system that operates synergistically in its power, meaning that other crucial factors played a role in the result. The elevator made the skyscraper possible. Clearly, tall buildings would never have been constructed were there not a way to get up and down them in a few steps. But equally clearly, architecture competent to construct tall buildings was also necessary. What good is a tall building with an elevator or escalator inside, if it crumbles in the first strong wind that comes along?

Provocative assertions of media theorists may appear to be claims of hard determinism, and have been derided as such, when in fact they are assertions of soft determinism, dressed to kill as hard. When McLuhan, for example, observes that "Had TV come first there would have been no Hitler at all" (1964, p. 261), he is claiming that the substance and style of Hitler's message found essential support in the intensely personal but faceless mass delivery of radio—an intimacy between speaker and audience shattered in the more arm's-length, antiseptic images of television. Such an assertion is provocative enough, but it is hardly an insistence that radio alone or inevitably brought Hitler or the Nazis into being. McLuhan's critics (see, e.g., *McLuhan: Hot and Cool,* edited by Stearn, 1967) often miss this. Obviously, Hitler was also the result of other factors and human choices—though, as we will explore in more detail in Chapter 8, the simultaneous mass acoustic audience created by radio resulted, even in open societies, in the two most powerful democratic leaders of the century: FDR and Churchill.

Soft determinism, then, entails an interplay between the information technology making something possible, and human beings turning that possibility into a reality. Human choice—the capacity for rational, deliberate decision and planning regarding media—is an ever-present factor in our consideration of the impact of media.

In the next two sections, we will briefly consider how human rational control of media has been and can be manifested, and then how media nonetheless seem to teem with unintended consequences.

HUMAN DIRECTION

Before we address the question of human control of media, we first must consider the larger issue of human control over any events at all. Do we have free will, or is everything we do determined (in a "hard" way) by our genetic programming, environmental influences, over-arching currents of fate in the cosmos, or whatever?

I have always found the most persuasive reason for rejecting such blanket determinism, and therein keeping the possibilities of free will in play, to reside in the recognition that were everything indeed so predetermined, so would this very text, so would your and my and everyone's consideration of this very issue be a complete sham or illusion. And since I believe with every fiber of my being that I most certainly have a choice in everything I write, not to mention a healthy suspicion for any argument that inherently undermines itself (to argue for total determinism, i.e., no free will, is to argue against the efficacy of argument itself, which plays no role in the predetermined outcome), I feel comfortable rejecting any doctrine of total determinism—scientific, religious, or otherwise. At the same time, I readily admit that this choice is one of emotion as well as reason—for my brief that argument counts may indeed be a self-reflective illusion—just as beliefs that the world is real, not my dream, or rationality is preferable to irrationality, are pre-rational, or choices which cannot be unparadoxically defended by reason alone (see Levinson, 1988, for more). As someone who believes that critical rationality is the best path toward progress, I'm not particularly happy about this; but as a critical rationalist, I have no choice but to admit it.

The invocation of free will as a fundamental principle, however, is no writ for a free ride in a universe in which anything goes. Free will comes with all manner of strings attached. For example, as I frequently point out to colleague devotees of science fiction (e.g., Levinson, 1994c), free will is incompatible with time travel to the future (unless we also claim an existence of cascading ever-emerging alternate realities), for if someone could travel to a time five minutes from when I was first sitting down to write at my computer, and look over my shoulder to see what I had written, then I would have no choice but to write just and only what the time traveler had seen.

And free will, of course, also entails responsibility: for to have control is to have responsibility about how we control. In a world in which free will operates, in which the impacts of media are possible outcomes

among which we may select and discard, mitigate and enhance, what control have we exhibited over our information technologies?

Unsurprisingly, as we will see in the very next section, the instances of human intention proceeding unimpeded from inception to invention to implementation are few in the realm of information technology. Indeed, unintended consequences of invention abound: Edison first thought his phonograph would be most used as a device for recording conversations on the telephone, which was in turn invented by Bell in pursuit of a hearing aid for his wife.

