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The Information Economy

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syntactical subtleties of words. Above all, it means being at home in a shifting mixture of words, images and sounds. Multimedia literacy makes us all skilled operagoers: it requires that we be very quick on our feet in moving from one kind of medium to another. We must know what kinds of expression fit what kinds of knowledge and become skilled at presenting our information in the medium that our audience will find easiest to understand.

We all know people who learn well from books and others who learn by hands-on experience; others, as we say in music, "learn by ear." Digital literacy greatly enhances our ability to suit the medium both to the information being offered and to the audience. Looked at one way, this new sensory targeting makes communication more efficient. Looked at another, it simply makes it more fun.

The multimedia mixture of talents was last advanced as an aristocratic ideal by the Renaissance humanists. The courtly lord and lady were equally accomplished in poetry, music and art. The Renaissance ideal now presents itself, broadened in scope and coarsened in fiber perhaps, as the common core of citizenship in an information society.

At its heart, the new digital literacy is thus profoundly democratic. It insists that the rich mixture of perceptive talents once thought to distinguish a ruling aristocracy must now be extended to everyone. It thus embodies fully the inevitable failures, and the extravagant hope, of democracy itself.

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# The Information Economy

## *How much will two bits be worth in the digital marketplace?*

by Hal R. Varian

Advances in computers and data networks inspire visions of a future "information economy" in which everyone will have access to gigabytes of all kinds of information anywhere and anytime. But information has always been a notoriously difficult commodity to deal with, and, in some ways, computers and high-speed networks make the problems of buying, selling and distributing information goods worse rather than better.

To start with, the very abundance of digital data exacerbates the most fundamental constraint on information commerce—the limits of human comprehension. As Nobel laureate economist Herbert A. Simon puts it: "What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." Technology for producing and distributing information is useless without some way to locate, filter, organize and summarize it. A new profession of "information managers" will have to combine the skills of computer scientists, librarians, publishers and database experts to help us discover and manage information. These human agents will work with software agents that specialize in manipulating information—offspring of indexing programs such as Archie, Veronica and various "World Wide Web crawlers" that aid Internet navigators today.

The evolution of the Internet itself poses serious problems. Now that the Internet has been privatized, several companies are competing to provide the backbones that will carry traffic between different local networks, but workable business models for interconnection—who pays how much for each packet transmitted, for example—have yet to be developed. If interconnection standards are developed that make it cheap and easy to transmit information across independent networks, competition will flourish. If technical or economic factors make interconnection difficult, so that transmitting data across multiple networks is expensive or too slow, the largest suppliers can offer a significant performance advantage; they may be able to use this edge to drive out competitors and monopolize the market.

Similar problems arise at the level of the information goods themselves. There is a growing need for open standards for formats used to represent text, images, video and other collections of data, so that one producer's data will be accessible to another's software. As with physical links, it is not yet clear how to make sure companies have the right economic incentives to negotiate widely usable standards.

In addition to standards for the distribution and manipulation of information, we must develop standards for networked economic transactions: the actual exchange of money for digital goods. There are already more than a dozen proposals for ways to conduct secure financial transactions on the Internet. Some of them, such as the DigiCash system, involve complex encryption techniques; others, such as that used by First Virtual, are much simpler. Many of these protocols are implemented entirely in software; others enlist specialized hardware to support electronic transactions. "Smart" credit cards with chips embedded in them can perform a variety of authentication and accounting tasks.

Even when the financial infrastructure becomes widely available, there is still the question of how digital commodities will be priced. Will data be rented or sold? Will articles be bundled together, as is done today in magazines and newspapers, or will consumers purchase information on an article-by-article basis? Will users subscribe to information services, or will they be able to buy data spontaneously? How will payment be divided among the various parties involved in the transaction, such as authors, publishers, libraries, online services and so on? Not one of these questions has a definitive answer, and it is likely that many market experiments will fail before viable solutions emerge.

The shared nature of information technology makes it crit-



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ical to address issues of standardization and interoperability sooner rather than later. Each consumer's willingness to use a particular piece of technology—such as the Internet—depends strongly on the number of other users. New communications tools, such as fax machines, VCRs and the Internet itself, have typically started out with long periods of relatively low use followed by exponential growth, which implies that changes are much cheaper and easier to make in the early stages. Furthermore, once a particular technology has penetrated a significant portion of the market, it may be very difficult to dislodge. Fortunes in the computer industry have been made and lost from the recognition that people do not want to switch to a new piece of hardware or software—even if it is demonstrably superior—because they will lose both the time they have invested in the old ways and the ability to share data easily with others. If buyers, sellers and distributors of information goods make the wrong choices now, repairing the damage later could be very costly.

