
The Knowledge Economy: The Nature of Information in the 21st Century

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This is a collection of research papers intended to provide a broad perspective on the nature and uses of information as we enter the 21st century. It can be particularly valuable to information systems executives and professionals by providing them with a stimulus to step back from their day-to-day activities and a framework in which to view their work in a larger context.

The research was sponsored by The Institute for Information Studies (IIS). IIS is itself interesting: it is a joint program of a high tech manufacturing enterprise, Northern Telecom Inc., and The Aspen Institute, a liberal arts-oriented educational organization which is an intellectual descendent of the University of Chicago's Great Books program.

One result of this collaboration is a focus on the impact of information technology on the larger society of which it is a part. The theme of the book is "... to examine information as a resource to be shared, not owned; to consider whether and how the availability of and access to new technologies are causing or influencing change in the nature and definition of information; to demonstrate how these changes are affecting the fields of education, economics, sociology, technology, business, and world affairs."

Neither the authors nor the editors make any claim that these are the only issues of importance, or that any of them has been dealt with here in a definitive way. Rather, their avowed purpose is to provide some useful insights into these issues and to stimulate discussion and debate about them. The book succeeds admirably on both counts. The insights are indeed useful and important. This review is a contribution to the debate.

The book consists of an introduction by Nicholas Johnson and six papers. We first examine the individual sections separately, and then attempt to place them in the overall context of information in the 21st century.

Like all collections of papers, this one contains some duplications and some contradictions. In this instance, these are all to the good. None of the matters discussed is settled; disagreement and controversy will help us clarify the issues and begin to resolve them.

In the Introduction, Johnson describes each paper briefly, and then provides an overall view of the nature of information. He develops and discusses a number of categories of information. Some are standard categories such as transactional information, consumer information, and management information. Others are somewhat unconventional: hobby information, entertainment information, and educational information. He identifies certain qualities of information which transcend categories: accuracy, timeliness, relevance, efficiency, form, and level of abstraction.

The diversity of the examples provides a springboard for posing the central questions of the book. What is the nature of information and how is information technology changing it? How will this new information and the related technologies change our lives?

"The Role of Technology in an Information Age: Transforming Symbols Into Action" by Stephen H. Haeckel and Richard L. Nolan.

Haeckel and Nolan discuss the ways in which the nature of information is changing in the context of a business organization. They show how an appropriate information technology infrastructure can be used to transform information from a role of passive support of business operations to an active creator of wealth. Their analysis of enterprise modeling (as it should be done) and its relationship to a learning organization is at once simple and profound.

Contemporary information technology can alter the nature of information in four ways: by processing it more rapidly, by

connecting more users to more information sources, by sharing information among users to increase their abilities to work together, and by restructuring information into more useful forms (by means of mathematical models, expert systems, etc.). However, this enhanced information can only provide value if it is used. Most current uses of information, enhanced or not, support current business operations. But the technology, properly applied, can do much more: it can enable an organization to learn to do new things.

Learning by a human being can be thought of as a four-step process, repeated many times: sensing (observing) what is going on in the external world, interpreting the observations, deciding what to do, and acting to carry out the decision. The results of the actions are observed, new interpretations generated, decisions made to take new actions, and the new decisions acted upon. As the process is repeated, the person comes to know more about her environment and the effects of her actions: she learns.

Organizations can learn in a similar way, given the proper information tools. Many of them are already in place: data gathering systems, telecommunication systems, decision support systems, etc. What remains is to establish a view of the enterprise as whole so that individual decisions and actions contribute to enterprise goals, and to develop a mechanism for modifying goals and decision-making processes as the world changes.

The first step is enterprise modeling: documenting the set of business processes which define the enterprise. Note that this is a business model, not an information model, and it must be built by business people, not information technologists (although information technologists may be able to help). The business model is an abstraction that describes the business in terms of "what we do around here and how we do it."

A learning organization is one where the organization can change its business model (and thereafter its related processes). One way that the potential for a learning organization can be realized is to put the business model in computer-sensible form, and *build tools so that the business model itself can be changed, automatically or by people, as the world changes.*

Consider a fully automated sales processing and production control system which stops production of an item when sales fall below a profitable level. Twenty years ago a company which had this capability would have been considered to be a "learning organization" (if the term had been in existence then). Today it is simply automation of a well understood activity, one which we have learned to do.

