Introduction 1

Few businessmen in the late 19th century were aware of how fundamentally machinery, transportation, electricity y, and communications technologies would change their lives. Most people could not foresee the profound social changes that these technologies would bring—the shift from an agricultural to an industrial-based economy; the exodus of people from rural communities to urban areas; the transformation of work from craft production to mass production; and the decl ine of small, proprietary business in favor of large, vertically integrated firms. Although revolutionary in their ultimate effect, the changes wrought by new technologies took place in an evolutionary fashion. Moreover, these impacts were both positive and negative, requiring considerable time and social and economic restructuring before they could be fully absorbed.

The United States is currently in the midst of a similar transition created in part by advances in communication and information technologies. These technologies have already transformed the structure, the markets, and the regulation of the communication industry, altering the ways that information is created, processed, transmitted, and delivered to consumers. Similar changes are taking place throughout the world. New communication and information technologies are making information products and services more available across national borders, wearing away the lines of demarcation between markets and communication systems that are considered domestic and those that are considered foreign.

These technological developments are radically altering the U.S. economy and changing the way that business is conducted. Markets are expanding globally; business organizations are streamlining: what we normally think of as a firm is becoming

Information and communication technologies will not only affect the nature of business organizations; they will also have considerable impact on the size, structure, and openness of markets.

blurred; some worker skills are becoming obsolete, requiring workers to be retrained; and production is being carried out "just-in-time" on a flexible schedule, rather than being mass-produced. These changes are fundamental and far--reaching. They challenge some traditional economic notions and definitions of terms such as the firm, competitive advantage, productivity, and economic performance.

The implications of these developments for business and the economy—as well as society as a whole—may only be fully appreciated by a few at this time. However, business leaders who take advantage of what these technologies have to offer will gain competitive advantages, while those who fail to recognize their potential will likely experience decline. To the extent that policy makers and businesses grasp the implications of these developments, they can make knowledgeable choices about how the nation will deal with them and take steps to offset their negative consequences. Unlike the lawmakers and businessmen at the turn of the century, who only reacted after new technologies had restructured their society, citizens today have an opportunity to comprehend and prepare for the radical changes taking place.

PURPOSE AND SCOPE OF THE STUDY

The study was requested by the Senate Committee on Science and Transportation and the House Committee on Science, Space, and Technology. The report identifies and frames the technological, economic, and societal issues related to the use of electronic networks for business and commerce. It provides neither cookbook solutions nor simple fixes for the complex problems raised by rapidly expanding uses of communication and information technologies by business and industry. The report is intended to contribute to the discussion and debate that will take place as the concept of a National Information Infrastructure (NII) moves from vision to reality.

This report describes and analyzes how advances in communication and information technologies will likely affect the future of American business and the national economy. It identifies the new opportunities that these technologies afford, as well as the technological, social, and economic conditions needed to take advantage of them. In addition, it describes and assesses the policy implications raised by electronic business networks; identifies where tradeoffs among values and stakeholders will need to be made; develops a framework and strategy that can be used to advance the debate; and suggests criteria for judging the options that Congress might consider.

This report is the latest in a series of OTA reports that address many of the technical, regulatory, and economic issues that communication and information technologies have raised. Prior OTA reports have addressed:

1. network and personal privacy;
2. electronic dissemination of government information;
3. delivering government services electronically;
4. managing radio frequencies for wireless communications;
5. protecting intellectual property in electronic environments;
6. the technology of advanced network design; and
7. the development of technical standards.]

In addition, OTA has several studies currently underway that address the use of the National Information Infrastructure for improving health care

[1] See the following publications from U.S. Congress, Office of Technology Assessment (Washington, DC: U.S. Government Printing Office): *Informing the Nation: Federal information Dissemination in an Electronic Age* (OTA-CIT-396, *1988); Critical Connections: Communications for the Future* (OTA-CIT-407, 1990); *Electronic Bulls and Bears: Securities Markets and Information Technology* (OTA-CIT-469, *1990); Global Standards: Building Blocks for the Future* (OTA-TCT-5 *12, 1992); Finding a Balance: Computer Software, intellectual Property, and the Challenge of Technological Change (OTA-TCT-527, 1992); The 1992 World Administrative Radio Conference: Technology and Policy Implications* (OTA-TCT-549, 1993); *Advanced Network Technology,* (OTA-BP-TCT-101), 1993; *Protecting Privacy in Computerized Medical Information (OTA-TCT-576, 1993);* and *Making Government Work: Electronic Delivery of Federal Services* (OTA-TCT-578, *1994).*

delivery, the role of wireless technology in the NII, and maintaining security and ensuring privacy within the NH environment.

This report, the prior OTA reports mentioned above, and those to be released later in the 103d and 104th Congresses will provide Congress with information and policy choices about technologies, problems, barriers, and economic implications of the development and deployment of a National Information Infrastructure.

NATIONAL INFORMATION INFRASTRUCTURE INITIATIVE

In September 1993, the Clinton Administration announced an initiative to promote the development of a National Information Infrastructure (NII):

> . . .that would create a seamless web of communications networks, computers, databases, and consumer electronics that will put vast amounts of information at users' fingertips. . ..[That] can help unleash an information revolution that will change forever the way people live, work, and interact with each other.[2]

The initiative relies on the private sector to innovate and aggressively pursue the deployment of these technologies. But certain problems in the deployment of the NH will persist that only the government can address.

The guiding principles for creating the NII include:

1. promotion of private sector investment;
2. extension of universal service at affordable prices;
3. promotion of technological innovations and new applications;
4. promotion of interactive, user-driven operation of the NII;
5. ensuring information security and network reliability;
6. improving the management of the radio frequency spectrum;
7. protection of intellectual property;
8. coordination within government agencies and with other countries; and
9. providing access to government information and improving government procurement.

This report focuses on the implications of the NII for business applications, and addresses many other issues related to the broader social and economic issues of the NII.

FACTORS DEFINING ECONOMIC PERFORMANCE

U.S. businesses are seeking new and more productive ways to organize their functions and activities in the face of increased competition from abroad. The new approaches have labels such as total quality control, customer-driven planning, lean production, just-in-time manufacturing, agile manufacturing, and electronically y integrated enterprises. Many of these ideas are inspired by innovations in foreign countries, some of which have been successful. An advanced communication and information infrastructure could make these tools even more effective for American business (see box 1 -1).

These new approaches are based on assumptions about the critical factors driving economic performance in today's global economy and about what constitutes *economic* success. Some, for example, stress the importance of national industrial policies; others emphasize the organizational cultures and structure of group relationships within the firm; still others focus on the use of technology to improve performance and eliminate unnecessary jobs and activities. But seldom are these factors considered in their entirety or as they relate to each other. Nor do they spell out in detail how, and under what circumstances, the communication infrastructure will likely contribute to economic success.

To ensure that the important factors are taken into account, it is necessary to consider how

[2]Information Infrastructure Task Force, "The National Information Infrastructure: Agenda for Action," Sept. 15, 1993.

BOX 1-1: Some Examples of How Businesses Are Using Information Networks

- Boeing Corp. has used networking technologies to reduce administrative overhead, speed production, and enhance product quality. Except for a few critical parts, most of Boeing's production is now being outsourced to suppliers throughout the world. Networked together using seven mainframe computers and 2,800 workstations, these suppliers have designed and preassembled the entire new Boeing *777* jet airliner. The company expects that this networked effort-the largest computer-aided design and computer-aided manufacturing project yet undertaken—will eliminate 20 percent of the project's total cost.
- Nike, Inc uses information networking technologies to reduce costs and achieve greater flexibility and responsiveness in an Industry that is subject to rapidly changing, global demand. Nike is the ultimate in "flattened" organizations. It "outsources" 100 percent of its athletic footwear production to suppliers. Having no production facilities of its own, it orchestrates the overall process, focusing on areas in which it has the greatest strength—research, design, and manufacturing.
- The discount retailer Wal-Mart uses networked point-of-sale technologies and reformation network tech nologies to Implement a quick response system with its vendors, Cash register data are collected, analyzed, and shared using electronic data interchange (ED I). This system has Improved Wal-Mart's efficiency, and many of its vendors have benefited from greater efficiency and increases in sales of up to 30 percent
- Computer use in financial markets was first initiated by the National Association of Securities Dealers Automated Quotations (NASDAQ) when it began in 1971 to provide computer listings of primary information for several thousand companies. A decade later, it developed a system to provide information as sales were completed. More recently, it has developed the PORTAL system, which provides the cross-listing of securities together with an automated trading system. Linked electronically with both the London and the Singapore exchanges, NASDAQ has become an important foreign exchange security market with trade totaling $6 billion in 1991,
- Networked services need not be high-tech for businesses to benefit. For example, toll-free services linked to the public switched network not only enhance business performance; they can also lower barriers to market entry. For example, 1-800 numbers can give small businesses access to a national, and even international, market. Many entrepreneurs, operating on a very small scale, are finding creative ways to take advantage of this opportunity John M Shanahan, for example, the founder and CEO of Gateway Educational Products, Ltd , used the toll-free number 1 -800-ABCDEFG to nationally market a musical phonics product, Hooked on Phonics, which he had originally developed for personal use to help teach his son to read. After *4* years, Shanahan's annual sales totaled $85 million, and he is now developing a follow-on educational math program. Shanahan attributes much of his success to his toll free "ABCDEFG" phone number,

SOURCE Off Ice of Technology Assessment, 1994

economic performance is defined and the conditions that foster high performance. It is then possible to examine the role of business as it relates to these factors. Economic performance entails three essential elements: 1) an increase in the average standard of living; 2) sustainable growth; and 3) greater sharing among all groups of the benefits of growth.[3]

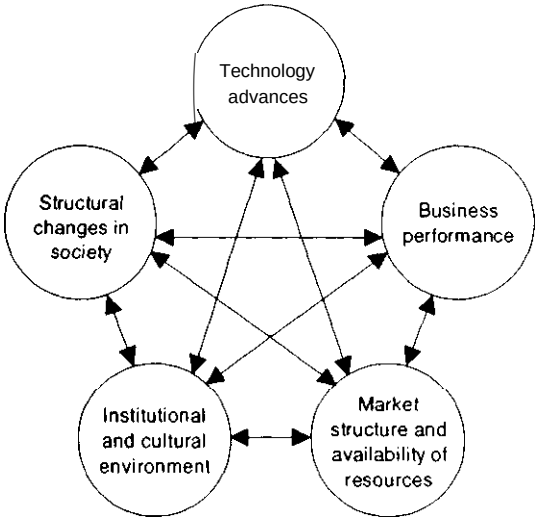
[3] As described by Rivlin: "There is no obvious single measure of how well the economy is performing in the long run, and there is lots Of room for argument about what aspects are important and how m measure them. At a minimum, Americans ought to want three things from their economy: the average standard of living should be rising; the improving level of living should be shared by all groups; and the rising standard should be sustainable. All three elements of this definition are important." Alice Rivlin, Reviving (he Americans *Dream: The Economy, the States, and the Federal Government* (Washington, DC: The Brookings Institution, 1992, p. 35).

The factors that determine economic performance, as defined here, include:

1. major structural changes in society that create new business opportunities or pose new constraints;
2. technological advances that create new possibilities and potential problems;
3. the ability of business and industry to seize these opportunities and adapt to their changing environment;
4. the impact of business decisions on market structure, factor resources, and other economic actors; and
5. the role of government and other institutions that support or inhibit business activities and determine the rules of operation for business and the marketplace (see figure 1-1).

These factors are interrelated and, over time, account for changes in economic performance. Technological advances, for example, are a major source of social and economic change. In economic relationships, technology developments will affect economies of scale, the availability of product substitutes, the cost of production, and the structure of the market.[4] Work relationships are influenced by technological advances, as the history of automation clearly attests.[5] New technologies also create new potential and new opportunities that change ideas about what is possible and what is not. By challenging conventional ways of thinking, technological advances also provide an opportunity to reassess and reconsider basic socioeconomic values, goals, and choices.[6]

FIGURE 1-1: Factors Determining Economic Performance



Economic performance is defined as growth sustainable over time including an Increase m the average standard of living for all groups Economic performance is a function of a complex Interrelationship of factors

SOURCE Off Ice of Technology Assessment 1994

Although sweeping in their impacts, technological advances are not without limits. New technologies are subject to social choice; they are also regulated by the institutional, cultural, and organizational environments in which they evolve. Businesses rarely adopt technological innovations in their original form; rather, they redesign and adapt them to meet their specific needs

[4]As Porter has described: "Technological change is one of the principal drivers of competition. It plays a major role in industry structural change. as well as m creating new industries. It is also a great equalizer, eroding the competitive advantage of even well-entrenched firms and propelling others to the forefront. Many of today's great firms grew out of technological changes that they were able to exploit. of all the things that can change the rules of competition, technological change is among the most prominent. " Michael Porter, *Competitive Advantage: Creating and Sustaining Superior Performance (New* York, NY: The Free Press, 1985), p. 164.

