



METROPOLITAN PLANNING COUNCIL

The Digital

Putting our minds together

Network

Infrastructure

and

Metropolitan

Chicago

A Report for the Metropolitan Planning Council

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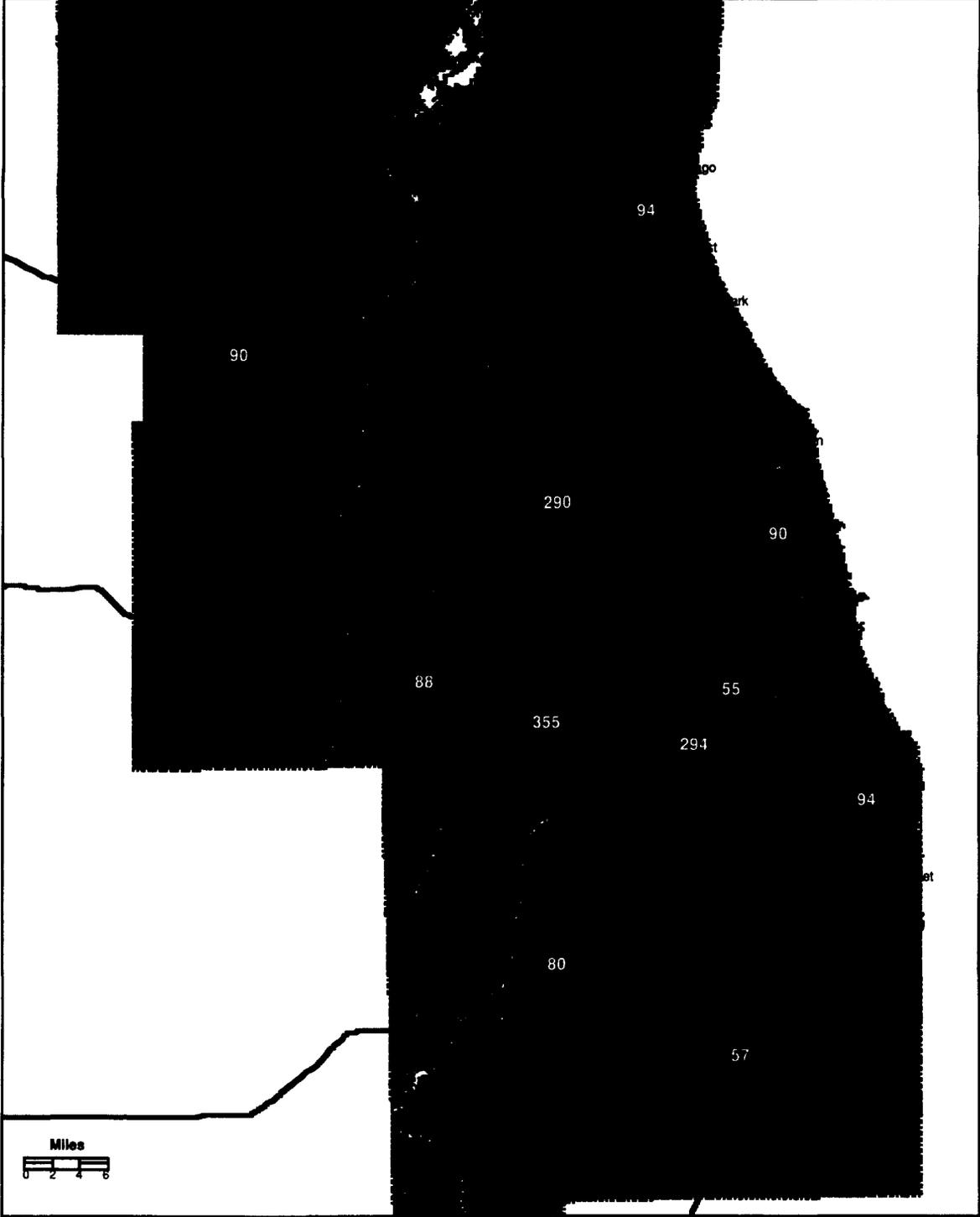
NORTHWESTERN UNIVERSITY
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SIX COUNTY CHICAGO METROPOLITAN AREA



**PUTTING OUR MINDS TOGETHER:
The Digital Network Infrastructure and Metropolitan Chicago**

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**Written for the
Metropolitan Planning Council
Chicago, Illinois**

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Scott Goldstein, MPC Regional Development Director, and MarySue Barrett, MPC President.

This paper can be found at
<http://www.nwu.edu/it/metrochicago/> and <http://www.metroplanning.org/>

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Dear Colleagues and Friends:

"PUTTING OUR MINDS TOGETHER" provides an assessment of the significant challenges and exceptional opportunities presented by information technology and access to the digital network infrastructure for Metropolitan Chicago. Few regions in the world possess the assets to quickly emerge as a leader in the information-based economy. With vision and leadership, Chicago can.

In January, 1998, I sponsored a Leadership Technology Workshop with Illinois' leading research institutions. I remarked then that our state was created because of its agricultural potential, it grew to dynamic status because of transportation, and now that same opportunity exists through the development of new technologies. As we closed the workshop I asked for an agenda for future actions. Dr. Widmayer and Dr. Greenberg have stepped forward with that agenda.

The message of the Leadership Technology Workshop and of this report is that Metropolitan Chicago has a unique convergence of the fastest digital networks on the planet. These networks can be used to extraordinary advantage for our economy and our citizens. This infrastructure, dynamically linking the region to the world, will be our stake in the 21st century.

I commend Northwestern and the Metropolitan Planning Council for the foresight to examine the remarkable implications of the digital network infrastructure. They present an ambitious agenda, and back it with a lucid, detailed consideration of the issues. Now is the time to again position the Chicago region as a global hub, this time using information technology.

To every reader I ask: "What can you do to make this agenda reality?" Take responsibility for some part of this extraordinary undertaking. We cannot miss the opportunity!

I look forward to being your partner in this endeavor.

Best regards,



Richard Durbin
United States Senator

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Dear Colleagues:

There is tremendous potential for using the digital network infrastructure to address many of the economic and social challenges facing the Metropolitan Chicago Region today. Each decision about its use, or the failure to use it, will have an impact. An alliance of public policy makers and corporate leaders, university officers and scholars, nonprofit organizations, leading consultants, and the legal community can make these decisions matter. The Metropolitan Planning Council deserves great credit for advancing this report as a way to inform the region and stimulate discussion.

At Northwestern University, we believe that digital networking is central to enhancing learning and teaching, supporting research and scholarly activity, and running our university effectively. "Putting Our Minds Together: The Digital Network Infrastructure and Metropolitan Chicago" has provided an opportunity to share some of what we are learning from this experience.

I thank Patricia Widmayer and Gary Greenberg for this outstanding work. It is an important contribution to the policy discussion and research on the impacts of the digital network infrastructure. My appreciation also goes to the Northwestern faculty who contributed "think papers" for the report: Louis Gomez, School of Education and Social Policy, and Computer Science; Edwin Mills, Kellogg Graduate School of Management; Mohan Sawhney, Kellogg Graduate School of Management; Susan Valdiserri, IBM Adjunct Professor of Leadership; Steven Wildman, School of Speech; Athanasios Ziliaskopoulos, McCormick School of Engineering and Applied Science; their graduate student colleagues Guy Cipriani, Kellogg Graduate School of Management; Scott Evans, Kellogg Graduate School of Management; Karen Frazer, School of Speech; Richard Halverson, School of Education and Social Policy; as well as Clarisse Croteau-Chonka, Director of the Chicago Consortium for Higher Education. I also want to thank other faculty who joined in issues seminars or provided insights.

We are pleased to have had the opportunity to work with the Metropolitan Planning Council to help identify the challenges and opportunities being made possible by the digital network infrastructure. We look forward to participating in the discussions about how the Metropolitan Region can take advantage of the emerging opportunities.

Sincerely,



Morteza Rahimi
Vice President for Information Technology

AN INTRODUCTION FOR METROPOLITAN CHICAGO'S PUBLIC OFFICIALS, POLICY MAKERS, COMMUNITY AND CORPORATE LEADERS

The digital network infrastructure that is expanding throughout the Metropolitan Chicago region is composed of services provided over fiberoptic cables, copper wires, coaxial cable, and radio/wireless transmissions. These services interoperate to transport any information that can be converted into digital format (see Appendix). Information technology and access to the digital network infrastructure are profoundly changing how we live, how we do business, and how we interact as people and institutions. As these technologies become more integrated into our lives, rather than risk letting chance take the upper hand in defining our future, a careful examination is needed by public officials, policy makers, community and corporate leaders to assess the opportunities and challenges that will confront us. Much can be gained for the region if the opportunities are seized and the challenges addressed. This report begins that examination.

Today, information technology and telecommunications affect each of us¹⁹. Our paychecks are automatically deposited in bank accounts and we use credit cards routinely to purchase clothing, tickets, and household goods. A single travel agent can coordinate airline, rental car, and hotel reservations. We can bank at an ATM machine 24 hours a day in most neighborhoods and in nearly every major city around the world. We can make business calls from a car phone while delayed in traffic. With a computer connected to the Internet from office or home, we can check the status of overnight deliveries, join a "chat room," play interactive games with friends, learn the latest news, follow a bill through Congress, or purchase books and gifts, computers and software, groceries and flowers from establishments that exist only as electronic storefronts.

We also move freely between different telecommunications technologies. We talk over the telephone, listen to music and news on the radio, watch movies and sporting events on broadcast, cable, or satellite television, and find information on the Internet through networked computers. While a different infrastructure is used to support each of these telecommunications technologies today, this is rapidly changing. Audio, text, pictures, and video can all be converted into a common digital format that is transmitted over the same digital network infrastructure.

Unlike the physical transportation infrastructure of roads, railroads, and air systems that moves goods and people, or the utilities infrastructure that is specialized to move resources like gas, water, and electricity, the digital network infrastructure can move all types of information in the form of digitized text, images, sound, and video, for many different purposes, instantly and simultaneously through a common "pipe."

"As these technologies become more integrated into our lives, rather than risk letting chance take the upper hand in defining our future, a careful examination is needed by public officials, policy makers, community and corporate leaders to assess the opportunities and challenges that will confront us."

The Networked Economy

A recent report by the US Commerce Department on "The Emerging Digital Economy"¹⁷ outlines the remarkable growth of the electronic marketplace and the digital economy. The number of potential consumers on the Internet grew from an estimated 40 million users in 1996 to 100 million in 1997. Traffic on the Information Superhighway is doubling every 100 days in the U.S. and the number of people connected to the Internet could reach 1 billion worldwide by 2005.

Sales on the Internet are increasing dramatically for pioneers in Internet sales and services. Sales at Amazon.com, the on-line-only bookstore, grew from \$16 million in 1996 to \$148 million in 1997. Dell Computer, which sells computers directly to businesses and consumers over the Internet, was selling \$1 million in computer equipment per day in January, 1997. Dell's sales reached \$6 million on some days in December, 1997. Auto-by-Tel saw purchase requests grow from 345,000 (\$1.6 billion) annually in 1996 to 100,000 requests (\$500,000) per month by the end of November, 1997.

Clearly, Information Technology (IT) is having a major impact on the economy. Information Technology¹⁷, as a percentage of the economy, grew from 4.9% in 1985, to 6.1% in 1990, to 8.2% in 1998. IT growth is twice the growth of the economy. In 1996 and 1997, it is estimated that IT industries lowered the overall inflation rate by 1%.