But there is an indirect, after-the-fact exercise of human rationality in media which is equally ubiquitous, and best captured in what I call the phenomenon of remedial media and the parable of the window shade:

Once upon a time, the only way we could look out of walls, necessary for our protection from climate and people alike, was to make holes in the walls. But these small holes resulted in our being rained on every time we used them in inclement weather. So, we invented the window. This information technology allowed us the protection of the wall from rainy, cold conditions even as we looked outside: the window was a wall, or a piece of a wall, that acted, informationally but not physically, like a hole. And therein was its great advantage.

But the advantage—like the advantage of all things evolutionary, and all things technological—was not without drawback. For as the window greatly enhanced comfortable perception from the inside out, it also enhanced easy perception from the outside in. The window brought into being the Peeping Tom. It increased our protection from climate outside the wall—for it replaced holes—but as it did this it decreased our protection from *people* outside the wall, at least insofar as they had increased informational access to the inside of our homes.

One very significant lesson we can derive from this is that all technological evolution—indeed, all evolution—entails tradeoffs. We who have vision and abstract language can be victims of optical illusions and lies which, as indicated above, are unknown to the lowly amoeba. So the window, like the vision it was designed to enhance, and the rationality that helped bring it into being, is a tradeoff.

But that same rationality allows us to do something more about tradeoffs than just accept them. Unlike the amoeba—and, indeed, all other living organisms, as far as we know—we can evaluate the tradeoff, and perhaps invent and bring to bear new technologies, remedial media, which improve the balance, if ever so slightly, in our favor.

And that is indeed what we did with the window. Rather than acquiescing to the Peeping Tom, or reverting back to holes in the wall,

we invented a battery of remedial media to give us the advantages of the window without its informational disadvantages: we invented window shades, Venetian blinds, all manner of curtains. Of course, these media do not bestow perfection—a window covered with a shade can still be broken into, whereas a wall cannot—but they do increase the ratio of benefits to drawbacks in this environment.

And we can see the operation of remedial media analogous to the window shade in diverse other media systems. Television once was criticized for its ephemerality, for the incapacity of its programming to be browsed before viewing, or captured for viewing or re-viewing in the future. These drawbacks were significant indeed, for they made television on a very basic structural level less amenable to human control than the book. Indeed, some of the more extreme critics of television (e.g., Mander, 1978) urged that it be abandoned entirely, if possible, in favor of the book. Fortunately, this advice, on a par with going back to walls in response to the problem of naked new-born windows, was not followed. Instead, we invented video-taping devices, which endow television with a reviewable past and a programmable future *vis-à-vis* the viewing audience. We might say that the VCR is to TV as the window shade is to the window.

As we will see in subsequent chapters (especially 10–13), the personal computer and its impact on writing can be seen as a remedial medium that addresses the inadequacies of writing lamented as far back as Socrates, who yearned for an "intelligent writing" which could respond to questions put to it, as in a dialogue, rather than preserving a "solemn silence" (Plato, secs 275–276). Of course, not all remedial media are invented for the corrective role they may come to play—computers certainly were not invented, in the first instance, as a way to improve upon the shortcomings of text wedded to paper.

Unintended consequences thus are pervasive, even in the deliberate application of human reason in the development of remedial media. We now take a closer look at this essential Darwinian process.

THE REVOLUTION OF UNINTENDED CONSEQUENCES

A fundamental tenet of Darwinian theory is that the generation of organic characteristics and organisms occurs independently of environmental influences— that is, the environment exerts its influence, makes its selection, after the organic characteristics have been generated. In this way, the environment's influence is expressed subsequent to its

encounter with an organism, which, if it survives and procreates, conveys genes that give rise to traits in some way compatible with the original environment.

This means that the gene pool and thus the generative process is far from random—the message in its code is rather at very least a blueprint for some kind of organic victory, or non-defeat, of the past. Moths, after all, do not come in all possible colors. The difference between all possible colors and the actual colors of moths is one measure of the non-random component of Darwinian generation.

