Trends and Factors Influencing Telecommuting in Southern California

George S. Park, Jack M. Nilles, Walter S. Baer

DRU-1465-SCTP

December 1996

Prepared for the Southern California Telecommuting Partnership
Preface

This report was commissioned by the Southern California Telecommuting Partnership (SCTP), which includes private firms, government agencies, and non-governmental organizations involved in telecommuting. For the past three years, the SCTP has been involved in the promotion of telecommuting in the Southern California counties of Los Angeles, Orange, Riverside, San Bernadino, and Ventura. It has acted as a resource for information, materials, assistance, and training in telecommuting. As part of its efforts, the SCTP commissioned this report to explore long term trends and factors influencing telecommuting in the region. The SCTP is currently incorporating as a non-profit 501 (c) (3) in order to apply for public and private sector grants. Such grants will enable the organization to continue promoting telecommuting through ongoing marketing, training, and research efforts in Southern California.
CONTENTS

CONTENTS ........................................................................................................................................... i
EXECUTIVE SUMMARY .................................................................................................................. iii

1. CHANGES IN THE WORKFORCE ...................................................................................................... 1
2. NEW BUSINESS PARADIGMS ....................................................................................................... 9
3. POTENTIAL IMPACTS OF TELECOMMUTING ON BUSINESS .................................................. 14
4. BARRIERS AND INCENTIVES TO TELECOMMUTING ............................................................... 18
5. EXPANDING TELECOMMUTING IN THE REGION ...................................................................... 26

APPENDIX 1: THE TELECOMMUTING MODEL .................................................................................. 27
APPENDIX 2: NEW BUSINESS PARADIGMS ..................................................................................... 31
REFERENCES ....................................................................................................................................... 34
Executive Summary

There is a widespread attitude that in order to "be" at work, one must travel to work, usually to some sort of office, shop, or factory. This concept was well-suited to the organizational structures of the Industrial Revolution, where large hierarchical organizations and expensive capital equipment favored the concentration of labor into central offices and factories. As long as physical objects had to be manipulated and transferred from worker to worker, it made sense to have all the employees in the same place. Information was considered in the same way as such objects, since the various media of information (memos, letters, conversations in the hallway) flowed more quickly and smoothly if all the relevant parties were in proximity. This type of organization was efficient and effective as long as the transportation system could support the commuting employees.

Southern California has an extensive transportation infrastructure and enjoys many other competitive advantages. But it also has a huge and rapidly growing population that could overwhelm that infrastructure, leading to the erosion of those competitive advantages (and potential loss of jobs). Based solely on simple demographic trends, difficult tradeoffs between competitiveness and quality of life may have to be faced in the near term because of limitations on the infrastructure.

There are two other trends that are significantly affecting the basic framework. First, an increasing number of workers are being employed for "information work;" that is, work which emphasizes the manipulation of information rather than physical objects. Second, telecommunications and computer technologies are making information portable, so that such information work can done outside traditional settings. Thus -- for certain functions and under certain conditions -- it is no longer necessarily true that one has to travel to work in order to be at work; with the proper tools, information workers can be at work nearly anywhere.

The basic idea underlying telecommuting is the use of the telecommunications infrastructure and information technologies as substitutes to physically commuting to work. In fact, there are different ways in which workers can telecommute. So far, the most popular form has been home-based telecommuting, where the worker works at home during part or all of the work week; a recent article suggested that 85% of all telecommuters are home-based.1 Another form of telecommuting makes use of local telecenters: offices or cubicles at local centers rented out and used by employees of remote businesses.2 Equipment at these sites could include telephone lines, faxes, computer workstations, videoconferencing equipment, and other devices and services to allow the employee to do his/her work and stay connected to the central office. A variation of the telecenter concept takes the form of alternative officing, an arrangement whereby an employee has the option of choosing to work from a number of different employer work-sites, regardless of the location of the employee’s main work unit. Once again, telecommunications allow the distant employee to stay connected with his immediate work group.

Scope of this Report

In this report, we assess the trends and factors influencing telecommuting in the Southern California region. A variety of economic, regulatory, technological, and environmental influences
act to constrain and encourage telecommuting; trends in these factors will affect the acceptance and growth of telecommuting. Understanding these external influences is thus necessary to assess trends in telecommuting and identify future telecommuting opportunities and needs. Our analysis focuses on the following general areas having direct relevance to telecommuting: changes in the work force, new business paradigms, and barriers and incentives to telecommuting (including technological developments).