Metropolitan Chicago's Infrastructure Assets

Metropolitan Chicago is in a pivotal position to take advantage of the emerging digital network infrastructure. Already, the presence of technology-based companies is sizable³⁶. Over 343,000 people are employed in technology-based companies, producing 11.6% of the Gross State Product. Of the State's technology-based companies, 75% are in the six county metropolitan area, with 56% of these in Cook County.

Nearly 25% of the 100 largest companies in Metropolitan Chicago are in electronics, computers, or telecommunications¹⁰. There is also a major cluster of small, but rapidly growing firms that provide telephone, wireless, cable, Internet, and satellite services. Telecommunications companies with headquarters in the region include Ameritech, American Information Systems, Focal Communications, Genuity, InterAccess, Motorola, Telephone and Data Systems, Tellabs, Telular Corporation, US Cellular Corporation, USN Communications, Westell Technologies, Worldwide Access, and 360 Communications. Other companies with a significant presence in Metropolitan Chicago include 3Com (including US Robotics), Lucent, TCI Great Lakes, CellularOne, AT&T/Teleport Communications Group (TCG), IBM, and MCI.

“Traffic on the Information Superhighway is doubling every 100 days in the U. S. and the number of people connected to the Internet could reach 1 billion worldwide by 2005.”

Consulting, with major practices in technology, and network integration firms also play a major role in Chicago, including Anderson Consulting, Coopers & Lybrand, Computer Sciences Corporation, Fleishman-Hilliard, Metamor Technologies, and Whittman-Hart. These companies are engaged in assisting business and industry worldwide to assess applications and deploy technologies. Further, Chicago is pioneering the use of technologies through the leading financial services and other key industries. The Chicago Board of Trade, Chicago Mercantile Exchange, and Chicago Board of Options, to look at just one industry, conduct business twenty-four hours a day around the globe over the digital network infrastructure.

Metropolitan Chicago's Strategic Position

The interconnection of three high-performance research networks in Chicago is solidifying the Metropolitan region's role as a national center for high-performance digital networking and provides a foundation on which to build tomorrow's commercial services and other applications. The three networks converging in Chicago are:

- The Metropolitan Research and Education Network (MREN) (<http://www.mren.org/>), created by the University of Chicago, Northwestern University and the University of Illinois—Chicago with Argonne National Laboratory and FermiLab in collaboration with Ameritech, has been described as the most powerful high-performance regional digital network in the country. The Big Ten universities, Notre Dame, and other major research institutions in the Midwest are establishing connections into Chicago to reach this network.



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Yet, there is also caution to be exercised. Even though technology holds enormous promise, it will not magically solve problems or allow us to avoid existing problems. Some problems may even be exacerbated by technology. Existing polarization on social, economic, and geographic lines will certainly increase unless deliberate actions are taken to include everyone. If the digital infrastructure does not extend to certain neighborhoods, if equipment and services are prohibitively expensive, or if technical training and support are not available to all, the social and personal costs will result in a great “digital divide.”

When the opportunities and dangers of the digital network infrastructure are well understood, strategic decisions can be made to improve social, economic, and geographic circumstances. However, because this infrastructure is invisible, it presents a special challenge to planners and policy makers who are much more accustomed to dealing with the impacts of roads, airports, and buildings.

“The challenge for the Chicago region is to both expand the digital network infrastructure and to strategically leverage the advantages and assets of the region to lead the transformation.”

Five Principal Policy Recommendations for Metropolitan Chicago

While there are many challenges and opportunities for Metropolitan Chicago resulting from the digital infrastructure, five principal policy recommendations should undergird our response.

- I. Build the Metropolitan Chicago Digital Network Infrastructure.** No matter what the application, industry, or initiative, each will be dependent upon the digital network infrastructure for the capacity to deliver information and services. For electronic commerce and technology-based economic development; for transportation, land use and resource management; for education, workplace training and health care; and, for entertainment and the arts, the potential opportunities and benefits described in this report will not be realized without ubiquitous access to the digital network infrastructure for the entire Metropolitan region.

Communities, corporations, agencies, and institutions will need to be purposeful in planning to guarantee the internal capacity and connections to serve their constituent, business, and client demands. Further, high bandwidth lines, described by some simply as “big pipes,” must be available to all classes of users, and an adequate backbone must be deployed across the region to assure that everyone benefits.

Providing universal access for business, industry, government, public agencies, and homes to the digital network infrastructure to advance economic and social development throughout Metropolitan Chicago is a remarkable task that will involve cable, telephone, satellite, and wireless service providers. Building the digital network infrastructure, with the necessary internal capacity and connections to the backbone network, will be a major challenge for communities, corporations, agencies, institutions, providers, and policy makers.

- II. Advance the Region’s Information Economy “Ecosystem”⁵⁸ and Establish Strategic Targets for Technology-based Economic Development.** The opportunities to advance the region’s diverse economy in the Digital Age are considerable. However, these advances will not happen without concerted planning and action to support the region’s information economy “ecosystem.” This will involve assuring an educated workforce, strong university-business collaboration, a seamless infrastructure of interconnected digital networks, an expanding cluster of entrepreneurial companies, available venture capital, and a favorable quality-of-life.

Added to these elements, the region must establish strategic targets for technology-based economic development. The Metropolitan region has particular opportunities as a testbed for the development of next-generation network technologies and in developing network applications and content for the diverse businesses and industries of the region. The more promising and “Chicago friendly” of these targets appear to be in the fields of transportation, health and the life sciences, advanced materials and manufacturing, environmental technology, telecommunications and information technology services.

III. Use Technology to Strengthen Elementary and Secondary Education, Higher Education, and Workforce Training. The region will not move forward economically or socially without everyone being educated to the highest level possible. In order to enjoy a vital quality-of-life and contribute to progress in the region, every citizen must not only be able to read, write, and communicate effectively, but must also have the essential skills and habits required by the emerging information economy. Elementary and secondary education must provide the strong foundation, higher education must advance new ideas and procedures, and lifelong learning must be integral to the workplace and home.

The social and economic progress of the region is, first and foremost, dependent upon strong education goals and performance. We can advance these educational goals by effectively utilizing technology and assuring that all are prepared for the Information Age.

IV. Implement Aggressive Plans to Mitigate the "Digital Divide." There is considerable danger that certain segments of Metropolitan Chicago's population, certain neighborhoods, and certain endeavors will be excluded from the advancements afforded by the digital network infrastructure. Much of this is tied to financial resources, as some families, schools, and communities are unable to afford or do not understand the imperative of information technology. Yet, the price for leaving some behind is too high.

An organized plan is needed among community leaders, religious and neighborhood organizations, state and local policy makers, regional planners and educators, business and industry to assure that the Metropolitan region is not characterized by a "digital divide." The health of our social, economic, and political fabric is dependent on ubiquitous access to the information, resources, services, skills, and opportunities that are being made possible by information technology and the digital network structure.

V. Establish the Metropolitan Chicago Regional Planning Network. The digital network infrastructure offers new opportunities, but also new challenges to regional planning and cooperation. A Metropolitan Chicago Regional Planning Network on the Internet can serve a central role in identifying and organizing regional initiatives, facilitating the timely distribution of information, developing a shared database of information from the region's communities, and providing a model that would encourage local communities and regional bodies to use the Internet to advance planning and cooperation. A Metropolitan Chicago Regional Planning Network and its supporting organizations can use the technology to bring the region's community and corporate leaders, policy makers, planners, and citizens together to advance the challenges and opportunities explored throughout this report.

PUTTING OUR MINDS TOGETHER...

This report examines the particular opportunities and challenges for Metropolitan Chicago to leverage the emerging digital network infrastructure. It identifies advantages the region might successfully exploit and considers some of the dangers that could have long-term consequences. Finally, it examines the social impacts and the potential actions needed to guide the development of the digital network infrastructure for everyone's benefit. The goal for the region is to foster strategic plans and actions by public officials, policy makers, corporate and community leaders to secure Metropolitan Chicago's place as a dynamic nexus of the Information Age.

Take a careful look at the issues raised. Then, put your minds together to use the potentials of the digital network infrastructure to promote economic and social development throughout this great region.

1. BUSINESS, INDUSTRY, AND ELECTRONIC COMMERCE

Cahners Publishing, one of the largest communications company in the world behind Time-Warner and Disney, publishes more than 150 trade magazines and newspapers (<http://www.cahners.com/>). Nearly fifty are published from the regional office in Des Plaines. The Internet has become pivotal to their business, equaling the importance of their location near Chicago-O'Hare International Airport. They use the Internet for communications with clients, advertisers, and suppliers, as a means to distribute their products, and for internal management. Their entry into cyberspace has been dramatic over the past several years.

Many companies, from the very large to the very small, are looking to electronic commerce to enhance their business. In the recently released report, "A Framework for Global Electronic Commerce"¹¹, President Clinton, and Vice President Gore, describe today's electronic commerce:

"Internet technology is having a profound effect on the global trade in services. World trade involving computer software, entertainment products (motion pictures, videos, games, sound recordings), information services (databases, on-line newspapers), technical information, product licenses, financial services, and professional services (businesses and technical consulting, accounting, architectural design, legal advice, travel services, etc.) has grown rapidly in the past decade, now accounting for well over \$40 billion of U.S. exports alone....."

Further, the Internet can facilitate the global sharing of information and resources and provide an efficient channel for advertising, marketing, and even the direct distribution of certain goods and information services. A good source of information about emerging opportunities of Electronic Commerce can be found at CommerceNet (<http://www.commerce.net/>).

"Many companies, from the very large to the very small, are looking to electronic commerce to enhance their business."

Business in Transition

The convergence of money, commerce, personal computers, and the digital network infrastructure is creating new market opportunities⁴². Content providers, production houses, network infrastructure providers, and carriers are joining the traditional participants in commerce—distributors, wholesalers, and retailers. Efforts are underway to create the secure and trusted financial environment necessary to guarantee payments and credits and prevent theft and fraud.

The benefits of electronic commerce are becoming increasingly apparent:

- **More Options for Consumers.** Consumers are able to comparison shop, with more options available daily, and use the Internet to quickly locate hard-to-find products and customized goods. This means more choices and lower prices.
- **Lower Business Costs.** Business and industry are seeing lower coordination costs internally, and intermediary transactions between producer and retailer are being reduced. Lower physical distribution costs are also being achieved as information is passed electronically, some links in the distribution chain are bypassed, and carrying costs are eliminated.

The risk in this shift, according to experts including Wigand and Benjamin⁶⁵, is potentially smaller profit margins that must be compensated for by higher volume and efficiencies.

This is not to argue that everyone has developed an effective strategy to capitalize on the Internet. Some of the largest companies in the Chicago region are still casting about for the best way to generate revenue through this medium. They are looking at the challenges experienced by initiatives such as Time-Warner's Pathfinder. In 1995, Pathfinder was one of the top three Web sites in the U.S., but it is now ranked twenty-third among the top twenty-five Web sites at home and is not in those ranks for Web sites at work⁵². This slide led to estimated loses of \$8 million annually and the major overhaul of Time-Warner's new media operations¹².

