

INFORMATION TECHNOLOGY GETS INTO SPACE

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ABSTRACT

Information Technology is changing the nature of organizations and the way all of us work. IT design variables make it possible to create new organization structures and new modes of operation. The second order impact of these new types of organizations and working arrangements is on physical space: virtual organizations, highly mobile work forces and electronic commerce will change the demand for and nature of office, retail and industrial space. Yet a third-order impact of this technology will be changes in cities, suburbs and rural areas brought about by these new trends in space.

SOME PREDICTIONS

Information Technology (IT), especially networks, is having a profound effect on organizations and the economy. A second-order impact of technology is a dramatic impact on the demand for physical space. The purpose of this paper is to identify trends in information technology that are likely to affect the demand for physical space. If the predictions here are correct, there will be a dramatic impact on cities, suburbs and rural areas. In this section I present some conservative estimates of the impact while later sections of the paper present the reasoning behind and evidence for these predictions.

A review of the literature and expert opinion about information technology and changing patterns of commerce suggests the following trends for the United States (and other post-industrial economies) over the next five years:

A trend toward telecommuting from home or satellite offices.

A trend toward the elimination of offices for sales forces .

Leading to an estimate of up to 30-40 million workers in total telecommuting by 2000.

A trend toward hotelling where workers share offices serially, for example, accountants and consultants reserve an office in a building their firm manages when they are in a particular location.

There are about 126 million jobs in the U.S. A conservative estimate from these trends is that

- 10% of workers will spend most of their time with clients and need no permanent offices (12.6 million),
- 5% - 10% will work from home at least one day a week (8-10 million),
- 5%- 10% will share offices (8-10 million).

leading to predictions of:

1. A 30% reduction in the demand for office space and

2. Office conversion to hotelling for at least 10% of existing office space.

Assume that 12.6 million workers need no permanent office, 10 million workers spend one day a week at home providing 2 million full-time equivalent workers without offices, and 10 million workers share offices, giving a total of 24.6 million workers who are not housed full-time in a private office. This total is 20% of all jobs and a much higher percentage of workers with offices, since not all 126 million workers have an office today. A 30% estimated reduction in the demand for office space is conservative!

A trend toward "value merchandising" (large stores competing on price like Wal-Mart).

A trend toward continuous replenishment of fast-selling items and extremely tight inventory control through networked computers and databases.

A trend toward electronic commerce on the Internet.

Estimates from these trends are hard to quantify because the phenomenon of electronic commerce is relatively new and unproven; currently, according to Nomura Securities, the retail vacancy rate in the US is over 9%. Extrapolating from this base and the trends above, I predict by 2001 there will be a:

3. Reduction in the need for retail space by 30%.

It is estimated that about 35 million people use the Internet today (*Wall Street Journal*, 10/21/96), and this number is growing rapidly. Internet users are likely to be more affluent and to spend a larger part of their incomes in retail stores than non-Internet users. There are about 266 million people in the United States so over 13% of the population has access to the Internet. There are 53 million households in the U.S. and the average size of each is 3.3 people. If we allow for two Internet users per household, there are 17.5 million households with net access, so 33% of households have Net access. If this number is growing and even half of these householders make purchases over the Net, a 30% decline in the need for retail space is a reasonable estimate.

The market is providing information that commercial real estate is not a great investment. Since 1986 investors in U.S. commercial properties have lost more than 50% of their capital. In contrast those investing in technology companies have seen returns of over 250% (*Pensions & Investments*, February 19, 1996).