**Changes in the workforce** - The population of the region continues to grow and change in age and ethnic composition. In addition, the regional labor force is going through structural changes in response to the changing economy. Many of these changes -- increases in female labor force participation, better educated workers, more familiarity with telecommunications and information technologies, and more information-based work in most occupations -- support the expansion of telecommuting in the region.

**New business paradigms** - Revolutionary changes are taking place in business paradigms and practices. Many firms now make extensive use of telecommunications to transact business; for example, a clothing manufacturer may advertise on computer networks, take an order by telephone, transmit the order to a warehouse over a microwave radio link, and record the transaction at a remote database. Telecommunications are changing not only the transactional aspects of business, but also organizational aspects, allowing the formation of "virtual" companies. These developments in business organization and practice are also expected to lead to increased telecommuting.

**Barriers and incentives to telecommuting** - Primary barriers to telecommuting include management attitudes, inadequate knowledge of telecommuting, and inadequate training. Laws and regulations often pose other barriers, though they can also provide important incentives. Another major factor in the adoption of telecommuting is technology. Developments in the availability, capability, and cost of telecommunications and information systems will strongly influence the growth of telecommuting. Increased performance and lower prices of such technologies will encourage many forms of telework. Telecommuting is also supported by the relative robustness of the telecommunications infrastructure, as was seen after the Northridge Earthquake.

Many data sources were compiled and analyzed to generate this report. As much as possible, we attempted to use quantitative regional data from objective sources such as the census and economic reports. However, we have also made use of other categories of data:

**National data and data from other regions** - While this study focuses on telecommuting in the Southern California region, data from other regions and the nation as a whole also shed light on the local scene. Of course, not all relationships necessarily carry over; the fact that heavy snow supports telecommuting in Minnesota does not apply to the situation in Southern California.

**Case studies and examples** - During the last few years, there have been many case studies of telecommuting made available through various organizations; such studies offer valuable insights about the implementation, costs, and benefits of telecommuting projects (though the ability to generalize such information should be treated carefully, as the factors for individual situations vary from case to case).

**Expert opinions and projections** - A number of findings, opinions and projections by others who have studied telecommuting are quoted in the text and cited in the references.
Expanding Telecommuting in the Region

Based on the demographic, economic and other trends documented in this report, we expect telecommuting in Southern California to increase in the coming decades. The number of information-work jobs, which are particularly well-suited to telecommuting, is increasing as a percentage of the total workforce; furthermore, continuing developments in technology are enabling workers to accomplish more outside the traditional workplace. In many instances telecommuting is a "win-win-win" option for businesses, communities and individuals, so that it will be adopted even without external promotion. On the other hand, telecommuting is a new paradigm for many, and resistance to it can arise because of uncertainties about its consequences for both individuals and organizations.

Government agencies and organizations such as the Southern California Telecommuting Partnership (SCTP) can help to accelerate the adoption of telecommuting through public marketing-educational campaigns. Since telecommuting affects individual businesses and workers differently, market segments with the highest potential for telecommuting success should be identified, and specific information about telecommuting should be directed toward employers and employees in those segments. Helping decisionmakers understand how to manage telecommuting in their organizations is also an essential part of any such marketing-educational campaign. Cost/benefit worksheets, such as the example given in Chapter 3, could be worked out to determine approximate financial returns from telecommuting programs, though employers and employees should consider that much of the impact of telecommuting involves factors that are not easily quantified, such as employee morale and disaster preparedness.

Just as there are different types of businesses, there are different types of telecommuters. Chapter 1 documents that home-based, part-time telecommuters are by far the most significant group of telecommuters in the region and most likely will continue to be so in the foreseeable future. Of course, the other modes of telecommuting (full-time home-based, telecenter-based) provide valuable alternatives for many. However, home-based, part-time telecommuting dominates in terms of acceptance and practice, and currently comprises over 90% of the telecommuting workforce. Consequently, the more that marketing-educational campaigns focus on home-based, part-time telecommuters, the more success they are likely to have.