1. Business, Industry, and Electronic Commerce

The Internet Land Rush

The Internet is having an important impact on day-to-day business³¹. Its use for electronic commerce is focuses on five areas:

- **Producing Products and Services.** Firms are beginning to provide new hardware, software, information content, and services. Metropolitan Chicago examples of this include Perceptual Robotics (<http://www.perceptualrobotics.com>) and Click Interactive (<http://www.clickinteractive.com>). Fee-based information services are also being offered, such as Crain's Chicago Business. Banks and mutual funds offer better consumer choices by providing new options for savings and capital investments.
- **Marketing and Information.** Many companies and organizations are hanging out a shingle on the Information Superhighway by posting informational Web sites. As Bollier⁵ writes from the Aspen Institute seminar, “(M)any sellers liken the cyberspace stampede to the Oklahoma land rush: It is assumed that the company that stakes the first claims will have the most attractive, commanding ‘real estate’ in the marketplace... Moving on-line, then, is not just a matter of reducing costs, eking out new efficiencies, and performing tasks with greater speed and convenience. It is about establishing a presumptive dominance in the marketplace that will assure long-term competitive advantage..... At present, the Internet’s chief value to commerce is as a promotional platform.”
- **Distribution Channels.** Other companies are using the Internet directing physical distribution and creating distributor networks. Wal-Mart’s supply chain is based on this concept. Similarly, the Automotive Network Exchange (<http://www.aiag.org/anx/>), built by the Big Three Automakers, is connecting suppliers, including many in Illinois, to share design specifications, just-in-time inventory, and other requirements.
- **Customer Service.** The Internet is also making business more effective by improving the quality of service through better communication with clients, business partners, and employees; streamlining ordering, shipping, invoicing, and payment with Electronic Document Interchange (EDI); facilitating market analysis, product marketing, and consumer testing; and, providing 7x24 access to information and support. The Internet is providing opportunities for business evolution by making it possible to serve new markets over a much wider territory and establish business relationships with more dispersed, even global, partners. Harley-Davidson’s extranet, for example, allows customers and dealers to file warranty claims, check recall status, submit financial statements, and, soon, order parts and accessories.
- **Internal Management.** Finally, the Internet is facilitating the internal management of business and industry. New Human Resources and Financial applications are revolutionizing the means and cost of doing business. The Internet is being used to improve business efficiencies by facilitating business process reengineering; improving product management, production, and quality control; reducing errors, time, and overhead; and, making it possible to easily share ideas, discuss problems, and identify solutions.

“The convergence of money, commerce, personal computers, and the digital network infrastructure is creating new market opportunities.”

Bollier continues by describing, “The stampede to create new value-added enterprises; to shrink the distribution and sales chain; to build new markets by accessing consumers directly; to invent new editorial and experiential venues; to provide comparative marketplace data and consumer information; to establish relationships of trust among strangers in the marketplace — all these functions will require a new species of intermediaries.” And many of these “cybermediaries” are, or will be, emerging in Metropolitan Chicago.

The new players to make or support the emerging value-added enterprises in the electronic marketplace will include content providers, production houses, network infrastructure providers, and carriers. Metropolitan Chicago’s particular strength or potential in these areas mean new and expanded business opportunities.

1. Business, Industry, and Electronic Commerce

Practical Issues

There are two functional matters, however, that should be attended to if Metropolitan Chicago is to take full advantage of the opportunities of electronic commerce.

- **Businesses Access.** Free market access to electronic commerce from all facets of our business community with minimal technical barriers, such as proprietary software or line exclusions, must be guaranteed. This is especially important for business-to-business transactions that improve economic performance.
- **Consumer Access.** Access for all current and prospective customers must be provided. Today, the typical Internet user is white, college-educated, young, mostly male, and employed in a professional occupation. But many more potential customers in the Metropolitan region are locked out of the electronic marketplace because they lack the expertise, money, or comfort level to enter cyberspace. High speed access, ease of finding an affordable service provider, and low-cost equipment are needed to assure broad consumer participation.

“It is in the economic interest of Metropolitan Chicago to assure that the digital network infrastructure is extended quickly and homes and businesses are connected.”

There is a long way to go before everyone is on the Information Superhighway. Yet, as is evidenced by the new opportunities for electronic commerce, it is in the economic interest of Metropolitan Chicago to assure that the digital network infrastructure is extended quickly and homes and businesses are connected. It is suggested by most sources that the private sector must play a key role to assure this reality.

Government's Role

There are some issues, however, that are for government, and others that government should resist. Together, public officials and policy makers, business and community leaders need to consider the legal framework that will undergird transactions on the Information Superhighway.

- **Where Does the Sale Take Place?** Exchanges are flowing constantly between Internet storefronts, product manufacturers and distributors, financial institutions, and consumers, all in different jurisdictions. Yet, there may be no predictable legal environment governing transactions, particularly for International contracts, liability, consumer protection, and other aspects of an exchange. Government, particularly states and the federal government, is right in addressing such issues.
- **What Can and Should be Regulated?** Problematic regulatory issues regarding electronic commerce are entwined throughout government, including taxes and duties, restrictions on the type of information transmitted, control over standards development, licensing requirements, intellectual property protection, privacy, and security. These issues warrant great caution from government lest the solution be more serious than the problem.

In “A Framework for Global Electronic Commerce¹¹,” Clinton/Gore advocate a minimalist approach from the public sector, while letting the private sector lead. “Governments should avoid undue restrictions on electronic commerce.... For example, the U.S. believes that no new taxes should be imposed on Internet commerce, and states should coordinate their allocation of income derived from electronic commerce. Governments should recognize the unique qualities of the Internet. The genius and explosive success of the Internet can be attributed in part to its decentralized nature and to its tradition of bottom-up governance.”

However, if firms doing business on the digital network infrastructure do not address the critical issues, and the public welfare is jeopardized, government will inevitably intervene.

1. Business, Industry, and Electronic Commerce

PUTTING OUR MINDS TOGETHER we can take advantage of the digital network infrastructure to improve the competitiveness of Metropolitan Chicago businesses, encourage the creation of new products and services, assure universal access that is required to make electronic commerce work, and provide a sound legal framework for transactions.

First, the business community, through the strong network of Chambers of Commerce and other business and trade associations, in collaboration with government and economic officials, should expand their efforts to provide a forum for understanding and capitalizing on the opportunities made possible by the digital network infrastructure. The agenda should include:

- Assisting all businesses to understand the potential of electronic commerce to increase competitiveness and expand market opportunities. This could be accomplished through seminars, workshops, conferences, Web-based information, and other vehicles;
- Working together to identify and eliminate the technical barriers to free market access, such as proprietary software, lack of standards, or line exclusions; and,
- Designing and implementing a strategy to assure, along with all governmental jurisdictions, that every corner of Metropolitan Chicago — homes and businesses — has access to the digital network infrastructure.

Second, public officials and policy makers should take the initiative to work with the private sector to assure an effective, sensible legal framework for electronic commerce without creating new barriers. This agenda should include:

- Facilitating actions related to contracts and liability.
- Consumer protection and security.
- Intellectual property and information content.

2. TECHNOLOGY-BASED ECONOMIC DEVELOPMENT

As the economy shifts dramatically from the production and movement of goods to the production and movement of information, global cities like Chicago have a natural advantage. The Metropolitan region has a concentration of infrastructure — air, ground and water transportation, digital networks, labor markets, business and financial services, medical complexes, and research universities. The creative and performing arts, cultural institutions, sports and recreation opportunities, and, in most cases, a recognized education system, make the Metropolitan region an attractive place to live. Metropolitan Chicago is a place where ideas, information, money, people, and services flow together, creating great opportunities for technology-based economic development.

Enhancing technology-based business opportunities can bring important returns. Duesterberg²¹ notes that, “Economists estimate as much as one-third of U.S. economic growth in recent years is attributable to dynamism in information technology.” The Illinois Coalition (<http://www.ilcoalition.org/>), in its “1997 Illinois High-Tech Yearbook³⁶,” cites the U.S. Department of Commerce estimates that each new information technology job results in five jobs being created in related industries.

The challenge for the region is to understand and strengthen Metropolitan Chicago’s technology-based economic development. Some cities are already identified with a strong technology-based economy. For a region as large and diverse as Metropolitan Chicago, rather than a single identity, technology-based economic development is likely to be most effective when considered across business services and applications in many fields. The new ideas, new money, new businesses, and new people arriving every day can define our future: “Metropolitan Chicago, The City that Works... with Technology.”

The Information Economy “Ecosystem”

Sawhney, Evans, and Cipriani⁵⁸ examined the core elements necessary for technology-based economic development in a “think paper” written for this report. They note: “In the information economy, economic value will be created by highly specialized firms linked via a digital information infrastructure. Instead of independent firms operating in a vacuum, information economy firms will grow and evolve in ‘economic ecosystems.’ Planners will have to think and act as gardeners. They will need to seed, feed, and weed economic ecosystems, and to compete against other ecosystems for investment capital and human resources.”

But, what is an “ecosystem” in this context? Sawhney, Evans, and Cipriani describe it: “Just as a biological ecosystem consists of symbiotic relationships among living organisms that grow and evolve over time, an information economy ecosystem consists of a network of economic institutions that co-evolve to create a thriving community of information economy firms.”

“For a region as large and diverse as Metropolitan Chicago, rather than a single identity, technology-based economic development is likely to be most effective when considered across business services and applications in many fields.”

There are seven core elements of an information economy “ecosystem.” each of which requires aggressive support to assure the growth of technology-based companies.

- A talented, educated workforce with continual opportunities for training and professional development;
- Research universities with close ties to industry that generate new ideas and procedures for future markets;
- The infrastructure to facilitate a business environment, including a robust digital network, transportation, research parks, financial and legal services, and government that works as a catalyst;
- Clusters of information economy firms that create a synergy to grow ideas and encourage entrepreneurs;
- The availability of venture capital, especially for early-stage, highly innovative ventures;
- A conducive physical, cultural, and recreation environment that offers a high quality-of-life; and,
- A perceived image as a technology center that draws and retains human and venture capital.

2. Technology-Based Economic Development

The leading information economy “ecosystems” — Silicon Valley (<http://svi.org>), North Carolina’s Research Triangle (<http://www.rtp.org/>), Austin, Texas (<http://www.ausven.com/austin.html>), Manhattan’s Silicon Alley, Boston’s Route 128, and Cambridge, UK³³ — were all measured by Sawhney, Evans, and Cipriani on each of these elements. Their assessment is that each has a definite personality and strategic position that builds on the traditional strengths of the region, and a position that is distinct from competing “ecosystems.”

The challenge for the Chicago region is to identify our strengths, address our weakness, and make strategic decisions that will drive technology-based economic development.

How Does the Chicago Region Stand Up?

When Metropolitan Chicago is evaluated in terms of the seven core elements of an information economy “ecosystem,” it is clear that the region is in a strong position to pursue technology-based economic development. What makes Metropolitan Chicago strong relative to other metropolitan regions is the diversity of its economy and its presence as a leading location for many business sectors.