This discussion about managing, distributing and trading in information is overshadowed by the more fundamental issue of how much data authors and publishers will be willing to make available in electronic form. If intellectual property protection is too lax, there may be inadequate incentives to produce new electronic works; conversely, if protection is too strict, it may impede the free flow and fair use of information. A compromise position must be found somewhere between those who suggest that all information should be free and those who advocate laws against the electronic equivalent of browsing at a magazine rack.

Extending existing copyright and patent law to apply to digital technologies can only be a stopgap measure. Law appropriate for the paper-based technology of the 18th century will not be adequate to cope with the digital technology of the 21st; already the proliferation of litigation over software patents and even over the shape of computer-screen trash cans makes the need for wholesale revisions apparent.

Computer scientists have been investigating various forms of copy protection that could be used to enforce whatever legal rules may be put into place. Although such protection often inconveniences users and requires additional hardware and software, ubiquitous network access and more powerful machines may eventually allow for unobtrusive and effective protection. File servers, for example, can track who owes how much to whom for the use of particular information, and documents can be subtly encoded so that investigators can trace the provenance of illicit copies.

Faced with such a daunting list of problems, one might be led to question whether a viable information economy will ever take shape, but I believe there are grounds for optimism. During the 1980s, 28,000 for-profit information libraries sprang up in the U.S. alone. Every week more than 50 million people visit these facilities, where they can rent 100 gigabytes of information for only two or three dollars a day.

Although these video rental stores faced many of the same problems of standards, intellectual-property protection, and pricing that the Internet faces today, the industry grew from nothing to $10 billion a year in only a decade. Ten years from now we may find the economic institutions of the information economy a similarly unremarkable part of our day-to-day life.

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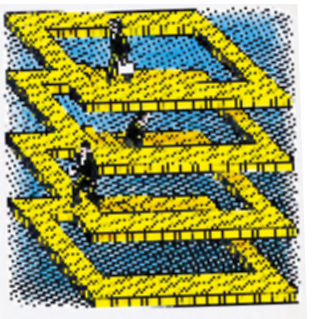
# The Emperor's New Workplace

## *Information technology evolves more quickly than behavior*

by Shoshana Zuboff



According to the U.S. Department of Commerce, 1990 was the first year capital spending on the information economy—that is, on computers and telecommunications equipment—exceeded capital spending on all other parts of the nation's industrial infrastructure. Scholars and commentators have cited these data as evidence the U.S. economy is now firmly rooted in the information age. They routinely declare that an "information economy" has replaced the industrial economy that dominated most of the 20th century. I heartily dissent.

In a true information economy, information is the core resource for creating wealth. Constructing such an economy demands more than just a proliferation of computers and data networks. It requires a new moral vision of what it means to be a member of an organization and a revised social contract that binds members of a firm together in ways radically different from those of the past. So far patterns of morality, sociality and feeling are evolving much more slowly than technology. Yet without them, the notion of an information economy is much like the foolish emperor of the fairy tale, naked and at risk.

A historical perspective makes the problem clearer. Early in the 20th century an organizational form—the functional hierarchy—was invented to meet the business challenges of increasing throughput and lowering unit costs. Business processes were divided into separate functions—manufacturing, engineering, sales and so on. Other innovative features included mass-production techniques, the minute fragmentation of tasks, the professionalization of management, the growth of the managerial hierarchy to standardize and control operations, and the simplification and delegation of administrative functions to a newly contrived clerical workforce. Collectively, these components were incredibly successful; they came to define the modern workplace.

The industrial hierarchy rested on the premise that complexity could constantly be removed from lower level jobs and passed up to the management ranks. That is, clerks and factory workers became progressively less involved in the overall business of a firm as their jobs were narrowed and stripped of opportunities to exercise judgment. Automation was a primary means of accomplishing this. Meanwhile the manager's role evolved as guardian of the organization's centralized knowledge base. His legitimate authority derived



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