Given good information about benefits and costs, employers and employees should be able to make sensible decisions about whether, and how quickly, to adopt telecommuting. However, as seen in Chapter 4, some existing laws and regulations enacted in an earlier era may impose unnecessary burdens on telecommuting or working from home. As a consequence, local governments should review zoning and other ordinances to see whether they are consonant with the employment patterns of today, including telecommuting.
1. Changes in the Workforce

The population of the region has been undergoing great changes, both in terms of number and composition. The labor force has also been going through structural changes as more and more workers are engaging in knowledge-based activities. The demographic and workforce trends tend to support some general assumptions about the region:

- the population and workforce are steadily rising
- the number of females in the workforce has been steadily increasing
- the workforce is becoming better educated
- information work is a growing component of the activities in a range of occupations
- the region remains the world leader in many industries, including the motion picture industry, aerospace, and multimedia
- global trade, especially with Asia and Latin America, is steadily increasing (merchandise exports made up 9% of California’s economy in 1995, compared with 5% in 1985)

The changes in the demographics and work force in the region have direct impact on the costs and benefits of telecommuting on both micro- and macro-economic levels.

Demographic Trends

In 1960, the Southern California region comprising Los Angeles, Orange, Riverside, San Bernadino, and Ventura Counties held a total of 7.8 million people, 78% of whom lived within Los Angeles County. By 1990, the population had nearly doubled, to 14.5 million, making the area the second largest metropolitan region in the United States. Will this growth continue? Despite the earthquakes, fires, floods, and recession since the 1990 census, projections indicate that the population in the Southern California region will continue to grow for the next few decades. The Southern California Association of Governments (SCAG) has projected that from 1995 to 2015, the population should grow by another 30%.

Not surprisingly, as the population in the region has grown, so has the labor force. Interestingly, the labor force growth has been larger than the general population growth due to such factors as the changing age distribution and the increasing participation of women. From 1960 to 1990, the percent of working-age females in the labor force increased from 37% to 58%.

Another significant trend in the labor force is the steadily increasing level of education of the general populace. From 1960 to 1990, the percentage of 25+ year olds with 4 or more years of college education rose from ~25% to ~50%. These increasing numbers of well-educated workers have filled
the ranks of executive, professional, and technical jobs. The increase in education levels of women has been especially impressive: from 1960 to 1980, the percentage of females with 4+ years of college education grew from 7% to 18%.

Figure 1: Regional population and labor force trends

![Graph showing population and labor force trends across different regions from 1960 to 1990.]

Figure 2: Increasing levels of education in the region

![Bar chart showing the percentage of 25+ year olds with a college education from 1960 to 1990.]

Economic and Labor Force Trends

General Economic Trends

From 1960 to 1990 the regional economy grew in parallel with population. The aerospace industry provided high-paying jobs for thousands of workers. The entertainment and tourism sectors also generated significant income to the region. The influx of new residents and workers fueled strong performance in the construction sector. Today, the significance of this economy can be considered from a number of different measures: the region has the world's 12th largest economy, accounts for 6% of the nation's jobs and spending, handles over one eighth of the nation's international trade through its customs district, and has the largest number of multimedia firms in the nation.
During the first half of the 1990's, California experienced a painful economic decline: in the period from 1990 to 1994, the state lost 1.9% of the total number of jobs. The Southern California region was particularly hard hit due to a combination of factors, including downsizing of the defense industry, financial sector restructuring, and the Northridge Earthquake. During this period, the number of jobs in aircraft, space and defense declined from 290,000 to 171,000 (over 40%); meanwhile, the number of residential building permits declined from 115,000 to 29,000 (a 75% decline).

In the mid-1990's, the Southern California economy is well into a recovery. It has significantly transformed its economic base, with much less reliance on defense and aerospace and more emphasis on foreign trade, professional services, and entertainment and tourism. The rise, fall, and rise of the regional economy is reflected in measured and predicted job growth, shown in the figure below.

**Figure 3: United States and Southern California percentage job growth**

![Job Growth Chart](image)


**Labor Force Composition and Information Work**

The regional employment distribution has also undergone significant change during the past 30 years. The figure below compares the occupational breakdown in 1960 to that in 1990. The most striking shift has been the decline in the relative number of blue-collar compared with the number of white-collar workers. In fact, experts predict that this trend will continue. The Bureau of Labor Statistics recently projected that nationally, the two occupational groups with the greatest employment increases from 1992 to 2005 will be professional specialty and service. Some people are concerned by these trends, believing that all the high-paying manufacturing-related jobs are being replaced by low-paying service jobs. However, while the shift to a service economy is certainly producing more lower-paying, lower-skill jobs, it is also producing more high-paying positions such as creative designers, health-care professionals, computer programmers, and the like.