- **Educated Workforce.** One of every fourteen persons in Illinois employed in the private sector works at a technology firm, providing an historic base and trained workforce³⁶. Illinois ranks fifth in the country in the number of scientific and engineering doctoral degrees awarded annually, providing a strong core of innovators. But there are major gaps in the education of large sectors of our diverse population that the region’s education institutions must address.
- **Research Universities.** Leading science, engineering, and computer science institutions, including Northwestern University, University of Illinois at Chicago and at Urbana-Champaign, the University of Chicago, Purdue University, Illinois Institute of Technology, and DePaul University are in the region or in close proximity, providing a continuing stream of graduates and new ideas that is not replicated in any state between the coasts. A challenge for the region is how to build and maintain strong relationships with business and industry across Metropolitan Chicago to channel new ideas from university research to entrepreneurs.
- **Infrastructure.** The major research universities have created the Metropolitan Research and Education Network (MREN), one of the most advanced regional digital networks in the world. MREN universities are also connected to the National Science Foundation’s very high-speed Backbone Network Service (vBNS), the framework for the emerging Next Generation Internet (NGI) and Internet2. The commitment of these universities to sustain their acknowledged leadership in high-performance digital networking, combined with the increasing availability of advanced commercial network services, provides a foundation for economic development throughout Metropolitan Chicago. However, as noted in the previous section, there is a considerable distance to go before universal access to the digital network infrastructure is assured for all businesses and consumers.

Sawhney, et al. further note that the infrastructure for supporting services, such as legal firms specializing in entrepreneurial technology businesses, and suppliers of business services is not as well-developed in the region as other metropolitan areas. Supporting this, Nunn and Warren⁵³ argue that “to effectively use the Information Superhighway, a local economy relies as much on the presence of firms that deliver computer services to all sectors, a well-developed computer support systems,...as it does on the communications technology....” While Chicago ranks fourth nationally among metropolitan regions in annual retail computer sales and third in the number of computer workers, the region does not rank in the top twenty-five in the ratio of computer support workers per 1,000 employees. Such cities as Washington D.C., San Jose, Boston, Dallas, and Atlanta have far better developed computer support services, providing them with the skilled personnel needed to operate their information technology infrastructure.

- **Clusters of Technology-based Firms.** Illinois ranked third in the export of manufactured technology products, representing almost half of Illinois’ \$32.2 billion in total export for 1996³⁶. The region is also home to technology giants, including Motorola, Ameritech, General Instruments, Tellabs, and US Robotics (now part of 3Com, headquartered outside Illinois). DeVol²⁰, however, assessed both the concentration and growth of technology-based companies in America’s metropolitan areas, and Chicago was not in the top 25 in either category. Based upon the concentration of high-tech industries, the front-runners are: San Jose/Oakland/San Francisco; Southern California

2. Technology-Based Economic Development

from Los Angeles to San Diego; Boston and surrounding towns into New Hampshire; Austin/San Marcos and Dallas; Washington/Maryland/Virginia; the New York corridor from New Jersey through the suburbs and city to Connecticut; Raleigh-Durham; Minneapolis-St. Paul; Philadelphia; and, Portland to Vancouver in the Pacific Northwest. While there are corporate giants and many growth technology companies are in Metropolitan Chicago, the numbers for other metropolitan regions suggest that the potential for the region is substantial. The growth of high-tech businesses has received considerable attention in Illinois recently, but not all of the factors have yet coalesced to make this a formidable high-tech region.

- **Venture Capital.** Venture capital investment in Illinois topped \$595 million in 1996³⁶, positioning the State eighth in the nation for technology-based investments. The majority of this support came from Illinois-based venture capital firms. Yet some experts have noted that there is not a well-developed venture capital community that focuses on seeking and supporting early-stage development.

'It is not enough to say that Chicago wants to be a Mecca for high-tech investment. This is tantamount to trying to be something for everybody, and everything to nobody!'

- **Quality-of-Life.** Many things contribute to the quality-of-life. For each person, the factors are different. But generally, Metropolitan Chicago's quality-of-life draws people from around the world. The arts and recreation, open spaces and the lakefront, world-renowned architecture and transportation, sports teams and a colorful political scene, a stable economy and many job opportunities, all combine to make this a livable city. Further, relative to competing high-tech markets, housing is more affordable and plentiful.
- **Perceived Image.** How do you change the image of a region? While some see Chicago as a dynamic, global metropolis, others, see it as the city of only Al Capone or of Michael Jordan. Chicago also continues to carry the dated perception of the "Rust Belt" and old-line manufacturing. Yet there is so much more. Even "old line manufacturing" has long ago become high-tech industries, such as the auto industry, or have disappeared. But the region's image has not kept pace with the reality. A concerted effort will be required to position Metropolitan Chicago as a technology-based center, "The City that Works....with Technology."

When matched against the requisite elements of an effective information economy "ecosystem," there is no doubt that Metropolitan Chicago has a substantial advantage, but there is more to be done.

Technology Intensive Sectors

The best opportunity for Metropolitan Chicago is to build on its existing strengths and foster an image that encourages technology-based economic development. The seven largest technology intensive sectors, as identified by the Illinois Coalition in the "1997 Illinois High Tech Yearbook³⁶," can provide the initial focus for technology-based economic development, along with the strong manufacturing sector. These sectors are:

- **Telecommunications**, with over 1,400 companies, including leaders Ameritech, Motorola, and Tellabs;
- **Life Sciences**, with more employment in health care and biomedical research and practice than anywhere else in US. Major firms include Abbott Laboratories, Baxter International, Medline, and Dade International, employing over 56,000;
- **Electronics**, including 3Com, General Instruments, Zenith, Molex, Bell & Howell, and Methode among a total of 1,558 electronics firms that profit from the region's large original equipment manufacturers;
- **Computer Software**, with 4,530 software companies including industry leaders Spyglass, PLATINUM Technologies, SPSS, and SoftNet Technologies;
- **Information Technology and Services**, including service and transaction processing businesses, such as Galileo International, Technology Solutions Company, Greenbrier & Russel, Whittman-Hart, and Comdisco;

2. Technology-Based Economic Development

- **Advanced Materials**, from ceramic engine parts to superconducting materials, are being developed by Illinois-based companies. Of particular importance are the business/industry/university Collaborative Access Teams (CATs) at Argonne National Laboratory's Advanced Photon Source (APS) that are working to improve or develop new advanced materials; and,
- **Environmental Technology**, one of the fastest growing sectors with over 1,400 companies led by Amoco, WMX Technologies (recently merged with USA Waste), Nalco, SafetyKleen, and others.

To this list we add:

- **Transportation and Resource Management**, one of the areas of greatest strength and expertise in this hub city.

Why Chicago?

For all of this, however, Metropolitan Chicago lacks a focus for technology-based economic development. As Sawhney, et al, note⁵⁸, "It is not enough to say that Chicago wants to be a Mecca for high-tech investment. This is tantamount to trying to be something for everybody, and everything to nobody!" The region will need to target and project a coherent image to differentiate Metropolitan Chicago from other information economy "ecosystems." Just as people and businesses are attracted to Silicon Valley for technology development, Southern California for multimedia and entertainment-related industries, and New York City for advertising and publishing, why will people and industries come to Chicago? This is not to suggest that the effort and image should be monolithic. The region's diversity is its strength. The strategic positions suggested by Sawhney and others play right into the diversity of Metropolitan Chicago. In addition to the sectors already developing here, two particular areas for entrepreneurial opportunity and investment exist:

- **Next-Generation Network Technologies.** The region has a unique opportunity to leverage the creation of the Metropolitan Research and Education Network (MREN) by the region's research universities and the growing commercial network infrastructure. With a commitment to maintaining the lead in providing a regional high-performance digital network, Metropolitan Chicago can offer the most advanced testbed for the development of next-generation network hardware technologies and the associated network software and services. The region could become the place where network and telecommunications companies will have to be located in order to develop innovative new products and remain competitive in a rapidly changing market.
- **Network Application and Content Development.** The region has traditional industries and services in which network application software and content is naturally developed. The strongest technology-intensive sectors in Illinois are identified above. Within the Chicago region there are clear niches that are most likely to be the focus of new network application and content development to meet the needs of the region's diverse business and industry, if that is the strategic focus taken. Areas that could provide new opportunities for entrepreneurship include transportation, financial services, architecture, the arts, and entertainment.

**"Equity and economic development
are inseparable."**

Leave No One Behind!

One critical caveat should be considered before this section is closed. Technology helps us do things better and creates new opportunities, but it does not, of itself, solve problems²⁷. There are social issues that need to be deliberately considered and addressed if the Chicago region is to have a productive information technology "ecosystem." Equity and economic development are inseparable. There cannot be excluded groups that are disenfranchised by the economic, social, political, and technological shifts that are occurring. Poverty is highly place bound and, to use Graham's term²⁷, "information apartheid" will diminish our return.

2. Technology-Based Economic Development

PUTTING OUR MINDS TOGETHER we can strengthen our information economy “ecosystem” to support extensive technology-based economic development across the region by concentrating on the most opportune niches for distinguishing Metropolitan Chicago, especially in network applications and content development to meet the needs of the region’s diverse business and industry, providing a regional testbed for the continuing evolution of next-generation network hardware and services, and acting on the pivotal social impacts of Information Technology.

Metropolitan Chicago is in an especially strong position to benefit from technology-based economic development. The challenge, together and independently, is to pull these strengths together into a greater whole and promote a shared vision for those who need to act. These actions should include:

- Deploy and maintain a high-performance digital network infrastructure with universal access for businesses and consumers. While the deployment will occur principally through the private sector, plans and targets can be driven with the public sector. The digital network is like the railroad, if you do not have a station, no one stops.
- Expand the computer services and support industry to assure adequate assistance to connect to and take advantage of the digital network infrastructure.
- Organize teams to aggregate the resources needed to address target opportunities, including next generation network technologies and services, as well as network application and content development, to meet the needs of the region’s diverse business and industry.
- Encourage and support business/university/state partnerships to share ideas and research findings that have market potential and invest in technology-based research and development initiatives.
- Ask local and state governments to play a proactive role, where appropriate, to enrich the information economy “ecosystem.” This should include facilitating the expansion of the digital network infrastructure.
- Make the technology assets and advantages of Metropolitan Chicago well known in order to establish a national and international reputation as a technology-rich business and industry environment that is supported by the most advanced digital network infrastructure in the world, “The City that Works....with Technology.”

Finally, the social impacts of information technology, especially with its potential for exacerbating the difference between the haves and the have-nots⁹, must be integrated into every topic touched in this report. References are threaded throughout, but should have special attention in the context of planning for future economic development.

3. TRANSPORTATION, LAND USE, AND RESOURCE MANAGEMENT

What is the impact of the digital network infrastructure on transportation, land use, and resource management? We are all dependent upon these systems to undergird the region's commerce and our daily lives. The availability and use of roads and bridges, public transit and communication lines, property, air and water, sewers and waste disposal are all determined through public policies that have been developed over several centuries. However, the impacts of the digital network infrastructure on these systems are not entirely obvious. Yet, although the digital network is invisible, its impacts on transportation, land use, and resource management are likely to be quite profound⁵⁴.

Demands on transportation systems and the ability to meet these demands will be guided by technology. The location of homes and businesses, spaces for parks and schools, and the designation of land for agricultural and readaptive uses will be affected by technology²⁷. And, resource management systems can be dramatically improved through technology. There is, quite literally, the potential that the enhancement of these amenities through technology will contribute to sensible growth and an even richer quality-of-life in the region.

But some of the most widely discussed outcomes of the digital network infrastructure, increased land use and decreased vehicle miles traveled, do not appear to be the most likely.