Creating a learning organization is a difficult and dangerous task. No one has much experience yet, so we don't clearly understand either the problems and or the risks. The enterprise model can provide both an anchor in the present

and a chart into the future.

"The Economics of Information: A User's Guide" by Roger C. Noll.

Roger Noll provides an economist's view of the economics of information. He suggests that some of the unique aspects of information as an economic entity are not well understood and that as a result, some public policy decisions have perverse consequences. He lists a number of areas where research in the value of information is taking place, but deals in depth with just two: the unusual economic characteristics of information, and the value of information when it used to decrease uncertainty (statistical decision theory).

Information (as distinguished from the means of its delivery) is an example of what the economists call a "public good." The cost of the initial production of information does not depend on how many people use it (although the cost of distribution does), and its possession and use by one person does not interfere with its possession and use by others. The total cost to society of a given use of information is the user's cost of using it (usually time), the cost of distribution (the cost of printing one copy of a book or a newspaper, or a connection charge of an on-line information service), and a share of the cost of producing the information in the first place. Noll asserts that "... as a matter of harsh fact completely efficient production and distribution of information is impossible if ... it must recover [from every user] ... some portion of the ... cost of producing it." His reasoning is that there will always be some potential users who could use the information and can afford to pay the costs of distribution and use but are unwilling or unable to pay their share of the costs of initial production. He recommends some kind of variable pricing in which users who do not value the information at full cost can pay some lesser cost, so long as it is greater than the cost of distribution.

This problem and this solution are hardly unique to information, or to public goods. Every capital intensive business from garment manufacturing to operating an airline faces the same situation. The garment manufactures use seasonal clearance sales and factory outlets as ways of variable pricing. The airlines use yield management: they offer different fares to different customers with the goal of selling every seat at whatever price the market will bear above the variable cost of filling it. Book publishers "remainder" unsold copies at very low prices. We have many mathematical models which enable us to develop effective strategies to maximize the profits under conditions of variable pricing, but there has been little formal application of them to the distribution of information.

Noll examines the value of information from the point of view of statistical decision theory. It asserts that information creates value by decreasing uncertainty so that decision mak-

ers can make better economic decisions. There is an important distinction between the value of information to an individual and the social value of information. A computer system for trading stocks may help one individual decrease his uncertainty and therefore make better decisions and more money. However, if many people use the same system, the aggregate effect on the market may be to make it unstable, to everyone's cost.

The perverse public policy effects come about for several reasons. One is that policy makers often do not understand the complex relationships among fixed costs, variable costs, prices, and sales volumes. (Neither do many private business people, but that is another story.) Another problem for public policy makers is that they must show evenhanded treatment of all who want information, which makes it very difficult politically to institute variable pricing.

Noll describes one example of perverse effects: the federal government has instituted a program to encourage cooperative research between public and private laboratories. Dissemination of information about this program has been put into the hands of a private contractor, who charges (so Noll asserts) far more than the cost of distribution. This denies information about the program to at least some potential users, thus defeating the very purpose of the program. There is an easy cure for this problem: allow competitive providers disseminate the information. The costs of distribution will soon fall to a level which provides only a reasonable return on the investment of the distributors.

He concludes that information and information technology offer opportunities to redistribute wealth and that government policies can effect this redistribution. In this he is undeniably correct. He also concludes that the redistribution will be from consumers to producers, which is not necessarily true. The net effect of the airline reservation systems (accompanied by deregulation of fares) has been to give consumers enough information about fares to force the airlines into ruinous price wars, transferring wealth from the airlines to their customers. He also concludes that the redistribution is from the less educated to the more educated. What he overlooks in this analysis is that the total amount of wealth in the world is not constant, and while the less educated (whatever that means) may have a smaller percentage of wealth, they certainly have a larger absolute amount than before.

“Competing with Information: Empowering Knowledge Networks with Information Technology” by Blake Ives and Sirkka L. Jarvenpaa.

Ives and Jarvenpaa provide an excellent exposition of the interactions between organizations and information technology as information becomes a key corporate resource in an increasingly competitive world. They show why non-hierarchical organizations will come into being and how they

will operate and compete.