Many of these new service-economy professions can be categorized as information work. We define information work as "any economic activity that is primarily involved in the storage, transfer, or manipulation of information." In Southern California this definition encompasses a huge variety of sectors including advertising, movie-making, financial, insurance and real estate services, communications network operation, and the administrative operations of business and government organizations.
A precise definition of which occupations comprise information work is not readily available; however, in the figure below, the occupations under "managers, executive, clerical" and "professional, technical, sales" may be generally considered to be information work, while much of "operatives, laborers, other" are not. While all categories have been growing, the overall distribution of workers has steadily tended towards the information side (as demonstrated in the pie charts above), with recent economic events in the region most likely furthering this trend. If we assume that all "managers, executives, clerical", half of "sales" and "professional and technical" are information workers, we would estimate that currently about 50% of the regional labor force is involved in information work, translating to roughly 4 million workers.

The Role of Telecommuting

Advances in computer and telecommunications technologies now allow information to be moved, processed, and stored much more quickly and cheaply than before. The shift to information work coupled with such technological advances has increased the opportunities for new work arrangements. Among the most common, telecommuting has the benefit of allowing a worker to work wherever is most convenient and productive for the employer and/or employee. The basic idea underlying telecommuting is the use of the telecommunications infrastructure and information
technologies as substitutes to physically commuting to work. There are different ways in which workers can telecommute, including combinations of full-time/part-time and home-based/telecenter-based, depending on the needs of the telecommuter.

Considering the emphasis on information work, it is not surprising that a telecommuting study performed in Orange County found that companies in the Service and Finance, Insurance, and Real Estate sectors (all fairly information-intensive) were the most likely to have telecommuting programs. A set of case studies compiled by the SCTP confirms that a wide range of organizations in Southern California engaged in information-intensive work currently make use of telecommuting.

Table 1: SCTP telecommuting case studies

- United Airlines
- Movo Media
- IBM
- First Interstate Bank
- Unisys Corporation
- Health Net
- City of Los Angeles
- County of Los Angeles
- Hughes Electronics
- Chaffey College
- TRW
- Cal State Northridge

**Projecting Future Telecommuting: An Optimistic Scenario**

In order to estimate the upper impact that telecommuting could have in the region with regard to the trends discussed above, we have developed an “optimistic scenario” of the number of regional workers potentially available for different kinds of telecommuting in the next 20 years (details of the model appear in Appendix 1). Our baseline estimate is that the five-county area had 194,000 telecommuters of all sorts at the end of 1992. About 75 percent of them (144,000) worked part time at home, typically less than 1.25 days per week. The rest either worked full-time at home (about 5,500) or at a regional center of some sort. We project forward using the optimistic assumptions that telecommuting is boosted by a combination of 1) regulatory and competitive pressures, 2) improvements in technology and 3) attitude changes on the part of potential adopters, so that nearly half (47 percent) of information workers in the region have the potential to become full or part-time telecommuters. Using these assumptions, the “logistic growth” model described in Appendix 1 projects a total of about 1 million potential telecommuters in 1995, rising to about 2.5 million by 2015. As shown in Figure 6 below, more than 75 percent of these potential telecommuters remain in the at-home, part-time category, although the model also projects substantial growth in full-time telecommuting at home and in telework centers. Of course, the number of workers who actually telecommute will be some fraction of these projections.
Figure 6: "Optimistic Scenario" of potential full-time and part-time telecommuters, working from home, telework centers ("Twrk Cntr"), and/or central business districts (CBD).\textsuperscript{23}

Potential Impacts of Telecommuting

We next estimate the possible benefits to the region if telecommuting reaches the potential shown in Figure 6. Again, these are upper bounds on potential benefits; the actual results will be some fraction of the numbers estimated below.

Time and Mileage Savings

Potential time and mileage savings from telecommuting based on the above model are estimated in Figure 7.\textsuperscript{24} Time savings are expressed in terms of work weeks saved, assuming an average 40
-hour work week and 240 working days per year. In practice, some of these “savings” are used by telecommuters for working; that is, telecommuters work during some of the time that they would otherwise be commuting. This is one of the factors behind the productivity increases demonstrated by telecommuters.

**Potentials for Regional Economic Development**

- **Productivity** - Telecommuting projects often show a common economic result: many employees and their managers perceive increases in worker productivity after telecommuting programs are initiated. Improvements on the order of 12% were reported for the entire group of City of Los Angeles telecommuters in its Telecommuting Project. Experiences at other organizations lead us to expect some organizations’ averages to be on the same order as the City of Los Angeles values. Using such results as typical and projecting them to all telecommuters in the region gives estimates of potential economic benefits in the range of billions of dollars annually.