Telecommuting, Transportation and Land Use

Chicago has been portrayed by some as the perfect setting for the telecommuter. They imagine Joe and Susan, both with information-based businesses, such as accounting, financial services, medicine, higher education, or web-based retail, representing the majority of workers in the first decade of the 21st century. They each have a home office in their suburban house or city apartment from which they work at least three-four days a week. They see clients or go to a temporarily assigned space at a central office one day, perhaps travel to the Loop, or other central business area, for entertainment or to visit a museum on the weekend, and shop at the closest mall. Other travel is minimal, as they can order things for delivery or find services near home.

In this projection, use of the transportation infrastructure is diminished substantially, resulting in far less pressure on roads, bridges, and transit lines in the future, but creating far greater pressure for development on low-cost land or rural areas. In fact, some predicted there would be no advantage to living in urban areas.

“The demand shifts seen by the experts suggest different and increased, not decreased, pressures on the transportation system.”

But, look again. Many transportation experts, sociologists, strategic planners, and managers see a far different reality emerging. Only limited numbers of people will ever have the flexibility to work from the home. Construction and retail workers, office support personnel, most managers, the vast service sector, and most government staff must all be at a certain location or locations to do their work each day.

And, of those who could work from home, each must have sufficient space, appropriate equipment, personal discipline, and flexible management, all of which may not be available, to carry it out. Further, those who have all the necessary support are not likely to work more than two-three days per week at home, as face-to-face communications have an intrinsic value.

Thus, the prediction that the digital economy would contribute to unplanned growth as large numbers of telecommuters move to the fringes of urban regions and into rural areas has not and may not be realized. It follows, then, that the digital economy may not significantly increase pressures on the environment, utilities, transportation, and other valuable resources in the outlying and rural areas. Rather, as Mills⁴⁷ concludes: “(There will be) enough complementarity with face-to-face (and electronic) communications that most business growth will be in the Central Business District and suburban subcenters.”

3. Transportation, Land Use, and Resource Management

The Impact on Transportation

The demand shifts seen by the experts suggest different and increased, not decreased, pressures on the central transportation system resulting from access to information technology and the digital network infrastructure⁵⁰.

- Access to computers, wireless telecommunications equipment, faxes, and other technology permits many to shift the time and place of their activities. This increased flexibility will simply redistribute a likely increasing demand on the roads and transit systems.
- Dispersed business centers across the region mean that people and goods are crisscrossing the transportation grid in increasing numbers to reach a place of business or delivery destination.
- The ability to do business over a much larger geographic region will mean longer business trips.
- Access to information about travel options will encourage greater travel. People not making trips to the office are likely to make more trips to other places during the day or week.
- Products and services ordered over the Internet or telephone require more delivery trucks on the road to homes and businesses.

Researchers are finding that there is a complementary effect on travel. Travel will become more attractive as technology makes it more efficient and productive. Rather than substituting for travel or diminishing demand, technology seems to be a travel stimulant.

Intelligent Transportation Systems (ITS)

While it would be wrong for planners to assume that technology will reduce overall travel, technology can be an important tool for making better use of the existing transportation infrastructure and tackling significant transportation problems. The real impact of information technology and the digital network infrastructure on transportation in the Chicago region will be in the evolving Intelligent Transportation System (ITS), the deployment of complex, large scale freight handling and service delivery systems, and increased efficiencies in transportation infrastructure maintenance and repairs. Efficiencies achieved may not only save dollars and lives, but by expanding the capacity of the existing transportation infrastructure make many new roads unnecessary. For example:

- Motor vehicles with Geographic Information Systems (GIS) will inform drivers about traffic flow, warn them about congestion, and recommend alternative routes. The Illinois Department of Transportation, the Federal Highway Administration, the Illinois Universities Transportation Research Consortium, Motorola, and the American Automobile Association explored such a system as part of the Advanced Driver and Vehicle Advisory Navigation Concept (<http://ais.its-program.anl.gov>).
- Vision enhancement systems and collision avoidance systems will reduce the number of accidents and save lives.
- Automated pay-as-you-go road pricing can be used to control demand for roads, especially at peak times. The I-PASS automatic toll collection system demonstrates the feasibility of this.
- Tracking devices in busses can permit flexible routing and scheduling of public transportation.
- New applications of technology for public transportation are being explored, such as Raytheon's Personal Rapid Transit 2000 (http://www.raytheon.com/res/trans_prt.html), a joint venture with the Regional Transportation Authority for Rosemont, Illinois.
- Extensive inventory databases are allowing transport and distribution companies, including the railroads, to wholly manage the flow of parts and assembled products from manufacturer to assembler to customer.

As Athanasios Ziliaskopoulos describes in the "think paper" written for this report⁶⁸, "ITS uses information processing, communications, and electronics ... to save lives, save time, and save money ... Total transportation spending makes up nearly 20% of the nation's economy each year. Each year more than \$330 billion is spent on freight movement, and almost \$600 billion is spent on passenger travel." The stakes are substantial for the region and for businesses. ITS offers great potential for real cost avoidance. The effects for individuals are also substantial. According to Ziliaskopoulos, it is anticipated that traffic jams can be reduced 20% by 2011 using ITS. An even greater benefit can be achieved if the growth of vehicle miles traveled can be held constant or reduced.

3. Transportation, Land Use, and Resource Management

Encouraging or Discouraging Growth

As dependence on information technology increases for both business and personal use, providing easy access to the digital network infrastructure can become a powerful tool for managing land use and transportation. Growth can be directed, both in the suburban subcenters and in Chicago, by decisions about the placement of robust connections to the digital network infrastructure. Rather than the predicted impacts on outward growth, the digital network infrastructure could have a very different effect on land use.

- **Making Spaces More Desirable.** As with the interstate highways and the railroads before, businesses will find areas more attractive where connections to the digital network infrastructure are established. Conversely, areas where connections are not available will be less attractive for economic investment, but may be filled by less desirable businesses. There is an opportunity to be proactive to encourage open spaces and contribute to the quality-of-life.

As personal and business use of technology from the home increases, housing with access to the digital network infrastructure will become more attractive. Planning decisions about living spaces and retaining open spaces can be supported by planned investments in access to the digital network infrastructure.

- **Reclaiming Spaces.** The digital network infrastructure can also provide opportunities to reclaim underutilized or abandoned spaces, and create new magnet centers, whether in the inner city, older suburban locations, or central business districts. Providing preferred access to the digital network infrastructure for lower-cost office space and housing can stimulate entrepreneurial activity and encourage new development, just as an interchange on the interstate highway system fostered growth a generation ago.

**“Growth can be directed . . .
by decisions about the placement
of robust connections to the
digital network infrastructure.”**

Most analysts point to the desire of homeowners to locate close to work, entertainment, and cultural amenities. The digital network infrastructure can be used to bring housing, offices, industry, and retail closer together in useful and meaningful ways. A networked community that supports personal, home office, telecommuting, and business needs can also use technology to provide more responsive and adaptive public transportation¹³. The need for car trips might be reduced as people walk or use their computers to secure goods and services, relate as a community, live, and learn.

Managing and Monitoring Resources

The digital network infrastructure will make it possible to collect vast amounts of data in real time to monitor and manage the utility infrastructure, the environment, and other community resources³⁸. For example:

- Remote metering can be used to control utilities in “smart” houses and commercial buildings, resulting in increased efficiencies and conservation;
- Environmental monitoring by remote sensors and satellites of water and air quality, waste management and recycling programs, etc. will make possible instant analysis and response to environmental changes; and,
- Improved resource management, made possible by complete inventories and monitoring of all roads, alleys, bridges, sewers, and tunnels, can permit communities to plan detailed repair and replacement schedules.

The result can be better-managed, more efficient communities that provide a more desirable quality-of-life to their residents.

What About Regulations and Zoning?

While the digital network infrastructure will be a powerful resource for planning, decisions by local officials can either enable or impede its development. Regulatory impediments can facilitate or block access to pipes, poles, and rights of way. Further, insufficient attention to cable franchise agreements as they are negotiated may mean missed opportunities to expand the digital network infrastructure.

An important factor affecting land use is zoning. Zoning codes, applied beginning in the early part of this century, created strict divisions between land uses. This was done initially to separate the hazards of manufacturing from residential areas. The result of separating land use has been to increase congestion throughout the region as people travel between home and business areas.

3. Transportation, Land Use, and Resource Management

However, as the digital economy makes location increasingly irrelevant for many functions⁷ and manufacturing becomes cleaner, the lines between appropriate land use are becoming blurred. Home-based businesses are in many neighborhoods. Warehouses in industrial districts are being converted into residential lofts. Condominiums are being built in business districts with commercial space at street level. If the digital network infrastructure can be used to make it attractive to live close to work, shopping, and entertainment, the need for multiple car trips could be reduced.

PUTTING OUR MINDS TOGETHER we can aggressively pursue opportunities made possible by the digital network infrastructure to develop a regional Intelligent Transportation System that can increase the capacity of the existing roads and highways, make possible more efficient public and commercial transportation service, encourage responsible land use, reclaim underutilized or abandoned spaces, better manage public resources, and remove unnecessary impediments to universal access to the digital network infrastructure.

The actions that are needed to fully capitalize on the digital infrastructure to improve transportation, land use, and resource management should focus on coordination and information sharing.

- Support is needed from regional bodies, policy makers, the corporate sector, and researchers to assure adequate funding and full deployment of the regional Intelligent Transportation System.

The experience achieved through development of the Intelligent Transportation System within the Chicago region should be shared worldwide as both an asset and a product. This important niche, growing from Metropolitan Chicago's existing reputation as a transportation center, can be exploited for new entrepreneurial opportunities.

- Regional planners and local and state officials should be assisted in understanding the potential uses of the digital network infrastructure to support sensible land use and other preferred policy outcomes and develop recommendations for bringing land use regulations in line with technological changes. The agenda should include:
 - How decisions by local officials about facilitating access to the digital network infrastructure can either enable or impede transportation, land use, and resource planning;
 - How policies and regulatory decisions can encourage or block high-performance network access to pipes, poles, and rights of way that are necessary to extend the digital network infrastructure;
 - How planned infrastructure repair, rehabilitation, and construction can be coordinated with plans to extend the digital network infrastructure;
 - How official regional forecasting for transportation, employment, and population is impacted by access to the digital network infrastructure;
 - Updating zoning and comprehensive plans to take into account the changes in both commercial and home business practices that result from access to the digital network infrastructure; and,
 - Inform commercial and residential developers about how they can package telecommunication services to their tenants and aggregate demand to provide better services.
- A thorough examination of the effective uses of technology for resource management in the region should be supported, followed by a comprehensive plan for deploying appropriate new applications that can have a beneficial important impact on the quality-of-life in the region.

The Metropolitan Planning Council can play an important role in this effort as coordinator or facilitator, bringing together those who should understand and act on how the digital network infrastructure can facilitate the further integration of transportation, land use, and resource planning for the region.

4. BUILDING THE DIGITAL NETWORK INFRASTRUCTURE

Once a heavily regulated monopoly, the telecommunications industry today is rapidly shifting to a competitive market. The Federal Telecommunications Act of 1996 provides the framework for a transition that began with the court-mandated breakup of the Bell System in the early 80s. Competition has come to local and long distance, cable and wireless communications with profound effects for businesses, residential customers, and communities.

Who Will Make the Investment?