[5]See, for instance, David Noble, *Forces of Production: A Social History of Industrial Automation (New* York, NY: Oxford University Press, 1984).

[6]Emmanuel G. Mesthane, "The Role of Technology in Society," in Albert H. Teich (cd.), *Technology and Man's Future (New* York, NY: St. Martin's Press, 1981); and Langdon Winner, Autonomous *Technology: Techniques Out of Control as a Theme in Political Thought* (Cambridge, MA MIT Press, 1977).

and to conform to their organizational cultures.[7] Businesses that can take advantage of these technological developments to reduce costs, increase efficiency, extend markets, develop new products, or otherwise gain a competitive advantage will prosper-others will not.

Technologies tend to embody social values and forms of social organization; thus, their impacts are felt far beyond the realm of business itself.[8] Technology will also have an impact on the nation's competitiveness, the structure of the marketplace, workplace skills, values, tastes and preferences, and the quality of the environment. Moreover, if the nation's economy is to perform well, it will need to create an environment in which businesses can be flexible in adapting to changes in the competitive environment. To do so, government will need to support the acquisitions of knowledge and learning, induce innovation, foster risk-taking and creative activity of all sorts, and help resolve problems and bottlenecks as they arise.[9] The communication and information infrastructure supporting these efforts will need to be widely accessible and flexible.

THE CHANGING BUSINESS ENVIRONMENT

Today, American businesses and the U.S. economy as a whole are confronted by a number of changes that require an innovative response (see box 1 -2). Among these are: 1) the emergence of a high] y competitive global economy in which multinational corporations play a greater role; 2) the growing importance of information as an economic resource and basis for competitive advantage; and 3) the shift from mass production to a system of customized, flexible production.

| Emergence of a Competitive Global Economy

The integration of the international economy has been facilitated and fostered by a number of developments. These include:

- the increasing similarity among countries with respect to tastes, infrastructure, distribution channels, and marketing approaches;
- the emergence of a global capital market, as witnessed by the large flow of funds between countries;
- declining tariff barriers and the establishment of regional trading agreements;
- shifting opportunities for competitive advantage due to technology restructuring;
- the integrating role of advanced information and communication technologies;
- slow and uneven world economic growth that has fanned the flames of international competitiveness; and
- the emergence of new global competitors, prin - cipally from East Asia. [10]

Together, these developments have given rise to a global economy in which patterns of international trade primarily reflect patterns of international production, Specialization takes place on the basis of parts and specialized components, rather than on the exchange of finished products as in the past. Thus, inter-firm and intrafirm trade is steadily replacing interindustry trade. [11] Today, for example, Japan provides approximately 40 per-

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[7] See, for instance, Philip Anderson and Michael L. Tushman, "Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change," *Administrative Science Quarterly, vol. 35, 1990,* pp. 604-633; and Wesley M. Cohen and Daniel A. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly,* vol. 35, 1990, pp. 128-152.

[8] Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (eds.), *The Social Construction o/ Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: The MIT Press, 1987).

[9] Douglas North, *Institutions, Institutional Change and Economic Performance* (Cambridge, England Cambridge University Press, 1990).

[10] Michael Porter (ed), *Competition in Global Industries* (Boston, MA: Harvard Business School Press, 1986), pp. 408-409.

[11] Robert Gilpin, *The Political Economy of International Relations* (Princeton, NJ: Princeton University press, 1987), p. 238. See also Jack N. Behrman, *Industrial Policies: International Restructuring and Transnationals* (Lexington, MA: Lexington Books, 1984).

BOX 1-2 The Economic Environment

Business environments change over time because of technology advances, major social and economic events, new ways of thinking about business and evaluating performance, and changes in the institutional norms and government rules that determine economic behavior These changes may be abrupt and revolutionary, as in the case of war, famine, and natural disaster More often than not, however, structural changes take place Incrementally, having a cumulative effect over time Even changes as significant as the demise of the feudal system or the Industrial revolution occurred not at one stroke, but in an evolutionary fashion as a result of a number of small but Interrelated events [1]

Structural changes create both new economic opportunities and new constraints The American Civil War, for example, gave rise to both It not only ended slavery, and thereby greatly constrained the mode of cotton production in the South, it also created new opportunities for textile manufacturing [2] More recently, a vast array of new market opportunities have been created with the sudden collapse of the governments of the Eastern European bloc

Over the long run, business performance depends on how well businesses react to such changes Those that respond creatively can gain advantage, while those that fail to adapt will likely experience decline [3] The railroad industry is an example In the fifties, when U S railroad companies were confronted by trucking and the airlines, they disregarded them They did not see these technologies as a threat because they thought of themselves as being in the railroad business rather than the transportation business This misperception was costly, the railroad companies were soon superseded by the emerging trucking and airline industries

National economies are also subject to such ebbs and flows This rise and fall occurs because the conditions for success—or competitive advantage—vary according to circumstances What works well in one case will not necessarily succeed in another [4] Thus, for example the U S economy gained advantage over many European economies during the Industrial era because mass production required a large market which existed only in the United States [5] Similarly, although the British economy was successful in the 19th century, it declined in the 20th in part because, unlike the Germans and others who invested in science and education, the British failed to anticipate the emergence of new markets and the growing Importance of knowledge resources [6]

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[1] As North notes with respect to the feudal structure "The Important point is that the changes were an aggregation of literally thousands of specific small alterations in agreements between lords and serfs, which in total made for fundamental institutional change Douglas North *Institutions Institutional Change and Economic Performance* (Cambridge UK Cambridge University Press, 1990) p 89 Braudel describes the industrial revolution in similar terms "When one is talking about social phenomena rapid and slow change are inseparable For no society exists which is not constantly torn between the forces working to preserve it and the subversive forces—whether perceived as such or not—working to undermine it Revolutionary explosions are but the sudden and short-lived volcanic eruption of this latent and long term conflict " See Fernand Braudel *Civilization and Capitalism 15th - 18th Century The Perspective of the World* vol III (Berkeley CA University of California Press 1992) pp 537-538

[2] See Brodus Mitchel *The Rise of Cotton Mills m the South* (Baltimore MD The Johns Hopkins Press, 1921) As the author points out the availability of slave labor tended to discourage the development of manufacturing in the South until after the Civil War when the textile industry began to flourish

[3] Andrew Schotter *The Theory of Social Institutions* (Cambridge, UK Cambridge University Press, 1981) pp 1-2

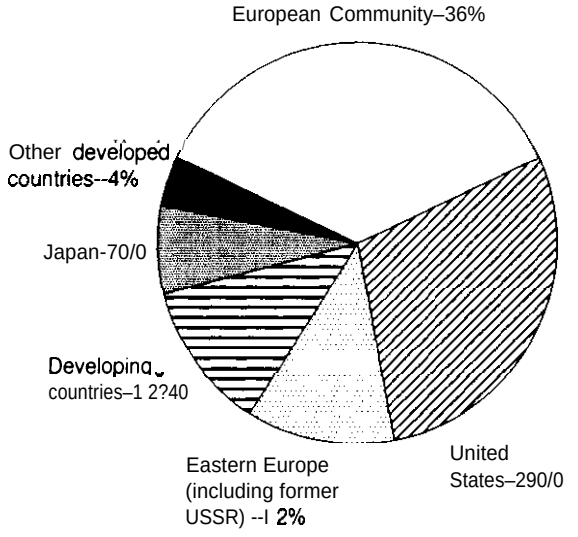
[4] As Karl Polanyi notes "A nation may be handicapped in its struggle for survival by the fact that Its institutions, or some of them, belong to a type that happens to be on the down grade—the gold standard in World War II was an instance of such an antiquated outfit Countries on the other hand which for reasons of their own are opposed to the *status quo* would be quick to discover the weaknesses of the existing institutional order and to anticipate the creation of institutions better adapted to their interests See Karl Polanyi, *The Great Transformation The Political and Economic Or/gins of Our Time* (Boston, MA Beacon Press 1957) p 28

[5] For a discussion of these factors in mass production see Harold Williamson (ed), *The Growth of the American Economy (New* York NY Prentice Hall 1951) pp 721-722

[6] See James Beckford ' Great Britain Voluntarism and Sectional Interests in Robert Wuthrow (ed) *Between States and Markets The Voluntary Sector in Comparative Perspective* (Princeton NJ Princeton University Press 1991) p 33

SOURCE Off Ice of Technology Assessment, 1994

FIGURE 1-2: Share of Major International Joint Ventures (Announced August-December 1992)



SOURCE Institute for the Future, "The Electronic Enterprise," contractor report prepared for the Off Ice of Technology Assessment, May 1993

cent of U.S. component parts in electronics and automobiles. [12]

Patterns of direct investment abroad also highlight this trend toward global economic integration and interdependence. Between 1960 and 1988, for example, direct investment abroad by all firms in all nations increased by over 10 percent per year to more than $1.1 trillion. This trend is especially pronounced in the United States where foreign direct investment increased during the same period faster than the world average—from $9.9 billion to $328.9 billion, or 18 percent per year. Moreover, foreign direct investment accounted for 3.4 percent of Gross National Product (GNP) in 1978, compared with 1.8 percent a decade earlier. ' [14]

Multinational corporations are also driving the trend toward globalization. To compete in today's global economy, companies must integrate their activities on a worldwide basis, allocating activities among a number of countries to gain the greatest advantage. [15] Depending on the particular case, it might be best for a firm to disperse its production facilities—such as design modification, fabrication, and assembly—to foreign countries, and to focus its own domestic production on the fabrication of key components. [16] or, alternatively, a firm might decide to manufacture a product domestically, but transfer abroad such downstream activities as distribution, sales, marketing, and service. When not fully integrated into multinational corporations, these firms are networking their activities across global boundaries through a variety of arrangements such as cross-1icensing of technology, joint ventures, orderly marketing agreements, offshore production of components, secondary sourcing, and crosscutting equity ownership [17] (see figure 1 -2).

[12] Porter, op. cit., footnote 10, p. 225.

[13] John W. Rutter, "Direct Investment Update: Trends in International Direct Investment," U.S. Department of Commerce, International Trade Administration, September 1989. The stock investment given here is the position of foreign direct investors, or the value of the foreign investors' equity in and loans to offshore affiliates. For the United States, a foreign direct investor is one that owns or controls at least 10 percent of a company's voting stock (or equivalent amount in an unincorporated enterprise)

[14] Ibid.

[15] See Porter, op. cit., footnote 10.

[16] Ibid.

[17] Gilpin, op. Cit., footnote 11. See also Peter Cowhey and John Aronson, *Managing the World Economy: The Consequences of Corporate Alliances* (New York, NY: Council on Foreign Relations, 1993). Once generally associated with U.S. industries, multinationals are, themselves, increasingly becoming global in nature. For example, globally networked Japanese and European firms, while differing somewhat in style from U.S. firms, have significantly grown in number in the course of the past decade. See Bruce Kogut, Weijian Shari, and Gordon Walter, "Knowledge in the Network and the Network as Knowledge," in Gernot Grabher, *The Embedded Firm: On the Socioeconomic's of Industrial Net\\orks* (London, UK: Routledge, 1992), p. 90.

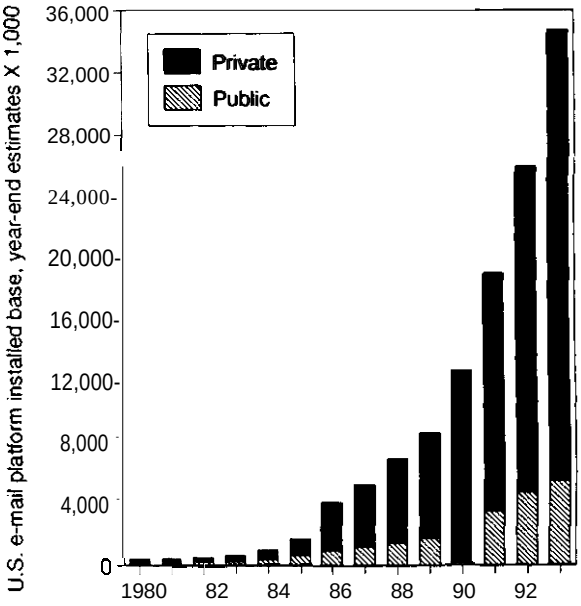
I Trend Toward an Information-Based Economy

There is an interrelated trend toward an information-based, network economy. Increasingly, information serves as a primary resource, a key factor of production. Information is becoming a prerequisite to the development and allocation of other resources. As such, it is treated less and less as a free good and more and more as a commodity to be bought and sold in the marketplace. As the economic value of information increases, the economic rewards of those who have greatest access to it grow as well. [18]

The trend toward an information-based economy results, in part, from the development and widespread deployment of information and communication technologies. The emergence of these technologies has increased: 1) the speed at which information can be communicated; 2) the quantity of information that can be collected, stored, manipulated, and transmitted; and the access to information (see figure 1-3).