The changes described above will affect construction and the physical environment; in particular there will be:

- **Little need for new office and retail space which will reduce the amount of new construction.**
- **A decline in the growth of shopping malls,**
- **A major role for cities and urban areas as a place for people to meet,**
- **A potential loss of property tax revenue for cities,**
- **A repopulation of rural areas by remote workers, and**
- **Reduced commuting with less time lost and less environmental damage.**

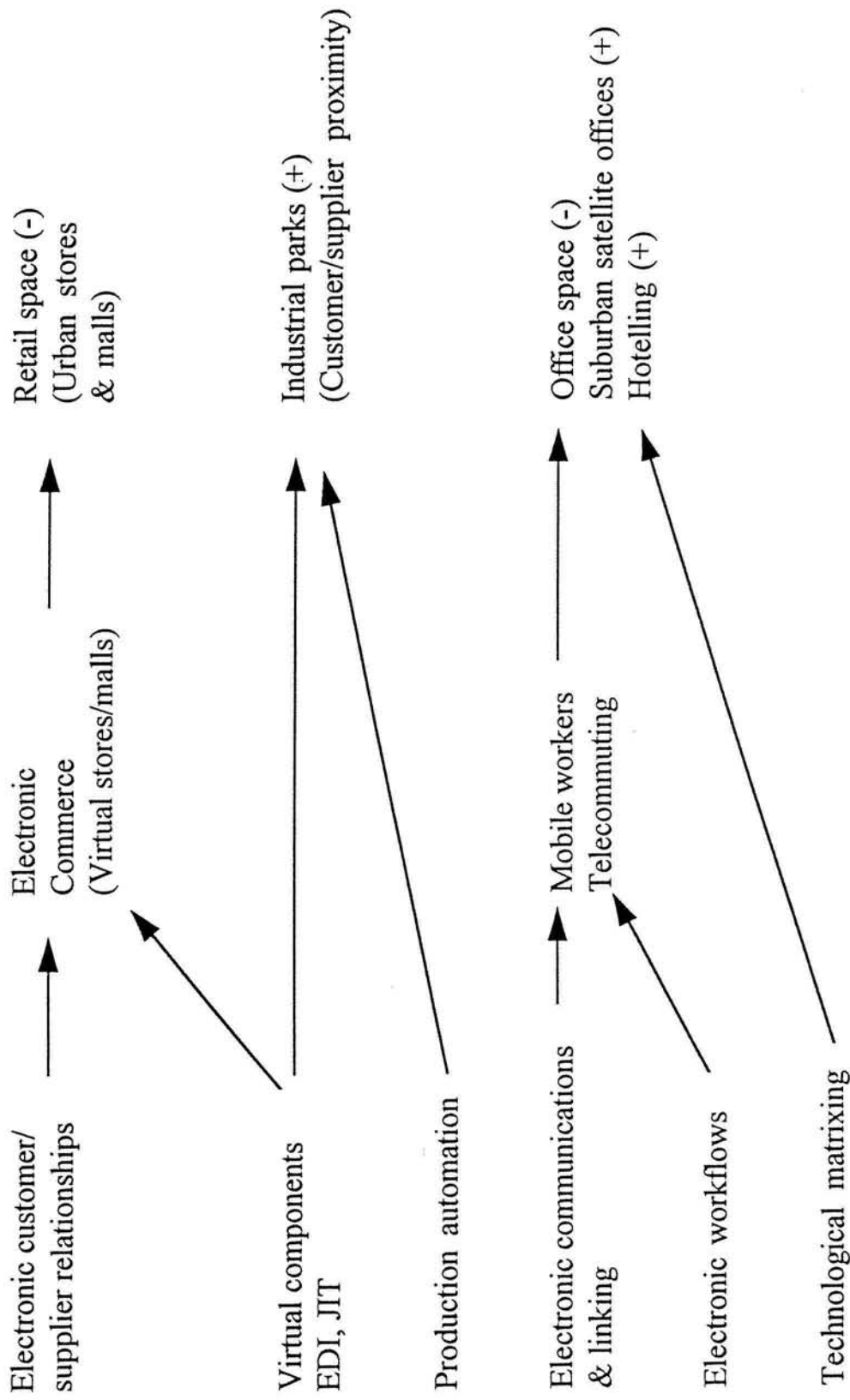
In addition to the evidence below, these predictions rely on some assumptions. One of the most important of these is the continued expansion of Internet access from homes and offices. For the predictions above to be realized, especially for retail space, we need to have over 50% of homes connected to the Net. Inexpensive Network Computers (NCs) and appliances should provide added impetus for this kind of Internet adoption. Given the estimate of 33% of homes with Internet connections, an increase to 50% in five years seems attainable.