As the telecommunications industry becomes more market oriented and deploys new technologies, decisions concerning infrastructure investments will increasingly be made in response to prices set by supply and demand and the assessment of risk in the marketplace. Infrastructure investments include everything from laying fiber-optic cable, to installing wireless telephone towers, to buying digital telephone switches, to developing and installing new data transmission technologies.

Today, while the incumbent carrier, Ameritech, owns the most extensive infrastructure, the Telecommunications Act of 1996 is designed to encourage others to enter the market. The three choices for new entrants are:

- Become resellers of Ameritech services,
- Rent portions of the network from Ameritech that are supplemented with additional infrastructure; or,
- Build a wholly independent network.

However, the entry of competitors providing new infrastructure investments has been limited. Rather, ongoing litigation, continuing regulatory impediments, and rapid technological change have mitigated against new investments. Therefore, if new investments in the digital network infrastructure are to be made, the market alone does not appear to be the solution. Rather, targeted actions will be necessary.

A Changing Competitive Telecommunications Environment

Duesterberg provides an analysis of the dilemmas today in deploying and regulating the digital network infrastructure²¹. He writes:

“The history of regulation of telecommunications, from its inception in the late nineteenth century, is primarily the chronicle of drawing boundaries and setting limits. From a technological point of view, boundaries between cable, television, radio, cellular telephony, and wireline telephony are largely irrelevant in the converging world where all communication is in digital form. As consumers begin to have a choice of purchasing all of their digital services through a single platform, the competitive landscape envisioned by the authors of the Telecommunications Act of 1996 will begin to take shape.

“If new investments in the digital network infrastructure are to be made, the market alone does not appear to be the solution.”

“Such ‘deep convergence,’ however, is not possible until high bandwidth services are available to all classes of end users and adequate backbone capacity is deployed... Alleviating the threat of massive network congestion and unleashing the higher growth potential of the information economy sector, as we have seen, are complementary benefits to the process of accelerating the rise of a competitive telecommunications environment.”

Leveraging Current Investments

While considerable investment will be required to assure a high-performance digital network infrastructure across the region, there are a number of systems, which could provide a starting point.

- Networks, or access to the Internet, for member institutions are being developed by the City of Chicago, the Chicago Public Schools, the Chicago Public Library, Cook County, the regional library systems, the State Board of Education, and others.

4. Building the Digital Network Infrastructure

- City and regional networks with unused fiber could provide new backbone services. Examples include the City of Chicago's 911 system that could possibly be used to connect public buildings, and the Illinois State Toll Highway Authority's planned fiber-optic expansion that will enable it to monitor traffic flow and collect tolls at the plazas and could offer opportunities to connect adjacent towns and cities.

“Such ‘deep convergence’ is not possible until high bandwidth services are available to all classes of end users and adequate backbone capacity is deployed.”

- The research universities are installing ATM networks and have formed the Metropolitan Research and Education Network (MREN). A university consortium in Metropolitan Chicago is designing a collaborative ATM network. These academic networks could provide high bandwidth connection opportunities for other colleges and universities, elementary and secondary school districts, and cultural organizations in the region.
- Commercial providers, including WorldCom/MCI, TCG, Ameritech, AT&T (soon to acquire TCG), TCI, 21st Century Cable, Sprint, and others, are laying fiber in some communities to meet growing demand and are working with business and industry to provide network services.

These are just some of the initiatives in the region. As public initiatives and private investments move forward, an inventory of the available infrastructure would help us better understand the opportunities for leveraging existing investments and experience.

Encouraging New Investment

The Metropolitan Planning Council examined the issues related to regulations and investments in the briefing paper titled, “The Telecommunications Infrastructure, Regulation, and Chicago: An Overview and Future Challenges⁴⁶.” The examination focuses on two issues that are addressed throughout this report, as well:

- How can Metropolitan Chicago encourage increased investment in advanced network technologies for the high-density areas of the region?
- How does Metropolitan Chicago address the potential inconsistency in investment and access to advanced network technologies for areas outside these high-density areas?

The MPC Telecommunications Infrastructure report concludes: “Fortunately, despite the present uncertainty created by the federal regulatory flux, the state and metropolitan area have taken steps to encourage competition and investment. In particular, the General Assembly recently passed a bill which makes the interface between telecommunications entrants and municipalities much more uniform across the State, making the process less time consuming and more straight forward.”

In this environment, establishing priorities and providing incentives in the rapidly changing technological environment are issues for immediate discussion.

4. Building the Digital Network Infrastructure

PUTTING OUR MINDS TOGETHER we can initiate a wide range of incentives and strategies to accelerate and coordinate investments in the digital network infrastructure.

The incentives and strategies recommended to accelerate and coordinate investments are extensive and include:

- Tax incentives, such as accelerated depreciation and tax credits for providers, and/or user assistance to make connections to the digital network infrastructure in under-served areas;
- Creation of enterprise zones and the utilization of TIF funds, such as the emerging Information Technology District in the South and West Loop¹⁸ which focuses on the conversion of Class C buildings into high-tech facilities by encouraging the real estate community to pre-wire buildings being rehabilitated in order to attract high-tech companies;
- Joint public/private community initiatives to aggregate demand and share network infrastructure between government agencies, health care organizations, educational institutions, libraries, and municipalities;
- Public/private cost and infrastructure sharing such as:
 - Leveraging publicly owned easements to lower installation costs;
 - Developing processes to include surrounding communities prior to requests for proposals (RFPs) being issued so that needs can be bundled; and,
 - Expanding present infrastructure cost sharing programs, such as Special Service Area arrangements (SSAs), to include telecommunications infrastructure;
- A regional clearinghouse to provide information, outreach, education, and technical advice to communities interested in increasing telecommunications infrastructure investments in their area.

Each recommendation requires the involvement of many public and private sector organizations and leaders. The Metropolitan Planning Council can play a role in encouraging action on these recommendations and in integrating the last recommendation into the Metropolitan Chicago Regional Planning Network, proposed in the section on Government and Community Networks of this report.

5. WORKPLACE AND TRAINING

The Lake County Education-to-Careers Partnership recently held a Labor Summit geared to a discussion of workforce development. Their principal issue: assuring a well-educated workforce to meet the requirements of tomorrow's jobs. Employers in Lake County face a shortage of workers with the needed technical skills. To meet the demand, they are both casting widely within the region and across the country, and engaging educational institutions to focus more specifically on technology literacy. In response, the College of Lake County has joined with three other community colleges in the north and northwest suburbs to address the shortage by integrating the needed skills into their high-tech career programs and actively recruiting students.

One university has so many information technology vacancies, as experienced employees are hired away by technology and consulting firms, that a full-time recruiter has been retained. The search for employees with the skills needed in academic and administrative applications, networking and support services is not easy.

A study of Information Technology (IT) and non-IT companies with 100 or more employees done in November/December, 1997 by Virginia Polytechnic Institute and the Information Technology Association of America³⁷ suggests that there were about 346,000 vacant IT positions in three core IT occupations: programmers, systems analysts, and computer scientists/engineers. This represents 10% of the total number of core IT positions, or about 3 vacancies per company. This is almost twice the 190,000 IT vacancies in 1996. One reason for the increase is that most positions now require a bachelor's degree.

Across the region, the urgency of securing a trained workforce is being discussed. Conversations between business groups and policy makers highlight this as a top concern. The central issues, as described by one community entrepreneurship and employability project, are:

- The need for more educated and well-trained workers with good work habits, communication skills, and computer adeptness to meet the demand for qualified workers; and,
- Using technology in creative ways for mentoring, one-on-one training, accessing information and resources, connecting businesses and training organizations to meeting one another's needs, and linking prospective employers and employees.

Changing Job Requirements

Frazer and Wildman, in their "think paper" written for this report²⁴, comment, "(T)he most desirable and high-paying jobs are being created in sectors dependent upon information technology, such as health care, telecommunications, and financial services." They could have said, simply, the most jobs. IBM, in the 1996 white paper series "Understanding the Global Information Infrastructure³⁸," estimated that 65% of all U.S. workers were using some type of information technology in their jobs and estimated that this will increase to 95% by the year 2000. Information Technology has become a required competency.

The transformation of the workforce is evident across the region. Frazer and Wildman observe, "Workers (in all fields) increasingly will be required to access new forms of digitized information, work collectively and creatively to produce and to problem-solve, and to communicate their finds and results effectively using advanced telecommunications and information technology. This will necessitate encouraging the freedom and professional development of workers even at the lowest levels of an organization...." The demands upon all levels of education, from pre-school through the colleges to lifelong learning programs, will be substantial.

"Across the region, the urgency of securing a trained workforce is being discussed."

5. Workplace and Training

The Changing Workplace

At the same time, structural changes resulting from information technology are remaking today's workplace and today's work:

- **Skills Standards.** Today's workplace demands workers who are more flexible and highly skilled than ever before. Employees must be able to access resources and perform complex logistical tasks, regardless of the industry in which they are working or the level at which they are employed.
- **Flattening the Organization.** Fewer middle managers mean that new lines and responsibilities are being created within organizations. This is happening because digital technology enables employees to assume greater responsibility and transmit reports and information directly to decision-makers.
- **Continual Education and Training.** Changes in job descriptions, increased responsibilities, and the assumption of increasingly complex computer skills and adeptness with other technologies, means most employees must constantly learn new ways of working. It is estimated that people must reinvent themselves every five years in order to remain viable in the workplace.

Implications for Employers and Employees

There are many implications of the changing workplace, both beneficial and problematic. Drawing principally on the "think paper" for this report by Valdiserr⁶², the benefits seem to be:

- **Employee Flexibility.** Employees with young children, elderly parents, or other personal circumstances requiring flexibility in hours or location can make adjustments far more easily and with employer support.
- **Employer Savings.** By not requiring a permanent office or paying relocation costs, overhead expenses can be reduced for employers.
- **Recruitment.** Companies can expand their labor pool by recruiting qualified people without requiring them to relocate. Rather, they can use their computer skills and technology from their home, a local business center, or, for larger corporations, in designated flexible office locations.

"The most desirable and high-paying jobs are being created in sectors dependent upon information technology."

But the problems, particularly for telecommuters, are more difficult to address:

- **Isolation and Stress.** Workers connected through computer, fax, and wireless phone tend to work longer hours than those in fixed offices with fixed hours because they are always reachable. While this may mean as much as a 20% increase in productivity, over time lack of face-to-face contact, greater isolation from co-workers, and loss of personal time can be detrimental due to employees.
- **Lost Career Opportunities.** Lack of regular contact with management may cause remote employees to be overlooked for promotions or prime assignments.
- **Marginalized Employees.** Many technology workers are becoming marginalized, working as temporary employees, consultants, or independent contractors without benefits or stability. While these arrangements may have short-term advantages for technology specialists looking for their next challenge, it has the ultimate effect of isolating workers and placing a great burden on the individual to assume all social, educational, and medical costs.

Adapting to the changing workplace will require a partnership between employers and employees.

Workplace Training and Retraining

State agencies, community colleges, labor organizations, and corporate professional development programs are the principal partners in workplace training. These partners are also collaborating in many states to define a voluntary system of industry skill standards that specify prerequisite skills for individuals entering certain industries and occupations, such as electronics, health care, printing, and human services.