These technologies provide numerous ways to improve efficiency and increase productivity, and thus engender growth. Information is, for example, reusable. Unlike capital resources such as steel and iron, it requires very few physical resources to produce and distribute it. Information can be used to substitute more efficiently for labor and to improve the overall efficiency of the productive process itself. As productive processes become increasingly complex, the largest reserve of economic opportunities will be in organizing and coordinating productivity activity through the process of information-handling [19] (see figures 1-4 and 1 -5).

FIGURE 1-3: Growth of Private and Public Electronic Mail Networks



NOTE The online computer version of mail, "electronic mail" (e-ma(l), is perhaps the most used and most basic computer network application Simpler to use than writing and mailing a letter, e-mail is installed on virtually every networked computer and the total number of e-mail addresses (mailboxes) is growing exponentially As depicted above, e-mail addresses installed by the private sector (corporations, nonprofit associations, and universities) have grown much faster than their public counterparts

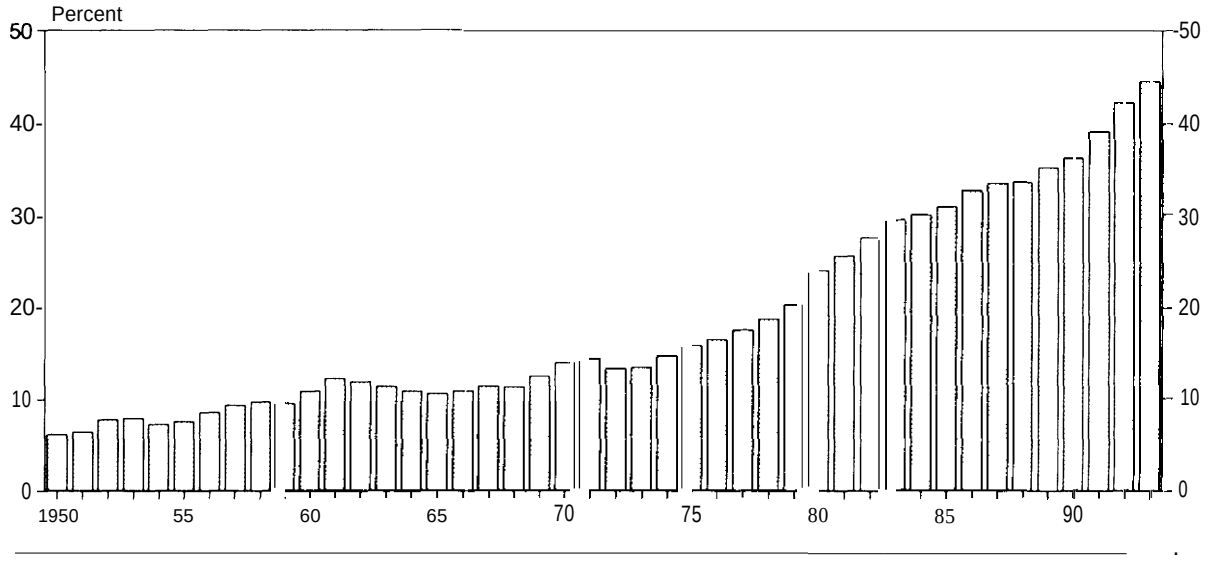
SOURCE Electronic Mail and Micro Systems Jan 1 1994, PP 1-10 (year-end 1993 figures revised April 1994)

Technology advances have also given rise to new businesses that specifically cater to business information needs. Information can now be processed in a variety of new ways, adding to its value from the point at which it is created or composed

[18] As noted by Merrifield "Wealth will no longer be measured primarily in terms of ownership of fixed physical assets, but rather in terms of time-critical access to needed resources; and to knowledge-intensive value-added operations. The value-added dimension, moreover, will be the deciding source of the comparative advantage required for industrial competitiveness. This shift in the basis of wealth formation is a major break with the past, a discontinuity that is driven by accelerating forces of change. One of these factors involves an explosion of technology that has created about 90 percent of all scientific knowledge over just the last 30 years. Moreover, this knowledge basis is likely to double again in the next 15 years." D. Bruce Merrifield, "Global Strategic Alliances Among Firms," *International Journal of Technology Management, Special Issue on Strengthening Corporate and National Competitiveness Through Technology*, vol. 7, 1992, p. 77.

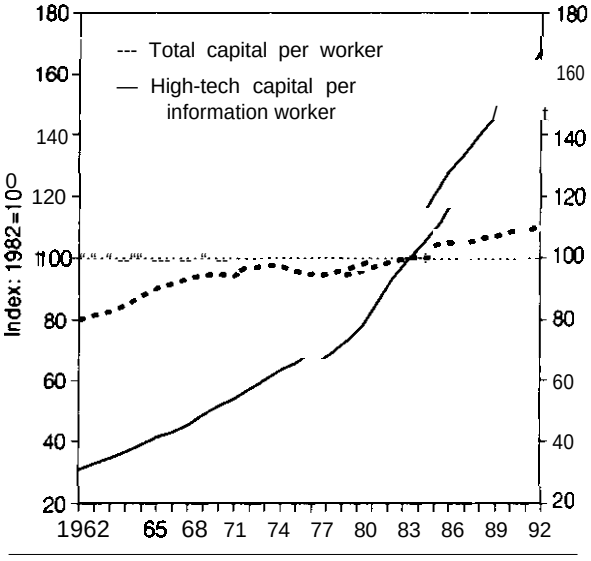
[19] Charles Jonshur, "Information Resources and Economic Productivity," *Information Economics and Policy* / (North Holland: Elsevier Science Publishers. 1983), pp. 13-35.

FIGURE 1-4: Information Technology as a Share of Total Investment in Producers' Durable Equipment



SOURCE Morgan Stanley Economics, 1994

FIGURE 1-5: Capital Endowment in the Service Sector



SOURCE Morgan Stanley Economics, 1994

to the point at which it is assimilated or used. As the opportunities for creating new information products and services have increased, so too have the number of commercial providers. Responding to the increased demand for information, the new technologies have spawned a rapidly growing industry. For example, in 1992, the worldwide market for online services totaled $10.1 billion, a 9.2 percent increase from $9.3 billion in 199120 (see box 1-3).

Shift to Flexible, Decentralized Production

To gain competitive advantage in a knowledge-based, global economy, firms must adopt new ways of doing business. Customers are now more diverse and sophisticated, and new, highly skilled competitors use communication networks to access foreign markets. Success in the global economy no longer depends only on achieving efficien-

[20] *Online Services: 1993, Review*, Trends & *Forecast* (Wilton, CT: SIMBA/Communications Trends, 1993), p. 11.

cy and cost reduction.[21] Increasingly, it depends on the effectiveness of businesses—their ability to innovate, respond just-in-time, focus on quality, and establish more cooperative interfirm and intrafirm relationships. To enhance their effectiveness, businesses are taking advantage of more timely and appropriately packaged information to help them shift from business models based on mass production to those that center around the concept of flexible, decentralized production[22] (see table l-l).

The system of mass production that developed in the United States was extremely efficient for its time. Because it eliminated variability, it greatly reduced the need for information. With lower information costs, firms could handle greater volume and reap even greater efficiency gains through economies of scale and scope, The system was self-reinforcing. Given lower costs, volume was sustained through price reduction and the generation of a mass market.[23] However, this system of mass production, which took the form of the assembly-line process, hinged on maintaining constancy. As a result, everything-parts, processes, tools, products, workers, and tasks—had to be standardized.[24] In addition, this system required a rigid, hierarchical business structure that would provide adequate control .[25] Equally important, it necessitated a tradeoff in favor of efficiency over diversity.[26]

Such a tradeoff is neither necessary nor appropriate today when diversity is at a premium. Flexible, decentralized production systems (also referred to as mass customization) allow businesses to customize production without sacrificing economies of scope. Using such an approach, businesses seek to control a particular market niche rather than maximize market size. As a result, scale economies are no longer such an important factor for success .27

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[21] As noted by Gehani: "For many years, the delay and the cost ..in the development of new products did not hurt most companies' bottom line very much. The customers generally waited patiently for new products to appear in the market. With few new organizations entering an oligopolistic and mainly domestic U.S. economy, [here was no significant erosion in (he customer base of an organization due to such delays. But with globalization of competition in the l 980s and ease of transcontinental movements of goods, money, and information, foreign competitors started entering as soon as some gaps appeared in the highly valued U.S. or European markets. " R. Ray Gehani, '"Concurrent Product Development for Fast Track Corporations, " *Long Range P/arming,* vol. *25,* No. 6, pp. *40-47, 1992.*

[22] As Stinchcombe points out: "'Structures of organizations, and of parts of organizations, vary according to the sorts of uncertainties the) confront, and according to what sources of information they depend on and to how that information is best got to the dec I sion-making un Its. " Arthur L. Stinchcombe, *Information and Organizations* (Berkeley, CA: University of California Press, 1990), p.3.

[23] As Williamson notes: "Mass production was the main support as it was the prerequisite of mass production. . . . The American home market, in the words of Andrew Carnegie, is a 'vast homogeneous market, and this factor too was a major influence affecting the evolution of mass production. Across the horizontal plane and its great geographical extend, as well as up and down the vertical social scale, the A merican market place underwent a standardization of taste and consumption that bore profound psychological and economic significance.' '" Harold WI II iamson (ed.), *The Growth of the American Economy (New* York, NY: Prentice Hail, 1957), pp. 721-722.

[24] Ibid. See also James P. Womack, Daniel T. Jones, and Daniel Roos, *The Machine 7-hat Changed The 14'orld: The Story of Lean Production (New* York, NY Harper Perennial, 1990), p. 27.

[25] James Beniger, *The Control Revolution: Technology and the Economic Origins of the Information Society* (Princeton, NJ Princeton University Press, I 986).

[26] As pointed out by Boynton et al.: "Change in either process or product works against the mass- -production formula. Changes m product make reach inery obsolete, force costly changeover and reduce managerial control. Changes in process complicate ind i vidual jobs, raise waste and error, and increase unit costs. Thus a mass production organization is intended to respond to and initiate as little change as possible. This design for stability requires limiting product variety as well as process innovation. '" A.C. Boynton, B. Victor, B.J. Pine II, "New Competitive Strategies. Challenges to Organizations and Information Technology," *IBM* Systems *Journal,* vol. 1, 1994, pp. 43-44.

[27] According to Ayres: "The key to the suggested "new paradigm" for economic grow [h is that increasing flexibility progressively reduces the cost d] fferential between customized and standardized products. The smaller this differential, the greater the demand for diversity and, hence, flex ibility. But this process, in turn, leads to further improvements in the manufacturing process , generating savings in both labor and capital, and in effect, restraining the traditional cost-driven engine of growth." R.U. Ayres, "CIM A Challenge to Technology Management," *International Journal of Technology Management,* December 1992, p. 21.

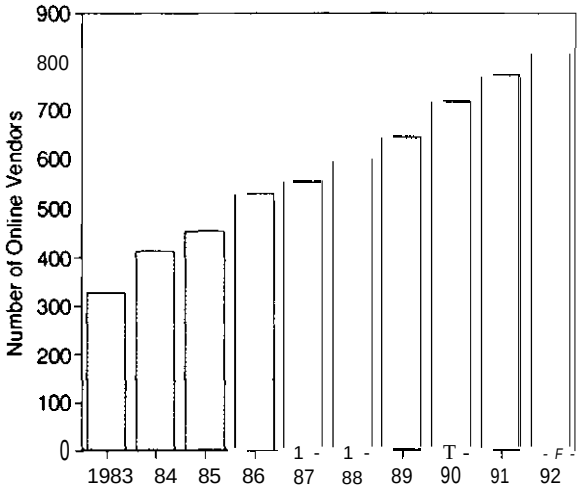
BOX 1-3: Online Information and Services Market

Online Information—facts, figures, pictures, numbers, and words traveling through telephone and computer networks, and stored and retrieved from computers—is prevalent and growing throughout the American economy Businesses and consumers are using this method of information-gathering and exchange to supplement telephone conversations, face-to-face conversations, and paper-based information sources While the most basic services only allow for information retrieval from a database, others allow communications such as electronic mail (E-mail), electronic bulletin board services (BBSs), and online chat sessions similar to telephone conference calls.