WHAT IS THE BASIS FOR PREDICTIONS?

The predictions above are based on the profound impact that Information Technology (IT) is having on organizations and workers. Information technology design variables make it possible to create new structures and entirely new types of organizations. See side bar for one view of how this occurs. The first order impact of the IT design variables is to create new types of organizations as described in the side bar. Their second order impact on space is shown in Figure 1.

In the Figure, electronic customer/supplier relationships and virtual components encourage electronic commerce featuring virtual stores and malls. Electronic commerce is changing the nature of markets and the role of intermediaries. Will there be a need for branch banks, brokerage offices, real estate and other financial services locations in the future?

Virtual components, EDI and JIT (Just-in-Time) and production automation impact the demand for industrial space. JIT production relies on suppliers to faithfully deliver materials on schedule. As a result, suppliers may choose to locate close to customers. A JIT plant can be smaller than a traditional, non-lean production facility. Better control of inventory means there is less need for warehouse space.



The Impact of IT on Physical Space
Figure 1

Electronic communications and linking encourage the elimination of offices for mobile workers, substituting telecommuting. Electronic communications and technological matrixing are prime reasons for hotelling, the time-sharing of office space.

The trends above point to a reduced demand for space in a variety of businesses. There will be a reduction in the need for office space as employees work remotely, both alone and in groups, and give up private offices. More alliances and virtual arrangements reduce the size of an organization compared to the “vertical integration” that characterized earlier periods of business history. Alliances and outsourcing reduce the amount of physical space needed to conduct business and manufacture products

Concomitantly with changes in office and manufacturing, there will be a significant reduction in the need for retail space for sales. There will be far fewer “intermediaries” as electronic markets and services replace middlemen. Electronic commerce means customers have fewer reasons to visit retail establishments.

While the focus of this paper is on space, there are challenges in managing these new organization forms which could slow their growth. The experiences reported by Borenstein et al. (1996) are helpful in understanding some of the management issues in organizations enabled by IT design variables. First there is more electronic instead of physical contact with coworkers, which can be unsettling. There are many temporary relationships that are project/client oriented and workers will spend less time in a given physical office. While it may sound attractive to work anytime and anyplace, this capability may lead to a new outbreak of workaholism with its negative impact on personal and family relations. To balance the negative, it is hoped that employees will become both more efficient and effective. If new organizational forms enable higher levels of performance, employees should be more satisfied with their productivity and contribution to the firm.

SOME EVIDENCE FOR THE PREDICTIONS

It is possible to model the demand for office space, though it turns out that these models are not much help in predicting the impact of IT on the demand for space. First, the models tend to be proprietary; they are available for sale to financial analysts and people in the real estate and construction industry. There is a published report on one of these models developed by William Wheaton at MIT. It is a macroeconomic accelerator model for predicting the demand for office space based on estimates of manufacturing employment, wholesale employment and after tax cost of capital, the vacancy rate and certain adjustments. The model is estimated with lagged independent variables since current office demand is based on past economic activity .

Our IT variables do not have a major impact on the independent variables in this model, except where new forms of commerce increase total economic output. Electronic commerce is so new that it could hardly have an impact on this particular model given its lagged independent variables. IT variables and trends portend a shift in economic activity;

they remove constraints of time and place and the need to tie activities to a physical office. It is hard to quantify this impact and include it in models.

Thus, it does not appear that existing econometric models will provide evidence for the predictions that opened this paper. Another possibility is to extrapolate from examples of new business and services enabled by IT and by the possibilities they suggest. Below are some of these examples along with their implications for the demand for space.

Retail

The impact of IT on retail space comes primarily from networks, electronic commerce, and the bypassing of intermediaries. (It is estimated that 75% of office demand is for Financial, Insurance and Real Estate firms, all businesses which will use technology to reduce their demand for space.)