5. Workplace and Training

While the training partners are focused on basic skill development, other areas have not had the same attention:

- Little research and programming has been done on the new relationships and personal strategies needed to adapt to a flexible workplace, except at the major business schools. Yet, more is needed to assist employers and employees in medium and small businesses, the fastest growing business sector, who are unlikely to be connected to major business schools, to adapt.
- Technical skill building is a constant process, yet most training must still be done off-site. Many community colleges and some universities are able to bring training programs to the workplace, but often are unable to provide it at the hours and in the quantity needed. Technology, such as videoconferencing, and Internet-based instruction is needed as an asynchronous or distance training tool.
- Finally, many of the training environments — small community colleges, union halls, for-profit seminars, and proprietary institutions — simply do not have experienced staff, up-to-date equipment, or network connections to effectively train to current requirements.

Programs and Initiatives

To address the issue of assuring a technically skilled work force, Governor Jim Edgar's office formed the Human Investment Resource Council with responsibility for organizing the skills standards efforts and coordinating educational resources that will enable people to acquire necessary skills. Also, a major push is underway to network all of the State's Employment and Training Centers and Private Industry Council programs, and to assure connections for schools, libraries, and community colleges.

"To reach those who lack today's skills will require innovative new means and up-to-date equipment through community centers, libraries, religious and other organizations . . ."

At the federal level, programs are also being developed. The Clinton Administration announced in January, 1998 a new series of actions to meet the demand for workers with information technology skills. Such initiatives as the U.S.

Department of Labor's National Workforce Assistance Collaborative (<http://www.ed.psu.edu/nwac>), the National Association of Manufacturers' Center for Workforce Success (<http://www.nam.org/workforce/about.html>), and the National Alliance of Business Welfare-to-Work initiative (<http://www.nab.com/reentering/welfare.html>) are contributing to the national effort.

Unlike many other areas, however, workforce training does not lack for players and initiatives. The problem appears to be that entrenched bureaucracies and layer upon layer of programs and reforms over the last four decades have made it very difficult to maintain focus. New requirements, technologies, and strategies take years to effect. Illinois, for example, is a late entrant in Education-to-Careers, passing on several years of potential federal funding, rather than shift the balance of players and consider program realignment.

Thus, while the frustration of business and industry, unable to find enough educated, technically skilled employees, continues, the challenge is finding the right programs and resources, as many already exist.

Reaching Those Who Lack Basic Technology Skills

Above all, the concern is for those who do not have basic computer skills. An entire segment of our society has been passed by, either by choice, or, more often, inadequate exposure in the schools. To reach those who lack today's skills will require innovative new means and up-to-date equipment through community centers, libraries, religious and other organizations that may not yet be reached by the digital network infrastructure, as well as the more traditional institutions.

This is not to diminish the extensive effort now underway, but to suggest that technology can be used to improve program matches, reach new locations, and model the skills needed. Providing opportunities for developing basic computer skills is particularly important, given recent welfare reform which requires welfare recipients to find work.

5. Workplace and Training

PUTTING OUR MINDS TOGETHER we can upgrade technology literacy and advanced skills for everyone in the region, and help employers and employees use technology in creative ways to support effective work environments and workplace training.

Workforce initiatives are being created every day by public schools and private training companies, by corporate human resource divisions, colleges and universities, by Web developers and vocational educational specialists.

From a technology perspective, the challenge is fourfold:

- Improve access to information regarding job skill standards and available programs for current and prospective employers and employees. One of the most promising strategies for introducing new ideas and cutting through layers of bureaucracy is to use the Internet to reach the U.S. Department of Labor's Training Technology Resource Center (<http://ttrc.doleta.gov>) and other resources on the Web;
- Expand the use of technologies in workforce training programs — the Internet, electronic mail, groupware, and interactive desktop videoconferencing — to enhance both access to and the responsiveness and quality of programs for employers and employees at all levels;
- Assure that employers, employees, and education providers all have access to the digital network infrastructure and associated equipment so they can take advantage of new training opportunities; and,
- Examine, in depth, the implications of information technology on the workplace, the new "flexible" worker, and related issues for employers and employees.

None of these challenges is easy to address, but each can be advanced in a different forum. State agencies and their constituents can be supported on the first two. The third rests with the broader issue of expanding the digital network infrastructure across the region. And, the fourth challenge should evolve from an expanded collaboration between business and educational institutions about the impact of technology on the workplace.

6. HIGHER EDUCATION

At universities across the country with a high bandwidth campus network connecting the university externally to the world and internally across the campuses, faculty, staff, and students reach daily into the digital world. At Northwestern University, for example, 83% of on-campus students use the connections at their desks to access the World Wide Web, communicate by electronic mail, and engage in exchanges that enhance their classroom experience⁶⁴. Computer laboratories provide access to capabilities not typically available on student computers, serve as classrooms for innovative courses, and provide access to students who do not own a computer. Smart classrooms enable faculty to bring data, voice, and video into the teaching and learning experience.

Northwestern University's experience illustrates the potential impact of the digital network infrastructure for all of higher education. It is being used at area universities, colleges, and community colleges to:

- Expand student participation and interaction beyond the time and location of a particular class;
- Take advantage of information, resources, and authentic materials at libraries, museums, archives, and national laboratories for research and scholarly activity;
- Collaborate with colleagues across the region, across the country, and around the globe to exchange, manipulate, and analyze information, data, and ideas;
- Share classes, meetings, and conferences at multiple locations;
- Access specialized equipment at off-campus locations such as the Advanced Photon Source at Argonne National Laboratory or a radio telescope at Socorro, New Mexico; and,
- Enhance administrative functions through human resources and student services applications, administrative data analysis, electronic communication, and document sharing.

Similar applications are being developed each day at the University of Chicago and the University of Illinois' campuses at Chicago and Urbana-Champaign, DePaul University and the Illinois Institute of Technology, Oakton Community College and College of DuPage, Northeastern Illinois University and National-Louis University, and Governors State University. All use, or will soon be using, the digital network infrastructure to enhance the work of faculty, students, and staff.

“Faculty, staff, and students reach daily into the digital world.”

Demand for Education is Expanding

The demand for higher education is expanding, driven in part by changes in the workplace brought about by technology. High school and college students who lack basic skills, or need more advanced skills to enter the job market, require additional education. Employees need training to develop the tools or knowledge required to advance within their company. Even experienced staff and management, expecting to change careers 3-5 times, are seeking more courses, seminars, degrees, and certificates.

To address these needs, colleges and universities, institutes and professional schools are developing imaginative new ways to apply technology to improve teaching and learning. The potential of technology is to:

- Assure continuous training and learning opportunities, both on-campus and in the workplace, to meet the changing demands of business, industry, and government;
- Provide expanded, individualized, interactive educational and training opportunities for our diverse population and needs; and,
- Remove the barriers of time and location to education and lifelong learning for everyone, including working adults and people with disabilities.

6. Higher Education

The challenge, in order to support both individual citizens and the growth of the region, is to bring together the needed technology, share the best models and resources for teaching and learning, and assist faculty in realizing the potential of using the digital network infrastructure to improve education.

“ . . . Colleges and universities . . . are developing imaginative new ways to apply technology to improve teaching and learning.”

Regional Economic Benefits

The ideas and discoveries from our colleges and universities, expanded by the capacity of the digital network infrastructure, also offer new potential for business and industry. Karen Frazer and Steven Wildman detailed this potential for the Chicago region in a “think paper” written for this report²⁴:

- New discoveries can become products in the marketplace;
- New research findings can improve the workplace and production;
- New information and programs can become the universal content of tomorrow; and,
- New procedures — medical, chemical, economic, or analytical — can enhance the quality-of-life for millions.

University research and development, in collaboration with business and industry or government research facilities, such as Argonne National Laboratory and FermiLab, provide opportunities to explore innovative ideas and develop new applications of technology. Initiatives such as the National Computational Science Alliance at the University of Illinois at Urbana-Champaign, which involves national research teams exploring advanced computational science applications, can bring next-generation technologies to the point where they are ready for commercial development. Universities are becoming the economic engines of the 21st century, providing the new ideas, technologies, and talent to fuel economic development⁴⁰. As technology innovators, colleges and universities partner with business and industry to transfer discoveries into commercial services. Students with experience using advanced technologies on campus bring new approaches and ideas to the companies they join. And, when the kernel of an idea offers an entrepreneurial opportunity, faculty and students have sometimes started their own companies.

Tighter links between higher education, the business sector, and the State can stimulate even greater technology innovation to advance the region’s economic development goals.

“Universities are becoming the economic engines of the 21st century, providing the new ideas, technologies, and talent to fuel economic development.”

Challenges for Higher Education

Higher education requires substantial bandwidth to support collaboration, information sharing, more effective teaching and learning, and wider accessibility to educational opportunities. But access to, and use of, the digital network infrastructure is not universal.

- Many colleges and universities have low-speed connections to the Internet, making effective use of today’s Web resources and network applications difficult, if not impossible.
- Faculty and students at some institutions lack up-to-date equipment to take advantage of new data, voice, and video applications. Or, faculty must share a single computer and students must wait to use the few computers in campus labs.
- Other faculty resist using the network as a tool to support out-of-class discussions or to provide new instructional resources. Yet, research studies show that student learning can be enhanced through technology and the richness of discussions between students and faculty can be expanded through use of electronic mail and electronic discussions.

This is not to suggest there is no forward movement. Strategic initiatives to train faculty and integrate applications into the culture of an institution are beginning. Promising new collaborative efforts are also being organized to accelerate acquiring new resources and adopting new methodologies. Further, investments in information technology for education have high priority for Illinois’ policy makers, with hundreds of millions of dollars targeted to this purpose since 1994. The proposed Illinois Century Network³⁵, advanced by the Illinois Board of Higher Education’s Future Technology Task Force (<http://www.ibhe.state.il.us/>), is the centerpiece of this strategy.

6. Higher Education

The Illinois Century Network will be a high-speed backbone network 100 times faster than is currently in use that will link every higher education institution in the State. It will enable higher education in Illinois to improve the quality of traditional education and address the need for ongoing training from home, workplace, or local access sites. In addition to connectivity, the plan includes funding for support staff, training, and content development. The proposal builds on technology investments and coordinates with other initiatives to achieve the goal of universal access to educational opportunities and information resources for the citizens of Illinois at reasonable cost.

“But access to, and use of, the digital network infrastructure is not universal.”

Finally, imaginative new ways to apply technology for teaching and learning are being developed.

- Courses are being enhanced or offered entirely on-line through the Web. Both two-year and four-year colleges and universities in the region are working with faculty to organize on-line resources and courses. For example, Distance Learning magazine recently cited American History 102 at the University of Wisconsin/Madison (<http://hum.lss.wisc.edu/hist102/>) as the best course Web site in the country.
- The University of Minnesota (<http://www1.umn.edu/tc/VirtualU/>) and the Western Governors University (<http://www.westgov.org/smart/vu/vu.html>) are developing virtual universities, designed to provide full course work and interactive video over the Internet, in addition to full support services.
- The combination of good, expanding Internet resources, and desktop videoconferencing suggest important options for workplace training and lifelong learning;

PUTTING OUR MINDS TOGETHER we can support universal access to the digital network infrastructure for higher education; support faculty, students, and staff in the best uses of technology to expand teaching, learning, research, and scholarship; create expansive opportunities to reach learners in the workplace and at home without the impediments of time and space; and realize greater transfer of new ideas and products to business and industry to help grow the region's economy.