Looking back in time, the first online service was computer time-sharing that gave businesses access to a central computer from a dumb terminal at a remote site Computer time-sharing allowed companies that could not afford in-house systems to benefit from computing After computer time-sharing took hold, publishers realized the benefits of distributing information as well as computing resources through similar shared network arrangements Today, online information and communications are generally accessed through personal computers instead of dumb terminals The installed base of personal computers is expected to number about 57 million in the United States and 148 million worldwide by 1994 [1]

SIMBA Information Inc , a market analyst, divides the online services market according to whether businesses or individuals are the customer. The services offered to businesses and consumers, however, may be similar as individuals demand business-oriented services, such as for professional correspondence or individual investing More specifically, the business services market includes brokerage, credit, financial news/research, legal/regulatory, and professional/library services, whereas the consumer services market includes general interest, individual investing, and gateways to more than one service provider

FIGURE 1-6: Annual Online Vendor Growth 1983-92



SOURCE Gale Directory of Databases, Volume 1Online Databases Gale Research, Detroit, MI, 1993

(continued)

[1] Dataquest Inc , San Jose, CA, as cited in Online *Services 1993 Review,* Trends&Forecast (Wilton, CT SIMBA/Communications Trends, 1993)

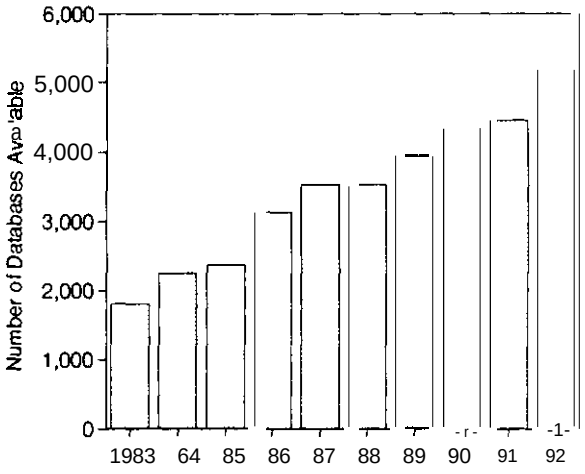
BOX 1-3: Online Information and Services Market (cont'd).

Brokerage services distribute real-time market information to banks and financial institutions Credit services collect and sell payment histories to credit grantors Financial news/research services provide news and decision support services for investors Legal/ regulatory services provide access to government information such as laws, corporate records and real estate transaction histories Marketing services sell targeted mailing lists and other market Information Professlonal/li - brary services sell scientific, medical, and technical Information Individual investor services give Information such as stock quotes and some permit Investors to initiate trades Gateways are telephone company services that provide links to many online services

The online services market IS growing rapidly Worldwide sales in 1992 topped $101 billion Of this amount, North American-based companies accounted for 60 percent and European-based companies accounted for 32 percent Annual sales growth was 92 percent in 1992 and averaged 91 percent between 1988 and 1992 Figures 1-6 1-7, and 1-8 depict the growth between 1983 and 1992 in the numbers of databases, database producers and online services (vendors who distribute database information) While these numbers are large, they are only a subset of a much larger information market that Includes the sale of information and services over private networks, electronic data interchange (EDI), networking offered by value-added networks (VANS), airline customer reservation systems (CRSs), real-estate multiple-l listing services (MLSs), electronic funds transfers (EFTs) and automated teller machines (ATMs)

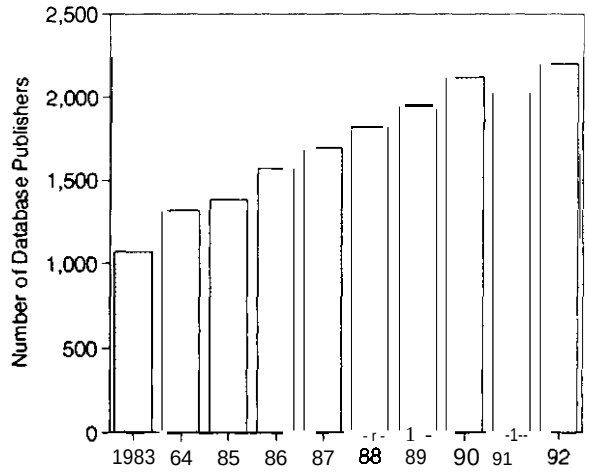
SOURCE *On/me Services 1993 Review Trends & Forecast* (Wilton CT SIMBA Communications Trends 1993)

FIGURE 1-7: Annual Online Database Growth 1983-92



SOURCE Gale Directory of Databases, Volume 1 Online Databases Gale Research, Detroit, MI, 1993

FIGURE 1-8: Annual Database Publisher Growth 1983-92



SOURCE Gale Directory of Databases, Volume 1 Online Databases Gale Research, Detroit, MI, 1993

TABLE 1-1: Changing Organizational Patterns in U.S. Industry

Old model	New model
Mass production, 1950s and 1960s	**Flexible decentralization, 1980s and beyond**
Overall strategy	
* Low cost through vertical integration, mass production, scale economies, long production runs. * Centralized corporate planning, rigid managerial hierarchies. * International sales primarily through exporting and direct Investment	* Low cost with no sacrifice of quality, coupled with substantial flexibility, through partial vertical disintegration, greater reliance on purchased components and services, ‘ Multimode International operation, including minority joint ventures and nonequity strategic alliances
Product design and development	
* Internal and hierarchical, m the extreme, a linear pipeline from central corporate research laboratory to development of manufacturing engineering. * Breakthrough innovation the ideal goal	* Decentralization, with carefully managed division of responsibility among R&D and engineering groups, simultaneous product and process development where possible, greater reliance on suppliers and contract engineering firms. * Incremental innovation and continuous improvement values.
Production	
* Fixed or hard automation * Cost control focuses on direct labor * Outside purchases based on arm’s length, price-based competition, many suppliers • Off-line or end-of-line quality control. * Fragmentation of individual tasks, each supplied in detail, many jobs classifications • Shopfloor authority vested ■ first-line supervisors, sharp separation between labor and management.	• Flexible automation, * With direct costs low, reductions of Indirect cost become critical * Outside purchasing based on price, quality, delivery, technology, fewer suppliers. * Real-time, on-line quality control. * Selective use of work groups; multitasking, job rotation, few job classifications * Delegation, within limits, of shopfloor responsibility and authority to individuals and groups, blurring of boundaries between labor and management encouraged
Hiring and human relations practices	
* Workforce mostly full-time, semi-skilled * Minimal qualiflcations accepted * Layoffs and turnover a primary source of flexibility, workers, in the extreme, viewed as variable csst	‘ Smaller core of full-time employees, supplemented with contingent (part-time, temporary, and contract) workers. who can be easily brought in or let go, as a major source of flexibility * Careful screening of prospective employees for basic and social skills, and trainability • Core workforce viewed as an investment, management attention to quality-of-workmg life as a means to reducing turnover
Job ladders	
• Internal labor market, advancement through the ranks via senlority and informal on-the-lob training	* Limited internal labor market, entry or advancement may depend on credentials earned outside the workplace
Governing metaphors	
* Supervisors as policemen, organization as army	* Supervisors as coaches or trainers, organization as athletic team (The Japanese metaphor organization as family.)
Training	
* Minimal for production workers, except for Informal on-the-job training. * Specialized training (including apprenticeships) for grey-collar craft and technical workers	* Short training sessions as needed for core workforce, sometimes motivational, sometimes intended to improve quality control practices or smooth the way for new technology * Broader skills sought for both blue- and grey-collar workers

SOURCE Off Ice of Technology Assessment, September 1990

Flexible, decentralized systems use information and networking to integrate and compress the time from product innovation to marketing to drive demand and to maximize customer responsiveness.[28] With a variable organizational structure, firms can rearrange their activities around teams and networks that bring together everyone who is involved in the life cycle of a product. Working together and sharing the same information, all processes can be carried out in parallel .29 This kind of structure reduces the time involved in product development and the likelihood of waste. It also leads to fewer defects and higher quality products. This is a major benefit because, as production processes become more complex, the cost of error detection and correction is rising as a fraction of total cost.'[30] Moreover, flexible teams are advantageous because they can be reconfigured to respond quickly to changing demand.[31]

POTENTIAL FOR BUSINESS

| Impact of Technology on Businesses

Information and communication technologies are both driving and facilitating the adaptation of business to structural changes in the economy. Businesses are now applying computer technology to almost all of their activities—from recruiting to laying off workers, from ordering raw materials to manufacturing products, from analyzing markets to performing strategic planning, and from inventing new technologies to designing applications for their use. Not only are these technologies being applied to traditional tasks; they are also being used to reconfigure the nature of the business process itself. While early innovators and adopters have often used these technologies to gain strategic advantage, businesses must take advantage of them over the long term for the sake of survival alone.

Conducting business on *a global scale,* for example, creates many new challenges and opportunities.[32] To fully benefit from the availability of worldwide resources and markets, businesses must have a truly translational perspective that harmonizes operations in the service of a single corporate strategy. Translational corporations must be able to balance their global operations with the requirements of local markets—such as the need to establish special sales channels, service contracts, and work relationships. In addition, as companies spread their corporate boundaries, they will need to make decisions that are far more complex based on information and data that

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[28]As noted by Bessen: "The phrase 'getting close to the customer' now has a definite high-tech ring. Farsighted companies like American Airlines and R.J. Reynolds have gained a decisive competitive edge by building powerful customer information systems. Through such systems, these companies not (rely understand individual consumers better but also employ information to develop and market new products." Jim Bessen, "Riding the Marketing Information Wave," *Harvard Business Review,* September/October, 1993, p. *150.*

[29]As Gehani points out, if such teams are to he effective: "'the organization human resources may have to be trained to share, communicate, and exchange Ideas with team members from other parts of the organization in a non-confrontory manner. In a traditional 'serial organization, product and process innovations may emerge independently in different parts of the organization. On the other hand, in an integrated "parallel organization, the product and process innovations in different parts of an organization develop and grow concurrently in a sharing and 'systemic' manner." op. cit., footnote 21.

[30]Ayres, op. cit., footnote 27, p. I 8.

[31]As noted by Gehani ". . .an accelerated product development process produces both internal as well as external benefits to an organization. The external or competitive benefits include market penetration due to faster customer responsiveness, premium pricing, precise flow of market research information, and ability to incorporate latest technology into a product." Op. cit., f(wtnote21. See also, Boynton et al, op. cit., footnote 26.

[32]See, for instance, Robert Mittman, "The Electronic Enterprise," contractor report prepared for the Office of Technology Assessment, May 1993. See also Stephen H, Rhinesmith, John N. Williamson, David M. Ehlen, and Denise S. Matwell, *Training and Development ./et/rfra/,* April 1989, pp. 25-34.

reflect cultural and political disparities.[33] Worldwide networks that can support group decision-making and information-sharing will be critical for operating in such a fashion.

If available to them, networked technologies will also allow small and rural businesses to participate more fully in the global economy .34 For example, a small business that serves only a single niche market may be able to greatly expand its operations by using technology to enter similar niche markets on a worldwide basis. Small companies may be able to link up with translational corporations as suppliers, value-added providers, or other market intermediaries. In addition, technology enables groups of small businesses to operate as if they were much larger entities, much like consortia, enabling them to compete with large businesses on a more equal footing. When working with translational corporations, however, small businesses may require high-capacity/high-quality networking systems comparable to those used by larger businesses, as well as the skills and expertise necessary to integrate them.

The international communication marketplace is rapidly responding to this demand for seamless, worldwide telecommunications services.[35] According to one account, in 1990, 16.3 percent of worldwide value-added service revenue was derived from international offerings. Estimates are that this figure will increase to 28 percent by 1996.[36] To provide service, a full range of providers are engaging in a variety of new cooperative arrangements-global partnerships, consortia, joint ventures, and foreign investments.[37]

The need to apply information and knowledge to an ever-growing number of complex business problems—as well as to share and leverage these resources both within and across organizational boundaries-will also increase business requirements for advanced applications and networking technologies, such as wide area networks, databases for information management, groupware, and electronic data interchange (EDI).[38] Sharing information and data permits businesses to employ production processes that shorten product cycles and adopt marketing strategies that are highly responsive to customers needs. For example, computer-integrated manufacturing (CIM) improves efficiency and product quality because the data describing the engineering parameters of a product, once created and stored electronically, can be retrieved by any member of a project team in a form most appropriate for his or her needs (see boxes 1-4 and 1 -5). Redundancies and discrepancies are avoided because everyone uses the same information.[39] Similarly, businesses can greatly improve customer service by employing distributed computing systems and relational databases

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33 Cresiencia Torres and Mary Bruxelles, "Capitalizing on Global Diversity," *HR Magazine,* December 1992, pp. 30-33.