The most important drivers of business changes are the increasing turbulence in business and commerce and the globalization of nearly every significant enterprise. Businesses must respond more quickly than ever to changes in customer demands, changes in technology, and changes in the marketplace. This means they must have rapid access to information and knowledge of all kinds. Information technology permits “electronic migration” of skills and expertise, so that work can be assigned around the globe to wherever it is most cost effective. Taken together, these things imply that hierarchical organizations probably cannot compete successfully in many markets. They are being supplanted by various kinds of “networked” organizations whose primary characteristic is the relative independence of each unit in managing its own activities. Effective cooperation and coordination among units is possible only with highly developed information systems.

Moving from a hierarchical organization to a networked organization is a major trauma both for the organization and for the people in it. The process usually begins with reengineering business processes, itself a difficult and contentious affair. Unfortunately, the companies which need reengineering most are those in which it is most difficult to do. There are many reasons for this, but most of them revolve around people. The best people to do the reengineering are those who work in the process, and they are the very people who are likely to be adversely affected by the changes reengineering brings.

The idea of competing with information has become part of the accepted business wisdom of our times. But it is not easy and many companies will not succeed. There are four major problems. First, there is the legacy of the old organization. Hierarchies organized to operate in a stable environment, often built on economies of scale and long production runs, do not easily change to networked organizations capable of rapid change. Second, information technology has its own limits. Systems are not as flexible or user-friendly as we would like them to be, and lack of standards and common systems often stymies efforts to conduct business process across organizational boundaries. The third barrier is that there is a cost of acquiring information and making it available. Whether this cost is generated internally or externally, some person or organization is creating information for use by someone else. The creator must be compensated or the information will not be available. Finally, the networked organization with its ubiquitous information systems will change the relationship between worker and employer. Personal privacy may suffer, and the empowered worker may have the right to “work himself to death.”

The authors have constructed a provocative mini-case to illustrate that some of the information technology issues

involved in managing a global company. In addition to providing interesting insights into the problems at hand, it illustrates a problem which every author faces in writing about this topic. The case, as presented, displays a clear bias in favor of common applications across the globe, resulting in an integrated, centrally managed information system for the enterprise. The authors know that this is not necessarily the right answer, but it is not possible to convey the complexity of the problem within the confines of a few pages.

This is a fine short exposition of a central problem in managing information technology.

“The Promise of a New World Information Order” by Peter F. Cowhey and M. Margaret McKeown.

Cowhey and McKeown see the information order prior to 1970 to the new world order of the 21st century: a “little bang” which took us from the 1970s to the 1990s, followed by a “big bang” which may happen if we make the right policy choices.

Prior to the 1970s, communication by telephone and telegraph were luxury goods, sold at high prices by government-owned or government-protected monopolies. Broadcast media were also government-regulated monopolies, with content as well as conduit controlled to a greater or lesser extent.

The little bang occurred as information technology gradually eroded the ability of these monopolies to control their markets. Cable television and video cassette recorders gave video consumers options beyond monopolistic control, just as alternate long distance carriers provided choices to telephone users.

The world is at the threshold of the big bang — the changes that will come as wide band digital technology proliferates. Public policy choices we make over the next several years will determine when we will cross this threshold and what we will find on the other side.

The United States has followed its tradition of relying on the marketplace by opening long distance telephony to competition, and is in the process of doing the same with cable and local telephone service. Our system encourages new entrants into all markets, both old companies entering new fields and new companies formed explicitly to exploit new technological opportunities. We have also been very aggressive in developing mechanisms to secure intellectual property rights for the creators of new information technologies. The big winners have been the users of the technology, both personal and business.

The European Community (EC) has taken an approach based on EC-wide consistency, mandating the development of standards and putting technological innovation largely in the hands of existing equipment manufacturers and government-owned telephone companies. The winners have been

these large enterprises. Japan has encouraged new entrants but under very constricting regulatory policies, limiting market segments that individual companies may serve and forbidding price competition in some lines of business. The winners have been large commercial users who have taken equity positions in the vendors of information technology, effectively buying from themselves. The losers have been the consumers, and Japan as a whole. The administrative guidance of the government has resulted in some monumental failures (high definition TV) and many delays in introducing new technologies, for example, cellular telephones.