The digital network infrastructure, readily accessible and effectively used, can benefit the lives and opportunities of individual citizens and contribute substantially to the economic development of the region. Several initiatives are needed to fully realize the potential benefits.

- The Illinois Century Network is needed to integrate digital technology into higher education and provide universal access to education and information resources. The models are tested and the benefits have been demonstrated. This State initiative requires investments that merit sustained support over the next five years.
- Programs are needed to support faculty training and curriculum development, and to demonstrate new approaches to learning. These deserve increased visibility and funding from public and private sources. A clearinghouse for these initiatives and applications, based at one of the universities, would be the most effective way to enhance their impact.
- Finally, an intensive effort is needed, emerging from a business/university coalition, to increase the transfer of new ideas and products from the universities to the marketplace. Such linkages are being fostered through mechanisms like the Evanston/Northwestern Research Park (<http://www.researchpark.com/>). Support for the technology-based economic development strategy advanced in an earlier section of this report is dependent upon stronger linkages and action.

7. ELEMENTARY AND SECONDARY EDUCATION

Digital TIME's Jamie Malinowski writes⁴¹, "(U)ntil a kid gets access to a computer, he or she is on the wrong side of history..." Quoting Donald Tapscott, author of *Growing Up Digital; The Rise of the Net Generation*, she elaborates that "time spent on the computer is time spent retrieving, reading, authenticating, and writing," kids will be "more critical and more fluent." This is engaged learning at its best.

Technology is compelling education to undergo a profound transition. Concludes Clarisse Croteau-Chonka in a "think paper" written for this report¹⁶, "Computers, the Internet, and interactive video are not just the latest fads, but are shaping the very process of education... Teachers and students alike, with more and more information available, are assimilating new ideas rapidly and continuously." Further, technology is ultimately shaping the quality of each student's future employment — a student becomes computer literate or career prospects are severely limited. Yet, the "digital divide" has grown steadily greater over the past ten years.

In Illinois, for example, Naperville has just built a state-of-the-art technology high school, while Harvey is facing a shortage of even the most basic educational technology. Chicago Public Schools are moving toward full connectivity and working to address teacher and technical staff development, while the schools of the Chicago Archdiocese spend far less on information technology.

This division is further complicated by the fact that economic, education, and racial differences define access to computers.^{51,66} A recent study by the U.S. Commerce Department National Telecommunications and Information Administration (NTIA)⁴³ analyzed Census Bureau data from October 1997. It found that 36.6% of U.S. households owned a computer in 1997, an increase of 51.9% over 1994 when 24.1% owned a computer. Although computer ownership increased across all income levels, the gap between higher-income and lower-income households has increased.

"Computers, the Internet, and interactive video are not just the latest fads, but are shaping the very process of education."

While PC ownership among African Americans and Hispanics has grown faster than the overall rate, White households (40.8%) are twice as likely to own computers across all income levels than Hispanic households (19.4%) or African-American households (19.3%). The report also found that education affects PC ownership as much as income. Those with a college education are ten times more likely to own a computer than those without any high school (63.2% vs. 6.8%). Those with a college degree are far more likely to have on-line access (38.4%) than those with only a high school diploma (9.6%) or those with no high school education (1.8%).

Improving K-12 Education

In schools with access to digital network infrastructure, new initiatives to improve teaching and learning are being fostered every day.

- Different styles of teaching and learning are integrated into the classroom. In one scenario, a group of students may be working directly with the teacher on a problem, while others are conducting research on the Web, and others are using technology to practice language skills.
- From their classrooms, students are participating in activities and expeditions, often interacting with experts as they become engaged in authentic research. In 1998-99, schools will follow the Middle Passage voyage with Captain Bill Pinckney as he retraces the voyage of the slaves from Africa to Cuba to Charleston, South Carolina (<http://www.highseas.org/>)
- Information and expertise not typically found in schools are becoming readily available. For example, the Library of Congress' on-line exhibit "1492: An Ongoing Voyage" (<http://sunsite.unc.edu/expo/1492.exhibit/Intro.html>) can be visited from anywhere and built into the curriculum;
- Students can use specialized, sophisticated equipment at remote locations to conduct experiments and investigations that might otherwise be too expensive or dangerous. Through the Chickscope Project at the University of Illinois' National Center for Supercomputing Applications (NCSA), students can remotely control a Magnetic Resonance

7. Elementary and Secondary Education

Imager (MRI) from their classrooms to study the development of a chick embryo (<http://vizlab.beckman.uiuc.edu/chickscope/homepage.html>).

“Inequities in our schools will be exacerbated along economic, racial, and geographic lines if we are not fully accounting for EVERY school.”

- Basic skills can be developed in the context of learning that is interesting and fun. For example, students can develop literacy skill while engaged in interactive activities that are applicable every day, such as finding job opportunities, learning about a city in another part of the country, reading about an environmental cleanup project, or buying groceries.
- Specialized educational needs can be met more easily. For example, as computers eliminate barriers to information or communication, disabled students may be able to explore new ideas and participate in projects and activities.
- Schools are involving parents and broadening communication with the community they serve through Web sites.
- Administrative efficiencies are achieved through new management applications.

In the best cases, technology is making it possible for students and teachers to do things they could not do before. In other cases, they are making costly resources, such as encyclopedias, more widely available and augmenting special activities, such as field trips.

Risks and Responsibilities

Given the potential benefits, can we imagine a school or a classroom without computers connected to the Internet two years from now? Unfortunately, that is possible.

- Many schools lack funds or do not have the necessary network and technical support for teachers to use network technologies in classrooms.
- Teachers in many settings avoid technology, concerned that they, as the model and guide, do not have sufficient grasp of how to use computers and other technologies to risk their traditional style.
- Constant pressure to achieve high test scores can impede the willingness of principals and teachers to experiment and innovate. The fear is that new efforts require time away from the assigned goals and standards, with no guarantee that they will succeed, and no way to compensate for lost time on task.

And, most pivotal of all, inequities in our schools will be exacerbated along economic, racial, and geographic lines if we are not fully accounting for EVERY school. Each school must have access to the digital network infrastructure, up-to-date equipment in the classroom, and teachers who know how to help students use the resources and technology. In the rush to connect, some may be left behind with troubling consequences.

In neighborhoods where few children have computers at home, connected computers and people who can help them are needed in libraries, community centers, and other places where children go after school. In their “think paper” written for this report, Halverson and Gomez caution²⁹, “Without secure, consistent and pervasive access for urban schools and families in urban communities, the information technology revolution will reinforce, not reinvent, the distinction between the haves and the have-nots.”

How Are We Doing?

Overall, the State of Illinois is a latecomer to supporting the integration of technology in elementary and secondary schools. This is demonstrated by the amount the State spent on each student for learning technologies in 1995-96, as reported in the Illinois State Board of Education’s “State of Illinois K-12 Information Technology Plan³⁴.”

State Investments in Learning Technologies 1995-96

	ILLINOIS	IN	TX	FA	GA	OH
Number of Students (millions)	1.8	.96	3.5	1.98	1.2	1.78
Investment/student (dollars/student)	\$8	\$21	\$29	\$51	\$65	\$70

7. Elementary and Secondary Education

Other sources also show Illinois very low in the implementation of technology for elementary and secondary education. Fortunately, many actions are now under way to close this gap.

- With State leadership, the K-12 Information Technology Plan³⁴ has been adopted and is moving forward.
- The State's Technology Revolving Loan Fund was established in late 1997 to make school technology hardware improvements. The fund is expected to make \$30 million available in FY 1999 for K-4 schools and similar amounts for other grade levels in subsequent years.
- The basic infrastructure is being laid to connect every school to the Internet, with 1,450, or 40%, of Illinois schools connected as of Spring, 1998.
- Many schools are writing Technology Plans, required for state funding, seeking connection fee reductions under the federal Universal Service Fund, and other support.
- Regional Technology Hubs, designed to assist teachers and other school personnel, have been established across the state.
- Support from teacher unions has been advancing.

This undertaking, however, requires a massive commitment in dollars and political capital from Springfield, and accelerated implementation and support in the field. As with any initiative of this magnitude, it can fail in the details without funding and pressure to follow through in every district and school building.

Challenges and Opportunities

Even with computers in libraries, labs, and classrooms, there is no guarantee that the best is achieved. As Halverson and Gomez warn²⁹, "Information is not knowledge and communication is not learning — they become so only when fitted into meaningful frameworks of interpretation and understanding..." The challenge is to use technology in many ways that improve learning through developing innovative models and practice in the curriculum, teacher training and professional development, and encouraging experimentation. To be sure, strategic initiatives to support faculty and integrate applications into the fiber of K-12 education are under way:

- Teacher education programs at many Illinois universities are advancing technology for the classroom. Both for teachers in training and for those in the field, technology is being recognized and demonstrated as an integral part of the curriculum.
- Districts have internal professional development programs and the Regional Technology Hubs provide assistance.
- Outreach programs from Illinois colleges, universities, research centers, and government laboratories are working with elementary and secondary teachers in the metropolitan region. For example:
 - The University of Chicago's Chicago Public Schools/University of Chicago Internet Project (<http://astro.uchicago.edu/outreach/cuip/>)
 - The Northwestern University Collaboratory Project (<http://collaboratory.nunet.net/>)
 - Argonne National Laboratory's Division of Educational Program's NEWTON BBS (<http://newton.dep.anl.gov/>)
 - Fermi National Accelerator Laboratory's Education Office (<http://www-ed.fnal.gov/>)
 - The Education Division of the National Center for Supercomputer Applications (NCSA) (<http://www.ncsa.uiuc.edu/Edu/>)

"Overall, the State of Illinois is a latecomer to supporting the integration of technology in elementary and secondary schools."

But much more is required to bring all Illinois students, teachers, and other school personnel into the 21st Century.

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PUTTING OUR MINDS TOGETHER we can bring the digital network infrastructure to every school and classroom, assure professional development and technical support for all school personnel, develop models and share experiences for teachers, and aggressively counter the potential disparities created by the Digital Divide.”

If we are to realize the learning potential we envision information technology can make possible for all children in Illinois, then State policy makers, regional bodies, business and industry, school boards, teacher unions, and parents must work together to include the following in their action agenda:

- Accelerate access to the digital network infrastructure and up-to-date equipment for every classroom in the State, with special attention to the poorest schools;
- Increase technical support and services for schools (this is similar to the needs suggested for business and industry);
- Expand support to teachers for professional development on how to integrate technology into the curriculum;
- Pursue creative projects to widely share existing applications and foster needed new instructional resources;
- Provide wider access to the digital network infrastructure from libraries, community centers, religious organizations, and other locations where children go after school; and,
- Make available affordable access to the digital network infrastructure from homes through telephone or cable services.

Unable to move ahead with school finance reform, Illinois Governor Jim Edgar first proposed a telecommunications network for higher education and an Internet connection for every elementary and secondary school to assure equity in a different way. The reasoning was this: if State policy makers are unable to agree on a means to provide adequate funding behind every child in the State, given the political barriers, then one way to address at least part of the problem, and not exacerbate the differences between wealthy and poor school districts, is to assure universal access to information and learning tools through the World Wide Web and other network technologies.

An initiative to assure access to information technology and the skills to use the technology for every child in Metropolitan Chicago can have a considerable impact on the goals of school finance and quality reform that the Metropolitan Planning Council has actively supported.