34 See J.E. Butler and G.S. Hansen, "Network Evolution, Entrepreneurial Success and Regional Development," *Entrepreneurship and Economic Development, vol. 3, 1991,* pp. 1- 16; Andrea Larsen, "Partner Networks: Leveraging External Ties to Improve Entrepreneurial Performance," *Journal of Business Venturing, vol. 6, 1991,* pp. 173- 188; and Torn Peters, "Rethinking Scale," *California Management Review,* fall 1992, pp. *7-29. See* also U.S. Congress, Office of Technology Assessment, *Rural America at the Crossroads: Networking for the Future,* OTA-TCT-471 (Washington, DC: U.S. Government Printing Office, 1992).

35 See U.S. Congress, Office Of Technology Assessment, *Telecommunications Services In European Markets,* OTA-TCT-548 (Washington, DC: U.S. Government Printing Office, August 1993); and Carol Wilson, "Global Economy, Changing Political Scene Play Havoc With Spending," *Telephony,* Jan. 6, 1992, pp. *21-26.*

36 Karyn Lynch, "Global Service Showdown: Communication and Computer Companies Jockey To Redefine Themselves as International Service Providers," *Communications Week International,* May 11, 1992, p. 22.

37 Cowhey and Aronson, 0p. cit., footnote 17.

38 See Berm R. Konsynski and F. Warren McFarlan, "Information Partnerships-Shared Data, Shared Scale," *Harvard Business Review,* September-October 1990, pp. I 14- 120; and Max Munday, "Buyer-Supplier Partnerships and Cost Data Disclosure," *Management Accounting, 1992, pp. 28-29.*

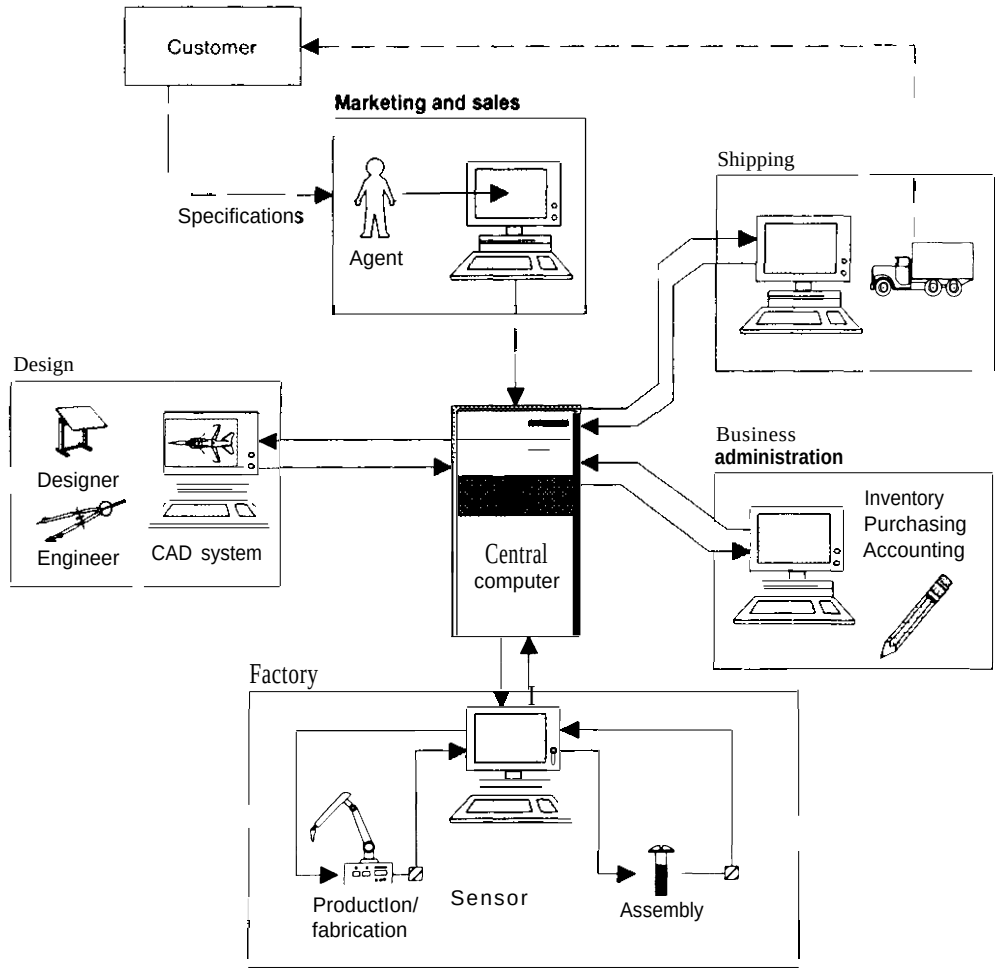
39 See Kevin Parker, "Reengineering the Auto Industry," *Manufacturing Systems,* January 1993, pp. 40-44; and Laura De Nardis and Marvin Chartoff, "CIM Users' Group Need for Flexible Net Underpinnings,. ' *Network World,* Mar. 16, 1992, pp. 1, 29-33, 38-40.

BOX 1-4: Enterprise Integration

The intensely competitive business environment has drastically shortened time-to-market, Product innovations must occur much more rapidly (see figure 1-9). Shorter life cycles mean that manufacturers need to be flexible and prolific, efficiently churning out higher quality products at much faster rates Competing effectively in this environment means that businesses must operate on a "just-in-time bass, " producing goods on demand and in response to specific customer needs, To reduce production time, many firms are Integrating their business functions around processes such as concurrent engineering and computer-integrated manufacturing (CIM) With concurrent engineering, process-oriented teams manage the engineering and production processes simultaneously, This kind of reorganization reduces costs in two ways it speeds up the production process itself; it also allows engineers to design for manufacturability. With computer-Integrated manufacturing and design, manufacturing and resource planning are not only Integrated, they occur online with the use of shared Information systems. CIM permits rapid prototyping enhances quality control, and greatly reduces waste.

SOURCE Off Ice of Technology Assessment, 1994

FIGURE 1-9: Enterprise-Wide Computer Network



SOURCE Off Ice of Technology Assessment, 1994

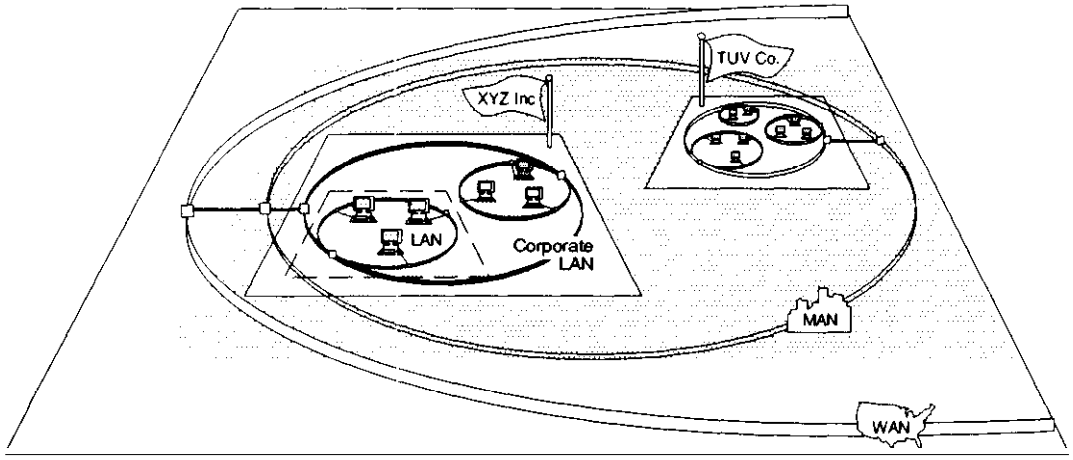
BOX 1-5: Shared Information System

Enterprise integration is greatly facilitated by the use of shared information systems, across groups and facilities, so that teams can leverage the Information resources of others, wherever they may be To support enterprise integration, communication must be seamless and reliable so information can be relayed in a timely manner and without errors

There are a number of technologies that support shared information systems Networking options include Local Area Networks (LANs), Wide Area Networks (WANs), and Metropolitan Area Networks (MANs), supported by a vast array of transmission and networking technologies, including Asynchronous Transfer Mode (ATM), Integrated Services Digital Network (ISDN), fiber optics, satellite, and many radio-based technologies (see figure 1-10) Open systems architecture and object-oriented programming environments wiII enable systems to be built more efficiently and effectively to facilitate information-sharing Client-server architectures that distribute data over a network of desktop workstations (as opposed to having the data reside in a central mainframe computer) wiII allow departments to own their own data and make it available to the people who need it Software such as groupware and distributed databases will provide the ability to store, search, and refine disparate pieces of Information

SOURCE Off Ice of Technology Assessment 1994

FIGURE 1-10: Network of Networks



This figure Illustrates how the data communications portion of the information superhighwayis composed of a complex network of interconnected networks A firms internal computer network typically consists of several smaller, linked local area networks (LANs), which in turn are Interconnected to increasingly wider networks, MANs and WANs

SOURCE Off Ice of Technology Assessment, 1994

to integrate, update, and deliver relevant customer information on demand at the point of sale or point of customer inquiry. [40]

Systematic and creative ways of providing information will also be required to support the growing number of knowledge-workers across all sectors of the firm. [41] Fixed, controlled procedures are being superseded by team-based flexible processes that require discretionary and diverse sets of capabilities. By learning and generating knowledge on the job, workers will be valued more for their cognitive than their manual skills .42 With the blurring of boundaries across hierarchies and organizations, decisionmaking will be distributed both downward and outward: managers will spend less time directly supervising, and more time making strategic choices and orchestrating and evaluating overall enterprise activities. [43] To enhance their capabilities and maximize their effectiveness, workers and managers will not only need access to information itself, but also to the technologies that can help them filter, process, apply. distribute, and further generate it.

Networked information technologies will also be a prerequisite for enterprise restructuring and reengineering. [44] Seeking new ways to improve quality. enhance efficiency, gain strategic advantage. and acquire greater knowledge and expertise, many businesses are rearranging their activities to carry them out in networks and teams (see box 1-6). Some businesses, for example, are entering into highly integrated, long-term relationships with customers and suppliers; others are setting up short-term, ad hoc alliances to address a particular problem at hand. Many of these networks transcend national as well as organizational boundaries. [45] *Technologies such as* wide area networks. v ideoconferenc ing, computer-integrated engineering and manufacturing, and electronic data interchange are necessary not only to support such activities; they also serve as a catalyst for organizational change (see box 1 -7).

| The Impact of Technology on Markets

Information and communication technologics will not only affect the nature of business organizations; they will also have considerable impact on the size, structure, and openness of markets. Networking technologies can greatly reduce the costs entailed in exchange transactions. As these costs decline, many business activities previously carried out within vertically integrated firms will likely be shifted to the marketplace. In addition, because exchange transactions will increasingly be carried out electronically and online. the network will in many instances serve as the mar-

[40]Robert Janson, "How Reengineering Transforms Organizations To Satisfy Their Customers," *National Productivity Review*, winter 1992/1993, pp. 45-53; and Regis McKenna, "Marketing Is Everything," *Harvard Business Review*, January-February 1991, pp. 65-79.

[41]See Ikuyiro Nonaka, "The Knowledge Creating Company," *Harvard Business Review*, November-December 1991, pp. 96-104. See also, Alan M. Weber, "What's So New About the New Economy," *Harvard Business Review*, vol. 71, No. 1, January/February 1993; and Kathryn Rudie Harrigan and Gaurov Dalmia, "Knowledge Workers: The Last Bastion of Competitive Advantage," *Planning Review*, November/December 1991, pp. 9, 48.

[42]Fred Porter and Jan Beanen, "The Power of Empowered Teams," *Mortgage Banking*, August 1992, pp. 22-26; Alan H. Magaziner, "Human Resources: Restoring the Competitive Edge," *Small Business Reports*, November 1989, pp. 25-28; and William Wiggenhorn, "Motorola U: When Training Becomes an Education," *Harvard Business Review*, July-August 1990, pp. 71-83.

[43]Howard E. Dolenga, "Management Paradigms and Practices for the Information Age," *SAM Advanced Management Journal*, winter 1992, pp. 25-29; L. Applegate, J.I. Cash, and D. T. Mills, "Information Technology and Tomorrow's Managers," *Harvard Business Review*, vol. 66, No. 6, November-December 1988, pp. 128-136; and Charles C. Snow, Raymond E. Miles, and Henry J. Coleman, Jr., "Managing 21st Century Network Organizations," *Organizational Dynamics*, vol. 20, winter 1992, pp. 5-19.

[44]On the need for reengineering, see Michael Hammer, "Reengineering Work: Don't Automate, Obliterate," *Harvard Business Review*, July/August 1990, pp. 104-112.