This history suggests that there are four important public policy areas that will influence the growth and dissemination of new information services and new information technologies: the rules of competition, the nature of the technological infrastructure, rules about intellectual property and transborder data flow, and ways to assure that the less developed countries are not left behind. The U.S. experience shows that the competition works to the benefit of consumers. The more competition, the sooner we will achieve the benefits of the big bang, and the greater those benefits will be. But competition won't come automatically because it attacks too many vested interests in Europe and in Japan. (There are some in the U.S. as well.)

The authors assert that the U.S. has much to learn from the European Community and from Japan about building the technical infrastructure, setting standards, and government research and development. They favor the technocratic solution of global standards as “essential to interconnecting the pieces of the information landscape.” They then cite as evidence a fact which directly contradicts this idea: “There is a brisk business in products to bridge incompatible standards.” In other words, when there are not standard interfaces, entrepreneurs will build substitutes and connections will take place.

In one sense, it would be convenient if there were global standards for information technology; but in the real world, those standards would be the lowest common denominator of what worked pretty well ten years ago (when the standard setting process started). Even if standards were to be set at the rapid pace that the EC has proposed (but has not yet attained) the standards would still be a consensus which would preclude many important new ideas. What standards committee, five years ago, would have addressed ATM (Asynchronous Transfer Mode) communications or 32-bit architecture for desktop computers? What Japan and the EC must learn from the U.S. is to accept the disorder and temporary inefficiencies of a competitive system in order to encourage bold innovations. What the U.S. must learn from Japan and the EC is not to repeat the mistakes of MITI (Japan's Ministry of International Trade and Industry) and the Brussels bureaucrats.

The issue of ownership of intellectual property is a much thornier one. In essence all intellectual property laws are anti-competitive. A patent grants to the inventor exclusive rights to her invention. A copyright prevents others from copying without permission of the owner. We have seen cases where ownership of a patent has stifled innovation by discouraging follow-up inventions. But we also know that if there were to be no patent protection (that is, no government-granted monopoly for inventors) there would be much less invention of socially useful things. We are left once again with an ambiguous situation. In the interests of society as a whole, there should be some monopoly for an inventor, but how much? Traditionally, patents have run for 17 years in the United States. Maybe that is the right number for information technology inventions; maybe a shorter period would be better. As a practical matter, there is not much we can do other than experiment.

The most important thing for the developing countries is to move into the information age so that they can be players in the marketplace for services as well as the marketplaces for natural resources and manufactured goods. The authors provide a compelling argument for the position that a highly competitive environment with some protection for intellectual property is in the best interests of the developing countries.

In summary, the authors believe that public policies should encourage competition, protect intellectual property, and provide for some government help with the infrastructure, research and development, and the standards setting process. Broadly I agree, but I put much less reliance on the government and much more reliance on the private sector. They refer to Internet as "arguably the most successful example of government-sponsored innovation in the information industry. ... a wildly successful exercise in subsidized anarchy ..." That should be our policy goal if we insist on governmental involvement: subsidized anarchy that is wildly successful.

"Technology, Information and Social Behavior" by Sara B. Kiesler and Pamela Hinds.

Liesler and Hinds examine the effects of E-mail and network-based bulletin boards on social behavior, mostly within organizations. They suggest a framework for thinking about the effects of information technology which differentiates between its effects on employees at the core of an organization (such as executives and members of corporate staff) and those at the periphery (salespeople, branch office personnel, etc.) This framework suggests examining whether additional information (provided by new information technology) has more effect on those at the core, more effect at those on the periphery, or about the same effect on both.

Qualitative and anecdotal arguments can be made for each of these mutually contradictory hypotheses, and em-

pirical studies can be found which support each. This simply shows that the question is ill-formed. The differential effects of information and information technology depend on the structure and the culture of organization. Previous research has identified a number of contextual factors as important determinants of the differential effects of new information technologies: (1) the managerial philosophy which drives the firm, (2) previous history of labor relations, (3) size of the company, (4) clerical intensity, (5) growth rate, (6) intensity of competition, (7) sponsorship of the new technology, and (8) the intrinsic dullness of the work involved.