Banking. The trend over the last ten years has been for a proliferation of branch banks across the country. Given information technology, one must question whether there is a need for any branch banks at all (except possibly a few locations with safe deposit boxes). Consider First Direct, a bank in Leeds, England. The bank has over 500,000 customers and no branch locations. It is the fastest growing bank in England, opening 10,000 accounts a month which is the equivalent of two or three physical branches.

First Direct uses technology to create a more personal relationship with customers. The technology makes a customer's complete record available to any banker who answers the 24,000 calls a day that come into the bank. By having complete client information available on a system, the bank representative can try to cross sell additional products and services to a customer on the phone, and can answer any question the customer has about his or her relationship with the bank. The bank is a division of Midland Bank and appeals to professionals. The average account balance is ten times higher at First Direct than at Midland in general and its overall costs are 61% less. It makes money on 60% of its customers compared to 40% at the average British bank. All of this is accomplished in one, large building resembling an aircraft hanger in an industrial part of Leeds (*The New York Times*, 9/3/95).

With the World Wide Web one does not have to rely on bankers to operate telephones, we can each become our own banker. Figure 2 shows the home page for Wells Fargo Bank, one of the US leaders in on-line banking. Home banking is also one of the major applications on the French Minitel system which suggests that it is likely to become popular with the Internet as well.

Stock markets and brokerage. There are a number of electronic stock exchanges and this leads to the question of whether or not we will have physical exchanges in the future. The London and Cincinnati stock exchanges are electronic as is the NASDAQ. There are also many markets similar to stock exchanges, for example, the flower market in Holland, auto and livestock auctions in the U.S., etc.

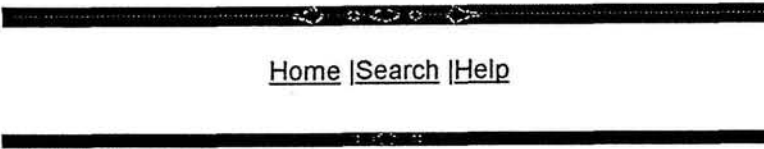


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Bills due?

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Wells Fargo On-Line Banking Page
Figure 2

If other companies imitate Spring Street Brewing which makes Wit Beer, the nature of markets and their demands for physical space will certainly change. Wit Beer set up a Web site to sell its own stock. In the first year Wit sold 844,581 shares, raising almost \$1.6 million. The company decided that, since the stock was thinly traded, it would create a market for it on the Internet. Buyers and sellers can post bid or ask offers to a bulletin board; the company does not do the matching or negotiate the deals. However, there is a convenient form on the site to be used to complete the transaction. The SEC asked the company to make a few changes including the appointment of an escrow agent for handling funds, and then issued a “no action” letter which meant it approved the market. See Figure 3 (*Internet World*, 7/96).

Wit Beer threatens conventional markets and stock brokers, none of whom is involved in its market. It also has a Web site dedicated to helping companies raise capital on the Internet (<http://www.witcap.com>). Other entrepreneurs on the Web are helping customers reduce trading costs by eliminating contact with a stock broker. See Figure 4 for an example of one of these firms. Brokerage firms maintain that customers want and will pay for the advice of a “full service” broker. However, if a substantial percentage of the investing public makes its own decisions, then how many retail brokerage offices will we need?

Real Estate. Real estate offers a natural market for the Web. On the retail side, most brokerage firms in an area form a cartel controlling the multiple listings service and jointly setting a fixed commission for selling homes. It is easy to envision a market in which one describes the location and characteristics of a home and lets a potential purchaser search for homes matching his or her preferences. Currently one can find a significant presence of traditional real estate brokers on the Web. However, individuals are also beginning to put their homes for sale on the Net. A recent Altavista search on “homes sale owner” resulted in an estimated 300,000 relevant documents. Does this suggest the eventual end of the residential real estate industry as sellers and buyers try to save 5%-7% commissions?

Insurance. The insurance agency may also disappear as consumers purchase insurance through the Web rather than an agent. However, the 650,000 insurance agents in the country will probably not surrender easily to a network. Today only a few thousand people shop for insurance on the Internet, but the potential for this kind of business is great. Most insurance on the Web today is term life which is relatively simple insurance to purchase. Quotations are available from <http://www.insweb.com>, <http://www.quickquote.com>, <http://www.quotesmith.com> (*New York Times*, 9/6/96).