But of the limited range of moth colors that are generated, those that survive at any given time do so because the color confers an advantage in a current environment. Moths whose wings are mottled in black-and-white, to use a famous example from England, once had an advantage over dark-colored moths in an environment in which lichen flourished on silver birch trees, and the resultant coloring rendered the mottled moths less visible to predatory birds. Soot from the Industrial Revolution reversed that advantage, killing the lichen and giving dark-colored moths the edge. Recently, however, we humans have cleaned up the air —a move healthy for us, but not for dark moths, which in the latest reversal of shades and fortunes find themselves easy prey against the lighter bark (see Yoon, 1996, for a parallel example in Detroit, Michigan).

In no case was the winning moth color the result of a plan or design; rather, the moth genotype generated a limited range of colors, and the color that prevailed was an unintended consequence of that color happening to be the same as the bark of the trees at a given time. In this sense, the survival of any organism is an unintended consequence of its characteristics—more precisely, the consonance of those characteristics with the current environment. And this capacity for any organic characteristic to suddenly fall in—or out—of favor relative to its environment makes evolution continuously surprising, or revolutionary.

Human technologies are of course the embodiments of their inventors' intentions. We might consider these intentions equivalent to the blueprints for past non-failure—the limited possible colors of moths —that comprise biological genomes. But as in organic evolution, the performance, impact, and survival of inventions in human society may not be in accordance with their inventors' intentions. The social environment in which the selections are made may change, like the lichen on the tree; the invention may wind up performing in an environment in which there are no trees at all, only shrubs and flowers. Bell's initial intention for his invention that became the telephone, as mentioned above, was a hearing aid. From the point of view of the

telephone, and its enormous impact on society, Bell's intention was as irrelevant as if the telephone had emerged as an unintended product of biological natural selection. Since the inventor's sphere of control by and large extends only to the embodiment of an intention in an invention—not to the marketplace of ideas, finance, and custom that will determine how the invention will be used, and how successful it will be in this use in satisfaction of human needs—technologies traffic in unintended consequences every bit as profoundly as biological organisms.

Certainly the most long-lasting and significant impacts of information technology throughout history were unintended consequences of their invention. When Gutenberg began printing Bibles in the mid-1400s, he had no idea that some fifty years later these Bibles would put teeth in Luther's thesis that people should read the Bible for themselves, rather than depending on Church interpretation— a dictum that was academic and unenforceable in a world in which every Bible had to be copied by hand. Thus, as we shall see in Chapter 3, was the Protestant Reformation made possible by the press. Its success, the first successful heresy against the Church in more than a thousand years, is a classic example of an unintended consequence.

Nor could Gutenberg have realized that the spread of reliable information by the press would stimulate the Scientific Revolution; the Age of Discovery via its printed descriptions of Columbus' voyage to the New World (his was certainly not the first—the Norse were there before Columbus—only the first after the presses were rolling); the rise of national states via the printing of vernaculars; and the rise of public education as a response to the urgent need to learn how to read engendered by the new availability of books. And, indeed, only with the wisdom of hindsight can we see how each of these threads stimulated and made possible the others—how the Church, weakened by the Protestant Reformation, was less able to oppose the gathering Scientific Revolution, whose success in turn further weakened the Church, which in turn allowed the fires of nationalism to arise and go forth in a bonfire of unintended consequences, a potent molten determinism that brought our modern world into being. Ultimately, this world would overtake in many ways the Chinese culture that had invented the very first printing devices, in perhaps the longest-range boomerang unintended consequence of all.

Of course, we have no such wisdom of hindsight regarding the impact of the computer and information technology in our own age. But after discussing the above and related impacts of the alphabet and the printing press, and the new world of electronic and photo-chemical media

—the telegraph, photography, motion pictures, radio, and television—that typified our informational lives until the past decade, we will turn our attention to the more speculative consideration of today's and tomorrow's media. To the degree that the consequences of these, like all technologies, are unintended, we can expect little guidance from their inventors and purveyors. Nonetheless, the mediation of human rationality in the fine tuning of information technologies can perhaps provide some grounds for reasonable expectations and predictions.

This constant assertion of human rationality is in the end what makes the information revolution different from the biological revolution of natural selection. At every turn, the impact of every medium is subject to an audience of human appraisal, expressed not only in ideas but in the behavior of utilizing a medium or not. Thus, unlike in the natural world, the selecting environment in technological evolution is a sentient one—imperfect in its capacity to learn, guided as often or more by emotion than reason, to be sure, but capable of learning and reason nonetheless.