[45]See B.R. Konsynski, "Strategic Control in the Extended Enterprise," *IBM Systems Journal*, vol. 32, No. 1, 1993; John R. Rockart and James E. Short, "The Networked Organization and the Management of Interdependence," Michael Scott Morton (ed.), *The Corporation of the 1990s: Information Technology and Organizational Transformation* (New York, NY: Oxford University Press, 1991).

BOX 1-6: Networking for Economic Advantage

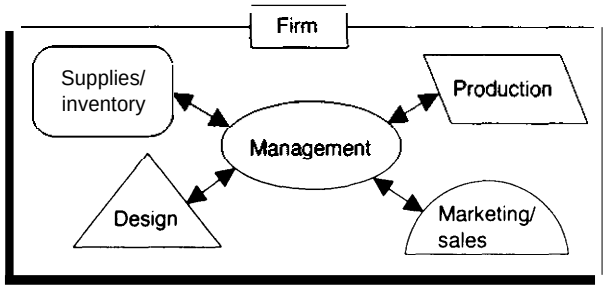
Networking provides new opportunities for businesses to enter new markets, gain strategic advantage, and reduce transaction costs These networks are effective because they cut across traditional organizational boundaries, either within or across firms

Business networks come in a number of varieties As depicted in section A of figure 1-11, some networks are internal to the firm They generally cut across traditional business functions, allowing firms to reorganize around processes that support team-based work for total quality control and just-in-time delivery A wide range of groupware applications are being developed to support such networks Businesses may also set up networks to create new interorganizational connections, as can be seen in section B An electronic data Interchange (EDI) network might be used, for example, to connect a firm to its suppliers Networking can also be used to support virtual corporations and agile manufacturing, as Illustrated in section C

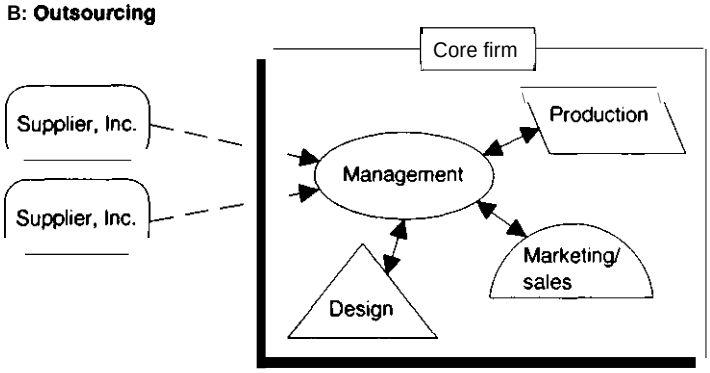
SOURCE Off Ice of Technology Assessment, 1994

FIGURE 1-11: Networking for Economic Advantage

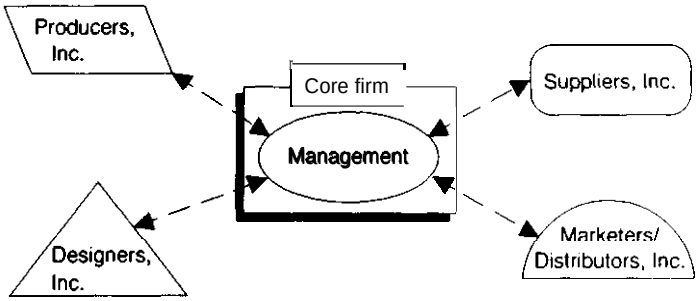
A: Fully-integrated firm



B: Outsourcing



C: Virtual corporation



SOURCE Off Ice of Technology Assessment, 1994

BOX 1-7: Technology Applications To Support Organizational Change

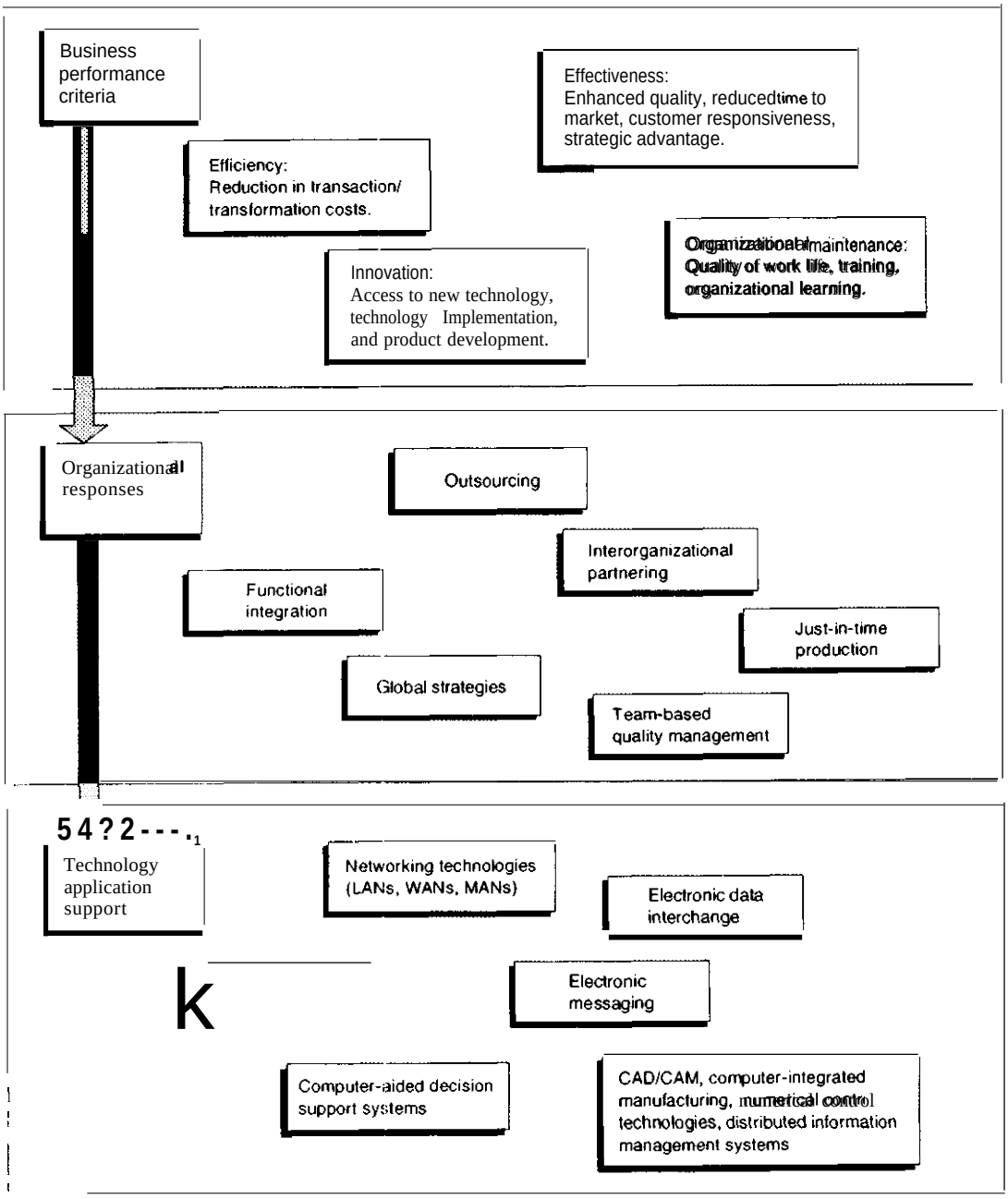
- Technology can help businesses reorganize to achieve greater efficiency, effectiveness, and innovation However, the benefits stem from the organizational change, not from the technology itself Some examples can serve to Illustrate (see figure 1-1 2),
- Mercedes Benz takes advantage of its computer-based communication network to differentiate and enhance its product It not only provides car owners with a toll-free 800 number to call for service, it also helps drivers locate a service provider, wherever they may be. Networked mobile phone and paging services also Improve service delivery by linking repair personnel to their offices while they are on the road With continual access, management can easily learn about schedule changes and hear directly from clients Improvements of this kind make firms more competitive
- The national drug company, McKesson Corp., used its networked Information systems to develop new products It offered its pharmacy customers a detailed analysis of their sales, including the profitability and turnover ratios of different items based on their orders over a period of time. The company also offered to print price labels for pharmacies.
- The OTIS elevator company uses its computer-based communication network to provide more efficient centrally coordinated repair activities, When clients call, they report their problem to a highly trained operator who records the information in a computer and dispatches repair personnel via a telephone/beeper system When the repair IS made, the information IS again stored in the computer so senior management can track repair efforts and deal with special problems as they arise Moreover, the recorded fault data, which are also immediately available online to the company's engineers and designers, can be analyzed by management to identify any recurring problems that might require more general corrective action
- In some companies, research data are now being integrated into other corporate information systems allowing for their more effective use throughout an entire organization For example, the Integration of systems at Marion Laboratories Inc allows the R&D department to send the formula for a new drug along with the engineering process control data, directly to the manufacturing department This same information IS sent to the sales and marketing department where it IS used to create educational materials for physicians to use when testing the drug.
- Using sophisticated databases that track consumer behavior, companies can refine their marketing campaigns Donnally Marketing in Stamford, CT, for example, specializes in providing this kind of service It gathers and correlates the responses to questionnaires that are mailed to consumers along with shopper coupons, and then stores the Information in a large-scale database where it can be reprocessed and retrieved as needed With this system, the company can track the purchasing patterns of more than 90 million households

(continued)

SOURCE Off Ice of Technology Assessment 1994

BOX 1-7: Technology Applications To Support Organizational Change (cont'd).

FIGURE 1-12: Performance Criteria, Organizational Responses, and Technology Support



SOURCE Off Ice of Technology Assessment 1994

ket. Where this occurs, market structure will depend as much on network characteristics, and the economies of networks, as it does on relationships among firms.

The rise of vertically integrated firms at the end of the 19th century was facilitated by the transportation, communication, and information technologies of the day—the railroads, the telegraph, and the telephone. By increasing the speed and control with which goods could be moved, processed, and distributed, these technologies made it possible to coordinate and manage production on a very large scale.

A reverse trend is occurring today[46] (see box 1-8). In a highly complex and rapidly changing global economy, vertical bureaucracies are pushed to their limits. Businesses everywhere are increasing their flexibility by downsizing and outsourcing.[47] They are increasingly purchasing in the market what they need, whether preassembled parts, logistical support systems, customized communication services, or packaged business information. At the same time, a multitude of new enterprises, structured to serve a particular business need, are appearing to provide these services.

This shift toward greater market reliance is being facilitated and fostered, as in the past, by technological advances. However, unlike earlier technologies that diminished the costs associated with large-scale organizations, today computer-based communication networks and shared information systems are reducing the costs of carrying out market activities.[48] These include, for example, the costs of searching for the right products and best deals, executing transactions, and monitoring and enforcing the terms of the trade. Taking advantage of electronic data interchange, for example, buyers can place orders with appropriate suppliers, execute exchanges, transfer funds, and update inventories, all automatically and online (see box 1 -9). Similarly, global corporations such as Chrysler Corp. can outsource the production and assembly of many parts to a number of suppliers located in different countries, knowing that these pieces, having been joint] y engineered and developed through computer-integrated engineering systems, will all fit together.

A growing number of technology applications are designed to facilitate and support various aspects of market exchange (see box 1-1 O). These include, for example: 1) search tools such as audiotext and videotext, online databases, electronic catalogs, and multiple-listing services; 2) exchange mechanisms such as 1-800 numbers; credit, debit, and smart cards; EDI; automated teller machines; and computer reservation systems; and 3) electronic monitoring and enforcement systems such as electronic data capture, credit card authorization, electronic funds transfer, and automated clearinghouses.

As these technologies and their various functions are brought together into integrated and interactive networks, more and more trade will take place electronically, online. How these electronic markets evolve, and the actual form they take, w ill have significant consequences for competition and the functioning of the economy as a whole. Because electronic markets can reduce the overall costs of doing business, they can greatly enhance efficiency and lead to expanded trade. This may

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[46] See Tom Malond, Yates, and R. I Benjamin, "Electronic Markets and Electronic Hierarchies: Effects of Information Technology on Market Structure and Corporate Strategies," *Communications of the ACM, vol.* 30, No. *6,* June 1987, pp. *484-497.* See also, Ajit Kambil, "Information Technology and Vertical Integration Evidence from the Manufacturing Sector"; in Steve S. Wildman and Margaret Guerin-Calvert, *Electronic Services Networks: A Business and Public Policy Challenge (New* York, NY: Praeger, 1991); and Stuart Smith, David Transfield, John Bessant, Paul Levy, and Clive Ley, "Factory 2000: Design for the Factory of the Future," *International Studies of Management and Organization,* vol. 22, No. 4, pp. 6 1 -68.