Shopping. The automobile and the suburbs together helped create the shopping mall; malls have eliminated retailing from a number of urban locations. The rise of two-wage earning families and the quest for more leisure has helped fuel a huge market in mail order sales. Mail order sales seem natural for brand name products like TVs and VCRs. A skeptic might have argued that they would never work for clothing because customers




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WIT Capital Home Page
Figure 3a



INTRODUCTION TO THE COMPANY

Wit Capital Corporation was recently formed to become the world's first investment bank and brokerage firm dedicated to arranging the public offering of securities through the Internet's World Wide Web. The Company also plans to develop and operate on the World Wide Web a digital stock exchange through which secondary trading of securities will occur.

The Company plans to offer businesses an array of financial advisory services and act as agents in the public offering of securities through the Internet. The Company also plans to develop, operate and promote a "financial marketplace" on the World Wide Web. The Company's Web site will include a public offering mart through which the official offering documents of issuers coming public through the Company will be accessible and through which such public offerings will be sold. The Web site will also include the Company's digital stock exchange.

The Company expects that investors will be able to purchase shares in the public offerings arranged by the Company as well as trade shares in the Company's digital stock exchange without having to use brokers or pay commissions.

Return to Wit Capital [main menu](#).





E-mail to : witcap@interport.net


Introduction to WIT Capital
Figure 3b



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E-Trade Home Page
Figure 4a



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Stock Order Verification

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Quote information as of 1/30/96. For demonstration purposes only.

20-Minute Delayed Sale Price: NETSCAPE

Ticker	Last Trade	Bid	Bid Size	Ask	Ask Size
NSCP	164 3/4	164 3/4	200	165 1/2	1,000

John Smith has ordered the following:

Account: IRA 252-99980-11

Account Type: Cash

Transaction Type: Buy

Quantity: 100

Symbol/Company: NSCP - NETSCAPE

Price: Mkt

Last Sale Price: 165

Term: Day

Est. Commission: 19.95

Est. Total Order: 16,519.95

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E-Trade Example
Figure 4b

need to see and try on the merchandise. However, some of the most successful mail order companies sell clothing. By establishing a reputation for quality and with free returns, they have succeeded in luring people away from stores. In 1994 50% of shoppers used catalogs and interactive services on TV and home computers; 25% of the nation's top 200 consumer goods advertise on the Web according to Forrester Research (Robert Burgess, *Bloomberg Business News*, 2/4/96).

It is easy to envision these services moving to the Internet; for example see LLBean at <http://www.llbean.com/> which offers its catalog and promises that soon you will be able to order from it on-line. In fact, why not a complete, virtual shopping mall. See Figure 5 for IndustryNet's home page. Of course, there are products which one has to see, for example, who will order a car electronically? Actually, a number of people use the Net to solicit bids for a car after they have visited a dealer and specified the model they want. You can buy this way through services like Auto-by-tel (<http://www.autobytel.com/>). How about the need to visit the store for a custom fit? Certain Levis stores will take a customer's measurements which are transmitted to a Levis factory where a custom pair of jeans is produced. Could you not instruct the customer on a Web page what measurements to take and submit on a form?

We will need retail space to see products and possibly to buy some of them. It is not clear that many merchants will maintain their present commitment to physical space purely to let customers see products that they may buy elsewhere electronically.

Disappearing Retail Stores. Initiatives suggested or underway make it likely that some familiar retailers will operate in the future without their stores. Phone and cable companies would like to replace the ubiquitous retail video store by providing video on demand services with electronic distribution. You can order CDs on the Web now, and one can envision electronic distribution for music, helping the music store go virtual. While few consumers seem to want to download a book, they may find it easier to order a book on the Web than visit a book store (<http://www.amazon.com/>). Finally, we will download software through the Internet and use the net to consult on-line software manuals and tutorials that go beyond the help function in the program; there will be little need for stores selling software.