There are two lines of thought which suggest that, within most organizations, the proliferation of information technology will have more effect on those at the periphery, giving them a position of power more nearly like that of those at the core. The first has to do with E-mail. Nearly all research on E-mail shows that it tends to democratize organizations which employ it. Workers are much more prone to express themselves freely with E-mail than with other forms of communication, to superiors as well as to peers. More important, the telecommunications networks which support E-mail also support bulletin boards. Bulletin boards tend to erode central control of any organization. In many cases they are self-formed organizations, and in every case the content is largely beyond the control of central authority.

The other force driving information technology to enhance the relative power of those at the periphery is business competition. We are learning that in many lines of business (some would say in all businesses), the hierarchical organization is a competitive dinosaur. Information technology is making it practical to empower workers at the periphery to do what has been the work of the core.

Some of the research referred to above showed that the effects of information technology depend on organizational context. The converse is also true: information technology can change organizations in profound ways.

"Network Literacy in an Electronic Society: An Educational Disconnect?" by Charles R. McClure.

In the paper described immediately above, the authors dealt with questions of how information technology can affect corporate culture and power structures. Here, McClure examines some of the implications for society as a whole of telecommunications networks and the information they can make available.

Individuals who use Internet (variously estimated at twelve to fourteen million people) already have a staggering amount of information available to them. As our national information infrastructure develops, many more people will gain access and even more information will be available.

There are social and economic forces which virtually guarantee that access to information via telecommunications

networks will become increasingly important to everyone. Entertainment and person-to-person communication are leading the way, closely followed by computerized credit information, tele-shopping, and individual medical records on line for remote access by traveling individuals and therapists at remote locations. Yet in the face of these emerging needs, most of our citizens have no skills in using information networks, and the country has no coherent program for teaching them these skills.

Network literacy is the ability to use a network to find, retrieve, and use information in pursuit of personal goals. It is analogous to traditional literacy, which is the ability to use written language for the same end. McClure defines "information literacy" as the intersection of traditional literacy, network literacy, computer literacy, and media literacy (the ability to extract and use information from media other than language). An individual who is information literate, so defined, is in classical terms an educated person. Thus the issue of network literacy can be addressed in terms of how it supports the processes of education, both current and potential.

There is little general agreement about the problems of network literacy, and no well established public policies addressing this question, although some are emerging. Some of the important issues are developing widespread awareness of the importance of network literacy, reaching agreement about what constitutes network literacy, revising our policy framework, and reinventing our libraries and educational practices to take it into account.

The most important social issue is how to prevent the development of an "information underclass": a group of people who cannot or will not use the information network and are thus excluded from the mainstream of American life. Two ideas are suggested. One is that the public library system become an information safety net, providing computer terminals, work space, etc. for access to the information network. The other idea is that educational curricula at every level be revised to explicitly include instruction in use of network-based information resources.

As we attempt to deal with the problems of network literacy, it becomes clear that there are many important things

which we simply do not understand. We need analysis of current social policies concerning access, privacy, and many other issues of network utilization. We need research on the effects of network utilization on individual productivity. We need to understand who the current users are, demographically, and how usage is changing. We need to develop programs for teaching and using the technologies in support of educational processes.

Several important themes run through this book. One is the peculiar nature of information as an economic entity. From the point of view of the discipline of economics, it is neither a good nor a service; it is something else, something we do not yet clearly understand. From the point of view of an enterprise, we do not know how to judge its value, beyond cost displacement and the statistical decision theory idea of the value of reducing uncertainty. Yet the main opportunities for use of information (and for spending money on information) lie beyond these two categories.

The most provocative idea is that information technology may change the nature of information. It is suggested that real time information is intrinsically different from old information, that the sheer volume of information available from Internet changes the information qualitatively as well as quantitatively, that information which allows an organization to learn is somehow different from information which allows it to operate, that graphical and video information are intrinsically different from other information. Again, we are in an area where there are many more questions than answers.

It is undeniable that public policies will have a major effect on the use of information in the 21st century. There is an activist tone to several of the papers which seems to imply that effective public policies require governmental or other bureaucratic actions: plan an educational program, organize the standards setting process, etc. In many cases this is exactly the wrong thing to do. The best answers often emerge from the chaos of the marketplace rather from the minds of planners, academics, or bureaucrats.

A stated purpose of this volume is to act as a catalyst for the curious and thoughtful reader's creativity. It did for me, and I think it will for you.