[47] See Gadi Kaplan, "Manufacturing A La Carte: Agile Assembly Lines, Faster Development Cycles. " *IEEE Spectrum,* September I 993, pp 24-27; and Gary Hamel, "The Core Competence of a Corporation," *Harvard Business Review,* May/June 1992, pp. 79-91,

[48] See J. Yannio Bakos, "A Strategic Analysis of Electronic Marketplaces," *MIS Quarterly,* September 1991, pp. *295-309.* See also Chris Holland, Geoff Lockett, and Ian Blackman, "Planning for Electronic Data Interchange," *Strategic Management Journal,* vol. 13, *1992,* pp. 539-550.

BOX 1-8: Markets, Firms, and Networks: Their Relationship to Information Technology

Information is required for all economic activity The exchange of information is at the heart of the market system A market economy relies on the communication of information to identify buyers and sellers, allocate resources, and establish prices Within firms, the availability of timely and accurate information is key to decisions about whether to enter or exit markets, how to finance, how to organize working relationships, and how to distribute and market goods. Where adequate reformation is not available, markets will fail and economic performance will suffer because of higher business costs

Information and communication technologies are critical in determining the nature of firms and the structure of markets These technologies reduce the costs of doing business, and can increase economic activity and foster economic growth in several ways To understand the Implications of newly developing reformation and communication technologies for the future organization of business and markets, they must be considered from a historical perspective

Once markets were face-to-face exchanges. Commerce took place in town centers where people congregated to exchange and trade goods. The costs of doing business were small, buyers, sellers, and the intermediaries who provided capital, credit, and brokered information were all present As transportation improved, local markets gave way to regional fairs, and later, with the development of sailing and navigational technologies, to port cities such as Lisbon, Genoa, Venice, Antwerp and Amsterdam [1] But, until the development of the telegraph m the last half of the 19th century, the size of markets, as well as the extent of trade, were constrained by the slow pace at which goods and market information could be transported [2]

Communication and information technologies also affect how businesses are organized When transportation and communication over long distances was difficult and slow, merchants had Insufficient information on which to base sales Prices differed significantly from market to market, so most merchants avoided long-distance trading, When they traded, they relied on merchants in distant trading centers to sell their goods for a commission To reduce and spread the risks Involved in distant trading, they sold a variety of products and avoided single product specialization

With the development of the railroads in the 1830s and the telegraph in 1844, the speed and control needed for specialization and large scale production was in place The speed of communication and the range of control afforded by the railroad, the telegraph, and later the telephone enabled the growth of large organizations with modern management structures, a first step in the centralization of production and distribution [3]

The impacts of these technologies were cumulative Trade gave rise to more trade As markets expanded, the number of merchant exchange networks using communication technologies and the amount of available market information increased As a result, distribution costs declined, and merchants were further encouraged to engage in trade Moreover, with larger markets and better information, businessmen faced fewer risks, and they were able to specialize in importing, wholesaling, retailing, or exporting Increased specialization led, in turn, to better coordination of markets and reduced costs, making trade even more attractive. The information-based networking technologies being developed today will have an equal, if not greater, effect on economic performance

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[1] Fernand Braudel, *The Perspective of the World, Civilization and Capitalism 15th-18th* Century, vol 3 (Berkeley, CA University 01 California Press, 1992), pp 118-119

[2] James Beniger, *The Control Revolution Technology and the Economic Origins of the Information Society* (Princeton, NJ Princeton University Press, 1986)

[3] Alfred D Chandler, *The Visible Hand* (Cambridge, MA Harvard University Press, 1977)

SOURCE Off Ice of Technology Assessment, 1994

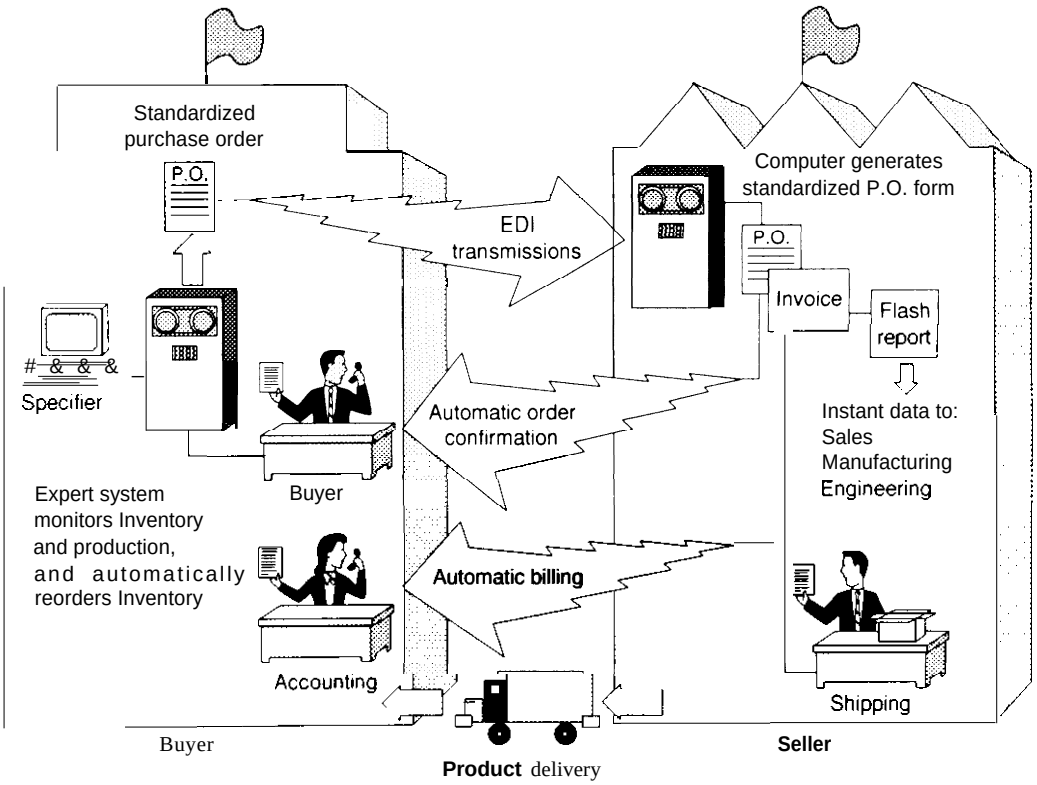
BOX 1-9: Electronic Data Interchange (EDI)

Electronic data interchange (EDI) is a notable example of how information and communication technologies are emerging as Important strategic tools for efficient and effective business operations EDI is essentially the modern, computer-based method by which companies order, invoice, and bill their products and services Such common transaction functions as invoices, shipping notices, and bills which traditionally have entailed the transfer and processing of paper documents, are replaced by electronic transfers between the businesses' computers (see figure 1-1 3)

EDI improves the efficiency and effectiveness of operations by enabling businesses to purchase supplies and to produce and distribute products precisely when and where they are needed The company's computer system, for example, wiII initiate a purchase order and execute the purchasing transaction when an item is requested and removed from the inventory The price, terms, and conditions of the contract are all stored in the computer In addition to the considerable savings gained as Inventory costs are reduced, EDI also minimizes human clerical error and the considerable processing costs involved with paper transactions By reducing or eliminating the prolonged and often error-plagued paper trail large retailers and manufacturers are able to gain a competitive advantage by streamlining transactions with their suppliers and buyers

SOURCE Off Ice of Technology Assessment, 1994

FIGURE 1-13: Electronic Data Interchange



SOURCE Reprinted from Datamation Mar 15 1988

BOX 1-10: Electronic Commerce Matrix

Markets can be viewed as the web of relationships between buyers, sellers, and products that are revolved in an exchange While only two basic roles—that of consumer and producer—are essential for an exchange to take place, more often than not others act as intermediaries facilitating transactions These might include advertisers, retailers, financiers, bankers, and brokers

There are a number of economic ("transaction") costs entailed in market operations These include the cost of searching for products, buyers, and sellers, the cost of arranging and carrying out the exchange, and the cost of ensuring that the terms of the trade have been met

Each of these transactions occurs through some form, or pattern, of communication interaction 1) a one-to-one connection—as in the case of two parties meeting face-to-face or connected by telephone, 2) a broadcast, or one-to-many connection—as in the cases of the fishmonger, the floor trader, or TV shopping channel; and 3) many-to-many connections, as in the cases of bazaars, regional fairs, or an electronic trading market

As depicted in the matrix, (see figure 1-14), communication and Information technologies can be arranged in each of these three ways to support each of these types of economic transaction In the past, when such technologies were not available, human Intermediaries carried out these roles For example, before the advent of the telegraph, it was the "jobber" who personally earned market Information relating to southern cotton to Manhattan where he sought buyers who would match the price The jobber's role was "to make the market " On the floor of the stock market, the broker (often referred to as a jobber) similarly "makes the market "

Many of the same technologies can be used to support different kinds of communication patterns and activities, and thus they appear within more than one box in the matrix The Important thing to note IS that, the more that these technologies can be linked together to provide more services to more users, the greater the savings in transactions costs and the closer the electronic network approximates true electronic markets

(continued)

SOURCE Off Ice of Technology Assessment, 1994

not occur, however, if electronic markets fail to interconnect for lack of standards, or if large businesses are overly successful in developing dominant, proprietary networks that are used to create new barriers to market entry.[49]

KEY FINDINGS AND POLICY IMPLICATIONS

| Transaction Costs in Determining Economic Performance

A major part of the cost of business is gathering, exchanging, and using information.[50] Information exchange is the essence of markets. Markets function through interactions among trading partners, suppliers, producers, vendors, brokers, and consumers. In this sense, information is the most valuable commodity in an economy.

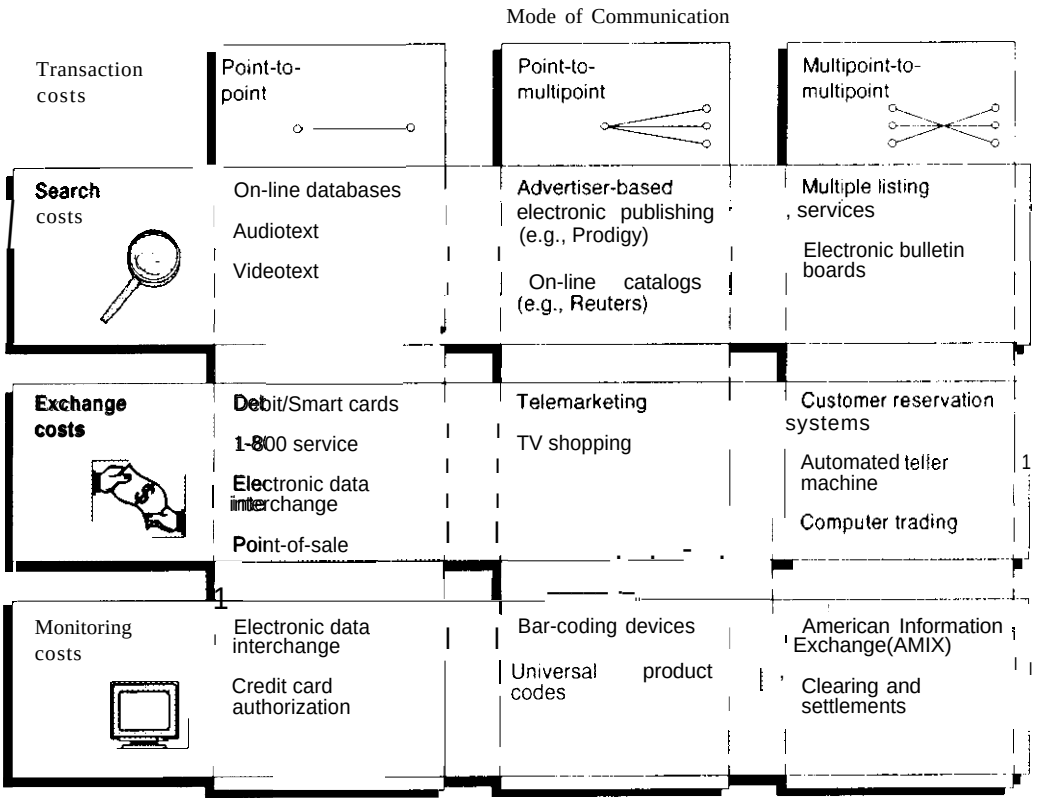
Consider markets in the context of a consumer buying a high-end stereo system. The buyer mulls over the features that are most important—wattage, audio performance, appearance, size, speakers, CD player, tape deck, and cost. There may be hundreds of dealers to choose from. The consumer reads catalogs, compares specifications, consults Consumer Reports, calls for price information,

[49] Ibid. see also Kogut et al op cit footnote 17; Robin Mansell, "Information, organization, and Competitiveness: Networking Strategies in the 1990s,"' in Cristiano Antonelli (cd.), The *Economics of Information Networks* (Amsterdam, The Netherlands: North Holland, 1992), pp. 217-227; and Stuart Macdonald, "Information Networks and Information Exchange, " in ibid.