Travel agencies. Another familiar physical presence, like the branch bank, brokerage office and retail shopping mall, is the corner travel agent. Airline computerized reservations systems are credited with saving travel agencies when the government deregulated much of air travel. Travel agencies' share of tickets went from 20 or 30% to 80% as they installed reservations systems. Airlines would like to have you book directly with them to save the 10% commission to the travel agent. Eeas Sabre is American's attempt to recapture some of this revenue; at first it was only available through a mass market service like Prodigy, but now it is on the Web. American booked more than one million reservations through Eeas Sabre last year (*Wall Street Journal* 6/17/96). American has recently established a Web site for making reservations (<http://www.americanair.com>) and is installing frequent flyer card readers in selected

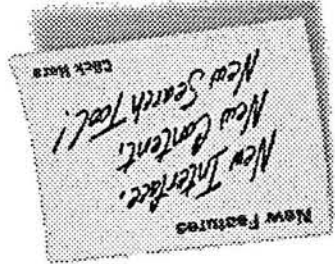
IndustryNet Home Page
Figure 5

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Win a 27" Color TV

-  **Search**
Find it in the IndustryNet Business & Industry Directory.
-  **Resources**
Access catalogs, jobs, seminars, trade shows, stocks, and more.
-  **Forum**
Make the connection to other business professionals online.
-  **Online Services**
Visit 17 online services and 18 trade associations.

 **Breaking News**
from the IndustryNet Report:
Tech Stock Plunge Rattles Wall St. Again
HP Stock Dives After Gloomy Forecast



Fri, Jul 12, 1996



NAVIGATION

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- News
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- Map
- Help
- About
- Feedback

airports so that a traveler making his or her own reservation on the Web will no longer need a paper ticket.

To obtain a listing for all airlines, you can visit Travelocity on the Web (see Figure 6), a neutral service aimed at individuals making travel plans. American and Cathay Pacific offer passengers the opportunity to bid for tickets, sometimes with cash and sometimes with frequent flyer miles. The URLs for American and Cathay Pacific are: <http://www2.amrcorp.com/cgi-bin/auction/user.cgi/> and <http://www.cathay-usa.com/>. While we might predict that the local travel agency will disappear, one of the most successful Web travel services, PCTravel (<http://www.pctravel.com>) allows you to make a reservation, but issues tickets through travel agents. Companies can connect to PCTravel through their Intranet and incorporate their own travel rules, for example, routing all trips through a preferred carrier. While travel agents may survive, it is less likely that the local office will be there in the future as we make our own reservations and centralized facilities print tickets for overnight delivery.

Office Space

It has been estimated that 10-20% of a firm's annual revenues go to space; the second largest cost after people (*Management Today* 1/96, *Financial Times* 11/17/95, 11/1/95). Hotelling described earlier; has been implemented in some locations by Coopers & Lybrand, Touche Ross, Reuters and IBM. Ernst and Young had 30% savings in space and IBM 25% in two projects (*Management Services* 9/95). Andersen Consulting accommodated up to 40% more people in the same site in one office (*Detroit News* 7/9/95). For some mobile workers at Xerox and AT&T there are no offices at all. The CIO of Verifone has two homes from which he works, but no office! Telecommuting is expected to grow from a 1993 estimate of 6-7 million to 30-40 million workers by 2000 (Midrange Systems 7/27/93). The impact on the demand for office space if this rate is achieved will be dramatic.

The ability to telecommute and to link locations easily is responsible for the prediction that population will shift from urban to rural areas. The *Wall Street Journal* reported (November 21, 1994) about an effort in Nebraska to encourage phone companies to install fiber optics lines across the state. The end result has been 6700 miles of fiber linking all but five counties in the state. Aurora with a population of 3800 had been in decline and had 12 empty store fronts. Today, all stores are occupied and the unemployment rate is 1.5%. The lines are used to bring classes to small schools and to connect patients and doctors to medical centers.