With these two balancing factors in mind—the profoundly unintended consequences of any information technology, coupled with our capacity to appraise and perhaps adjust for its effects—we embark on our tour of the history and future of the information revolution, a tour of how this revolution has made our world possible, a tour of what worlds this revolution may make possible in the future.

2
THE FIRST DIGITAL MEDIUM
The alphabet and the rise of monotheism

Sometimes an idea can be too big for a medium to convey.

Consider, for example, the notion of a monotheistic deity, omnipotent, omnipresent, and—invisible. Difficult as it is for such an idea to be thought, spoken, and discussed, how would one draw a picture, even a stylized rendering, of it? How can visual representation be given to that which is everywhere and nowhere at the same time?

In ancient Egypt, the stylized visual representation of hieroglyphics was the dominant medium. Indeed, it was the only mode, other than the natural device of memory, for preserving the spoken word beyond its immediate and total physical decay. But unlike our alphabet, in which visual symbols represent sounds rather than images, the components of each hieroglyph were usually rooted in some visual depiction of the world. A stick figure of course is a poor rendering of a human being, but it is physically and literally derived from the human form in a way that the words "human being"—or any words, alphabetically written or spoken—are not.

One hundred and fifty years before Moses, Amenhotep IV (reigned *c.* 1372–1354 BC) had an idea about an all-powerful, ubiquitous, essentially formless monotheistic deity. As Pharaoh of Egypt, Amenhotep IV was the most powerful person in his realm. Who better than he to convey this revolutionary notion to his priests, his people, and their descendants? Moreover, Amenhotep IV seized upon a literally brilliant icon to portray this all-powerful, all-present deity that had no animal or vegetable form: the sun.

Amenhotep's glorious sun reformation—which also brought him the name of Akhenaton or Ikhnaton, after Aton, the disc-sun god—succeeded to the extent of his own reign (see Redford, 1984, for details). It ended with the death of his son-in-law, Tutankhamen, forgotten until uncovered by modern archeologists. The failure of such an idea to take hold after such a politically potent send-off, coupled with

the success of more or less the same idea in the hands of the politically powerless Hebrews a few years later, serves as one of the most important demonstrations in all of history of the power of media to make or break the ideas they carry.

For other than the extraordinary disproportion of temporal power in favor of the Pharaoh, the other significant difference between the two cultures is that the Hebrews sought to convey their monotheistic notion via an abstract alphabet— the origin of our alphabet—whose letters had no visual connection to anything on or off Earth.

Such letters, then, were far better repositories of an idea about a deity whose centers were everywhere—far better than even the sun, which, for all its inchoate, globally dispersed energy, is after all easily discernible as being located somewhere.

The Pharaoh's hieroglyphic failure and the Hebrews' alphabetic success in conveying the monotheistic idea is the story of this chapter, the first stop in our history of the information revolution.

MONOPOLIES OF KNOWLEDGE, AND THEIR JEALOUS GUARDIANS

Harold Adams Innis—Canadian economist, pioneer in media theory, and acknowledged mentor-from-afar of Marshall McLuhan—coined the phrase "monopolies of knowledge" (1950, 1951) to describe the way those in possession of scarce information technology hoard and wield the advantages it provides. Nowadays, we find such monopolies in limited linguistic areas, like the professional jargons that doctors and lawyers use to differentiate their special caches of knowledge from that of the lay public. Much is made of computer elites, and the monopolies of knowledge of those who have access to the Internet and Web (see, e.g., Rifkin, 1995, and Sale, 1995, summarized in Lohr, 1995; also Ohmann, 1985); but as we will see in detail later in this book, computer elites are in practice self-eliminating, because computers are getting both cheaper and easier to use.

Literacy probably constitutes the most significant monopoly of knowledge in human history. Our public education system is in effect predicated on breaking that monopoly of knowledge, or making sure it does not arise in the first place. Our open democratic society believes, quite rightly, that having access to knowledge of the day—not only via broadcast media available in this century, but to older, printed modes of communication that still provide the most depth of detail and analysis—is a cornerstone of healthy political existence.