[50] See O]iver E, Williamson, *The Economic Institutions of Capitalism (New* York, NY: The Free Press, 1985).

BOX 1-10: Electronic Commerce Matrix (cont'd).

FIGURE 1-14: Electronic Commerce Matrix



SOURCE: Office of Technology Assessment, 1994

and visits dealers to compare models and prices. The search can take hours, days, or weeks. The time spent in research, comparative shopping, and making the deal are "transaction costs, " as are the expenses for fuel, wear and tear on the automobile, magazine and catalog purchases, and telephone charges.

Manufacturers are also faced with transaction costs. First. a manufacturer has to read the market for signals about the size and specific nature of demand. Then he must find the necessary materials and contract with suppliers; search for the most suitable workers and managers: negotiate their wages and salaries: and perhaps even provide on-the-job training. Assembling people and materials in the right place at the right time, and coordinating and monitoring the actual production process. is also costly in terms of time and effort. So, too, is the task of sett ing up distribution channels or dealerships. To stimulate future demand, the manufacturer will also have to promote his product among potential customers, track customer behavior, and invest in advertising.

These kinds of transaction costs are on the rise in today global, knowledge-based economy comprised of many more players and fewer standardized, mass-produced products. Now buyers and sellers must explore a multitude of options and be able to compare costs and values acrossf languages and cultures and on the basis of differ-

ent currencies. When laws and institutions differ, special arrangements are required to guarantee contracts, warranties, and standards. Many American businesses wanting to trade in Europe have had to make costly arrangements to certify that their products meet European standards.[51]

As transaction costs begin to constitute a greater proportion of the total costs of production and exchange, a firm economic performance, as well as a nation's competitiveness, will increasingly rest on its ability to efficiently process and distribute business-related information. When businesses can access the best available information at the most appropriate moment in time, they can reduce their costs and enhance their productivity. Similarly, when buyers and sellers can easily locate one another, and have a good idea of what they can expect in terms of quality and price, they are more 1ikely to engage in trade. The result will be greater economic growth and development.

| Using Networking To Reduce Transaction Costs

Economic activities are all based on some level of "social" networks. Doing business is a social activity.[52] Trust, respect, knowledge, and even friendship are part of any business transaction. This subtlety is often obscured by one of the myths of American business—that deals are based on impersonal, fact-based, hard-nosed business decisions. In other countries with different cultures the connection between family position, castes, and friendship and business dealings are more obvious. The "Kerietsu" of Japan, the "Impannatore" of Italy, and the familial nexus of businesses in Taiwan are al1 examples of the commingling of business and personal networks.

These social networks are extremely efficient because much of the information that is usually transferred in the course of doing business is already accepted as a given .53 Thus, transaction costs are very low. Buyers and sellers are well known to one another. Shared expectations and an established level of trust reduces the need to haggle over prices and wages. In addition, the existence of social sanctions reduces the need to monitor performance and assure that the terms of business transactions have been adequately met.[54] The benefits of social networks are, however, generally limited in scope. When extended to global markets, for example, time, space, culture, language, and different legal traditions will likely undercut the basis for a common understanding.

Today, communication and information technologies can be used to conquer time and space. With advanced networking technologies and the growing number of business applications they can support, buyers and sellers—regardless of their geographic locations-can interact online in a virtual, electronic space. Under such circumstances, the network will, in effect, become the marketplace. Linking buyers and sellers directly, the need for information—as well as for costly intermediaries to transport, process, and interpret it—will be significantly reduced.

For example, electronic data interchange (EDI) is a computer-based system that allows companies to order, invoice, and bill their products and services electronically. Common transactions such as invoicing, shipping and billing—which traditionally have entailed human interaction and the transfer and processing of paper documents—are replaced by automatic electronic transfers between business computers. Prices, terms, and the conditions of a contract are all stored electronically. Electronic data interchange networks that allow businesses to operate on the basis of a shared information system can greatly improve efficien-

[51]Amy Zuckerman, *ISO 9000 Made Easy: A Self-Help Guide to Certification* (Amherst, MA: INEX, Information Export, 1993).

[52]Mark Granovetter and Richard Swedberg (eds.), *The Sociology of Economic Life* (Boulder, CO: Westview Press, 1992).

[53]North, op. cit., footnote 9.

[54]Robert Axelrod, *The Evolution of Cooperation* (New York, NY: Basic Books, 1984).

cy, triggering purchasing and distribution just when and where they are needed.

To some extent, communication and information technologies can substitute for some of the social and cultural "glue" that welds social networks together, giving rise to a number of efficiencies. Reducing transaction costs, they can improve productivity, greatly extend markets, and thereby generate wealth. Nonetheless, technology is the medium, not the end in itself. The social and cultural relationships-the trust, dependability, and honesty-of those who do business over the electronic business network will spell its success or failure in serving American business and the nation's economy.

| Designing Networks To Meet Business Goals

The "architecture" of electronic business networks is critical in determining their economic impacts. Like a sculpture that is fashioned from Tinker Toys, a network's structure is determined by the connections and 1inkages that give it shape. How these networks are formed and ultimately joined together to comprise a national infrastructure will influence the cost of doing business. Their design will also affect the overall efficiency of the economy, the size and scope of markets and the ability to conduct trade, the distribution of economic costs and benefits throughout the economy, and the nature of work and the quality of jobs.

To serve business and the nation's needs, the network architecture will need to be flexible and open, Without such versatility, businesses will be unable to rapidly reconfigure their networks to respond to changing circumstances and market demand. Nor will they have the leeway needed to customize applications and networks to support changing business processes and flexible working relationships. Moreover, with the freedom to mix and match a wide variety of network components, businesses can use technology to add value and develop new products and services.

To fully reap the benefits of communication and information technologies, networks and network components will also need to be interoperable and open for interconnection. Open, interoperable systems reduce transaction costs. Proprietary systems with closed standards both increase the cost of doing business and create significant barriers to market entry, Interoperable components provide greater network flexibility. greater ease of use, and reduced network costs. Technology diffusion will occur faster and more broadly, and equity of access will be encouraged as a result. Interoperable systems also provide a standard platform for the innovation of new components and applications.

In addition. if the economic benefits of networking are to be broadly shared. technology must be evenly and widely deployed. BUsiness networks may allow the first developer of a network to gain a significant competitive advantage. Networks benefit from economies of scale and scope; therefore latecomers may be at a disadvantage in attracting users and providing services. Latecomers might also be disadvantaged because business networking requires not only extensive expertise, but it also requires considerable "learn - ing by doing. " Although the profits derived from gaining a competitive advantage will likely stimulate network development, if all potential newcomers are locked out of the marketplace, anti - competitive behavior may result.

| Requirements for Access

The requirements for access will need to be recon - sidered with the advent of electronic commerce. To operate on a level playing field in such an envi - ronment, a business will need to be able to access the electronic network that serves as the market.

Today, a manufacturer who does not have outlets of his own must find a retailer to sell his products, This is generally not a problem; in any given geographic area—with the exception of rural areas—there are a considerable number of retailers who are willing to provide the manufacturer with shelf space. Bringing buyers arid sellers together, the retailer in effect "makes the market," and is thus paid for reducing everone's transaction costs.

In the case of electronic commerce, the situation is 1ikely to be much more complex. Electronic markets can be costly to establish with respect to both financial investment and expertise. Thus, they may be much less ubiquitous than today's retail outlet, at least initially. Unlike the local grocer, the profits to be gained from establishing electronic markets depend to some extent on their exclusivity. As a result, electronic markets may become more restrictive than retail stores in terms of access.

These differences stem from the incentive structure that is associated with the economics of networking.[55] If a network vendor decides to establish an electronic market, he must first generate a critical mass of users. Unless there is sufficient demand, the vendor will be inclined, at least at the outset, to pursue an open network strategy. However, given a critical mass, the vendor might choose an alternative strategy. Under such circumstances, the return on investment will likely be greater if he adopts a restrictive approach. Users would probably be willing to pay a premium for exclusive network access to gain in two important ways. First, they will have greater control over their customers or suppliers, as well as privileged access to market information. Secondly, they will benefit from the "economies of aggregation"[56] (see figure 3-3 in ch. 3) that stem from a significant reduction in transaction costs. Moreover, the benefits of reduced transaction costs will become increasingly important with the proliferation of independent electronic markets, as products become more customized and complex and markets are extended further across time and space.

Organizational Change Within Firms

New communication and information technologies are, to some extent, subversive; to be effective, they require organizational change. The most sophisticated technology and the best designed network architecture will not be effective without concurrent changes in business attitudes and procedures. Technology can, however, serve as a catalyst, helping businesses make the necessary adjustments to their changing environment.

In the new business environment, cooperation may prove more rewarding than competition, and information-sharing more fruitful than information control. Equally important, given the rapid pace of social, economic, and technological change, the most successful businesses will be those that employ information technologies not to control situation and events, but rather to enhance their ability to adapt to take advantage of them.

The workplace environment will be of critical importance. The overall shift in the structure of the economy from one dominated by mass production to one that is more flexible and centered on services will require a workforce that is similarly flexible and increasingly skilled. However, information technology can provide flexibility in one of two diametrically opposed ways. For example, shifting the burden of uncertainty onto the labor force, information technologies can be used to foster worker monitoring and a greater reliance on contingent labor. On the other hand, the same technology can be used to enhance worker skills and encourage team participation. If the benefits of electronic commerce are to be widely shared, strategies will be needed that foster quality jobs, high standards of living, and collaborative work environments.

The Government Role

As the world moves toward a global economy, the role of government will necessarily change. All major industrial nations are being forced to rethink their government's responsibility towards the maintenance of their economies in this era of rapid change. Russia and the republics of the for-

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[55] See, for discussions, Steve S. Wildman and Margaret Guerin-Calvert, *Electronic Services Networks: A Business and Public Policy Challenge* (New York, NY: Praeger, 199 *I*), Bakos, op. cit., footnote 48; and Antonelli (ed.), op. cit., footnote 49.

[56] Sometimes referred to as "economies of aggregation."

mer Soviet Union and Eastern Bloc are undergoing the most dramatic readjustment to free markets. Europe is struggling with the transition to a single, unified market where national governments play a lesser role. Japan is experiencing similar doubts and reservations, while trying to sort out its government's role in pulling the country out of a severe recession.

The United States faces its own global readjustment, which will require moving from an unproductive ideological debate misdirected at whether the nation should have an "industrial policy." This kind of dialogue obscures the fact that government has always played—and, in fact, cannot avoid playing—a role in structuring economic relations and outcomes.

Take, for instance, the case of the National Information Infrastructure. The private sector clearly has the primary role for developing, deploying, and operating the NII. Similarly, for the most part, industry will develop the technology. provide the bandwidth, offer connectivity, and ensure the availability of services and products in the pursuit of profit, Government, however, cannot stand idly by. In its various roles as regulator. broker, promoter. educator, and institutional builder, the government must establish the rules of the game and the incentive structure that will help determine private sector choices.

The same is true of electronic commerce. In its role as regulator, the government will need to ensure that electronic networks and markets are evenly deployed, open, and accessible on an equitable basis. Acting as a broker, the government can bring together potential, but disparate, network users, thereby helping to generate a critical mass. Serving in the role of promoter, the government can take steps to overcome specific market failures with respect to advanced research, development, and/or technology deployment. As an educator, it can promote electronic commerce by fostering demand and the effective use of networking technologies. Finally, and perhaps most importantly, the government can create an institutional environment that strives to assure that electronic commerce is conducted in a manner consistent with the nation overall social and economic object ives.

| Impact of Information Technology Choices

The age-old adage that "knowledge is power" applies to a knowledge-based society. Whether referring to work relationships in a firm, competition in the marketplace, or trading relations among nations, having access to information and the ability to package it for a particular use is a key determinant of success or failure.

Clearly this was always the case. What is different today is the extent to which knowledge is now actually embedded in information and communication technologies. As a result, choices about these technologies-their design, architecture, and structure, or the rules and regulations governing their availability and use—will have far--reaching social and economic consequences.

Equally important, many of these choices will be irreversible, at least in the short and medium terms. Once a decision is made. technology tends to become firmly established along a given path. This pattern is especially evident with networked information technologies, which require vast amounts of sunk capital and social investment. Thus, periods of rapid technological advance provide a rare opportunity to reassess and redirect both the nature of a particular technology itself. and the economic and social relationships that are structured around it. Given the significance of the moment, and the potential consequences for winners and losers, care should be given not only to what technology choices are being made, but also to the process of how, and by whom, they are made.