Telluride Colorado established itself as a pioneer location for telecommuters. Leaders in the city obtained a state grant to set up an Internet server and make it available to people in the town. As a result many who had second homes in Telluride have become year-round residents, telecommuting where ever they need to go. The ten regions most favorable to working at home range from Santa Monica at 5.2% of residents who work at home to San Diego with 9.4% (*New York Times*, 7/14/96).



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SEARCHING FOR CASH?



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Travelocity Home Page
Figure 6

The success stories in Nebraska and Colorado show how information technology provides an opportunity for governments to invigorate local economies. Policy makers have additional strategies they can use to reverse the decline of a city or region, or to expand the opportunities available for their residents. During the 1980s there was a decline in population in most rural counties. However, the Census Bureau reports the trend is reversing and it estimates that 75% of non-metropolitan counties grew during the 1990-94 time period; some 2 million people left urban areas for rural locations (Clark, 1996).

I have argued that IT will reduce the demand for office space in general. However, it should be pointed out that the technology industry does create a demand for offices, and that this industry is one of the fastest growing in the world. From Silicone Valley California to Silicone Alley in New York, the technology industry itself offsets in a small way the second order effects of IT in reducing the demand for space.

Industrial Space

The formation of alliances and the use of virtual components along with EDI and JIT will also impact the demand for industrial space. With Just-in-Time production, the manufacturer keeps a minimal supply of raw materials and in process inventory, reducing the need for storage space. Suppliers, linked with EDI, produce to a stable manufacturing or build plan, reducing their finished goods inventory requirements. There is also a trend to work with a small number of high-quality suppliers; these suppliers may choose to locate small plants near major customers to facilitate JIT production. This trend can be seen in places like Northern Italy where the highly successful motor scooter manufacturer Aprilia is a virtual company, manufacturing nothing (*Business Week* 6/10/96).

To enhance the ability of companies to establish customer/supplier links, CommerceNet at <http://www.commerce.net/> is working to establish standards. In its first test, the Bank of America and Lawrence Livermore Laboratories used the Internet for EDI-like exchanges.

The trend of establishing JIT relationships and alliances with other organizations suggests a decline in the need for warehouses. Companies like Wal-Mart connect directly to suppliers electronically; the suppliers replenish store shelves, reducing the need for Wal-Mart warehouse space. However, as Nomura Securities points out, the demand for warehouse space is actually increasing in certain areas due to burgeoning foreign trade. Today the U.S. imports and exports about 10% of its gross domestic product. The annualized rate of US merchandise exports in 1995 were \$588 billion and imports came to \$771 billion (Christensen and Ackerman, 1996). Warehouse space is reported to be tight on the West Coast because of extensive trade between the US and Pacific Rim countries. Increasing use of air freight has stimulated the demand for warehouse space near airports. Thus, the demand for warehouses is influenced by two conflicting trends; it is difficult to

predict whether or not increased trade will offset the impact of IT in reducing the need for warehouses.

SUMMARY

Estimates based on demographics such as those that began this paper, opinions from various experts in the field, documented changes like the Nebraska fiber optics story, the variety of creative services and businesses on the Web and the direction we believe IT is moving all provide evidence that technology will dramatically alter the demand for physical space over the next five years and beyond.

IT enables telecommuting, which in turn reduces commuting and pollution while providing telecommuters with more flexibility. IT makes it possible for consultants, sales representatives, or anyone who spends considerable time with clients, to work without a permanent physical office. These “road warriors” can make use of a single, shared facility, or hotelling arrangements in different locations where their employer maintains a site.

Workers who telecommute are good prospects for electronic commerce. They are comfortable with the technology, and are used to the convenience of not traveling regularly to a place of business. Value merchandising, which features low prices and careful maintenance of stock, extends nicely to the Web. The WWW shopper can compare a number of different prices, and easily switch vendors if one is out of stock.

These trends in society and technology reinforce each other; they suggest that the need for office and retail space will decrease substantially in the next five years. Referring again to Figure 1, we see that electronic commerce and virtual stores will reduce the demand for retail space. More mobile workers and telecommuting will do the same for office space, while increasing the demand for satellite offices and hotelling.

Within five years, a decline in the need for physical space discussed in this paper will alter commuting, living patterns, communications and social relationships, and will change urban and rural environments. The need for less space will also have an impact on wealth in the United States. It is estimated that real estate makes up 40% of the combined wealth of U.S. industry and accounts for 20% of gross domestic product (Robert Burges, *Bloomberg Business News*, 2/4/96). Will new business activity and wealth stimulated by information technology make up for the impact of technology on real estate capital and business?

CONCLUSIONS

Information Technology facilitates the design of new types of organizations and institutions. These changes will have second order impacts on the demand for space for manufacturing, retailing and offices. The discussion above demonstrates the possibilities

for new ways of doing business in which *information technology substitutes for physical space*. If the predictions in the beginning of this paper are correct, we will see a dramatic change in our physical environment. Cities will be meeting places for business and rural areas will gain population at the expense of urban ones. The nature of retailing and its space demands will also change. While the impact of these changes on employment and the construction industry are hard to forecast, we should all benefit from less pollution from reduced commutation and a reduction in urban densities.

What is most exciting about these second and third order impacts of information technology is that they provide choices. Managers, consumers and policy makers now have alternatives that did not exist before. Our challenge is to recognize the potential for technology to change our environment and then shape it in the way that provides the most benefits to the largest number of people.

Borenstein, N., "Perils and Pitfalls of Practical Cybercommerce," *Communications of the ACM*, Vol. 39, No. 6 (July 1996), pp. 36-44.

Christensen, M. and K. Ackerman, "Warehouse/Distribution Facilities: Emerging Industry Trends and Future Market Implications," *Creating Tomorrow's Competitive Advantage*, Washington, D.C., Urban Land Institute, 1996.

Clark, B., "The Implications of Telecommunications and Information Technologies for Residential Development," *Creating Tomorrow's Competitive Advantage*, Washington, D.C., Urban Land Institute, 1996.

SIDE BAR**IT Design Variables**

Information technology offers a number of variables for designing organizations. These variables can be combined with more traditional ones like span of control to create new organization forms.

Design Variable	Definition
Virtual components	Components of an organization that appear to belong to it, but in reality do not exist or are part of another organization, e.g. a virtual raw materials inventory for just-in-time production.
Electronic linking	Connecting two entities electronically, e.g. EDI links
Technological leveling	The use of communications technology to increase the span of control for managers and to eliminate the need for layers of management through direct communications between upper and lower levels.
Production automation	Classical automation of production processes
Electronic workflows	The capture and routing of information in electronic form rather than on paper.
Electronic communications	Communications through e-mail and groupware
Technological matrixing	Matrix management enabled by e-mail and groupware reducing or eliminating the need for extensive physical contact among members of the matrix.
Electronic customer/supplier relationships	Extensive electronic linking with customers and suppliers using e-mail, EDI, groupware and direct links to speed the flow of information and reduce paperwork.

Information Technology Organization Design Variables
Table 1

A natural tendency will be to use these IT design variables to create organizations with the characteristics found in Table 2, a T-Form Organization.

Flat organization structure
Substitution of technology for layers of management
<i>Flexible, fast-response organizations</i>
<i>Matrix management using technology</i>
<i>Decentralized decision-making</i>
Trust between superiors and subordinates
Concern over logical rather than physical structure
Shifting reporting relationships
<i>Remote work</i>
<i>Extensive interorganizational systems</i>
<i>Electronic connections with customers/suppliers</i>
<i>Virtual components</i>
Strategic alliances with other firms
Ability to manage information technology
Robust technological infrastructure including networks
<i>Participation in electronic markets</i>
Increasing complexity
Capacity for fast response

Characteristics of Technology Enabled Organizations
(Characteristics in italics influence space demands)

Table 2

For more information, see Lucas, H.C., Jr. *The T-Form Organization*, San Francisco, Jossey-Bass, 1996.

Appendix A: URLs for Figures

Figure	URL
2	http://www.wellsfargo.com/
3	http://www.witbeer.com/
4	http://www.etrade.com/
5	http://www.industry.net/
6	http://www.travelocity.com/