- **Disabled Groups** - Another regional economic benefit of telecommuting is its ability to bring work to workers who cannot easily go to a traditional workplace. With telecommuting, work can be sent to residents who are mobility handicapped because of physical impairments. Over 800,000 Americans workers are disabled every year. Assuming proportional distribution, about 40,000 of those newly disabled workers live in the five counties area. If telecommuting permitted 10 percent of newly disabled individuals to work productively, the benefits could be on the order of $100 million annually.25

- **Disadvantaged Groups** - Telework centers have also been considered as a means of helping another disadvantaged group: residents of distressed areas who might not have viable job opportunities in the immediate neighborhood. The Los Angeles County Metropolitan Transit Authority has set up workstations in its Blue Line Televillage in South Central Los Angeles as a means of providing various services and opportunities to the members of the local community.26

- **Reduced Wear on the Transportation Infrastructure** - Telecommuting can also improve economic development in the community by reducing the "external" costs of commuting, including the price of pollution, noise, congestion-related delays, and wear on infrastructure.

**Pollution Reductions**

Air pollution data from the California Air Resources Board for the five county region show that the pollution contribution from cars in 1995 to be 1,409,000 tons of carbon monoxide, 144,000 tons of reactive organic gases, 131,000 tons of nitrogen oxides, and 930 tons of particulates. According to our analyses of the combined Census and Air Resources Board data, commuting constitutes more than 60% of all automobile use in the region.27 The figure below shows the model’s estimate of the potential reduction of commuter automobile-induced air pollution if telecommuting grows to the levels shown in Figure 6.28 These estimates correspond to potential air pollution reductions of up to 4 percent in 1995, increasing to up to 10 percent in 2015.
The damage done by pollutants was recently highlighted in a *Los Angeles Times* article, which reported that nearly 6,000 residents of the region may be dying annually because of heart and lung complications associated with particulates.²⁹
2. New Business Paradigms

Revolutionary changes are taking place in business paradigms and practices. Many firms now make extensive use of telecommunications to transact business; for example, a clothing manufacturer may advertise on computer networks, take an order by telephone, transmit the order to a warehouse by microwave, and record the transaction at a remote database. Telecommunications are changing not only the transactional aspects of business, but also organizational aspects, allowing the formation of "virtual" companies. These developments in business organizations have direct consequences for the potential number of telecommuters in the region.

Impact of Information Technologies

During the last half century the national economy has shifted from a manufacturing to an information base. This trend is typified in the figures below which show: 1) the steady growth of information-related jobs versus the stagnant level of jobs in vehicle manufacture,\(^{30}\) and 2) industry’s increasing investment in information technology equipment over other investments.\(^{31}\)

Figure 9: Nationwide changes in information jobs and investment

In fact, information technologies are changing many of the basic paradigms of business. A business can be considered as an organization that makes a transaction with the customer and delivers some
product or service. Information technologies are causing changes in each of these areas, and these changes are having impacts on the adoption of telecommuting (as considered further in Appendix 2).

**Organizational Forms**

New products and services and new methods of transactions are developing the potential for many businesses to allow their employees to telecommute. In addition, there are also major changes occurring in organizations that are allowing businesses to exploit these potentials. In the following sections, these changes are considered in terms of different forms of organization.

**Traditional organizations**

During the Industrial Revolution, physical centralization was a necessary feature of the evolving manufacturing-based economy. The development of systems of mass production required many workers to take care of large machines that necessarily were located near transportation centers. This industrial centralization model (as shown as the “industrial” organization in the figure below) was applied to the information sector as well, since the requisite communications and organizational activities of the various employees could only be accomplished if they were in proximity.

The benefits of this type of organization began to wane as continued centralization of activities led to traffic congestion (leading to lost time and employee dissatisfaction) and escalating office costs. Businesses often attempted to solve this problem by opening new facilities, away from central business districts, as shown on the right figure below as a “dispersed” organization. In a few cases of this type of dispersion, workers were allowed to select the most convenient work site, regardless of job function. In such cases, much of their intra-work-unit communications were done via telecommunications rather than by face-to-face interaction. This organizational mode was characteristic of the first telecommuting programs in the mid-1970s. At that time, employees who worked with computers used “dumb” terminals connected to distant mainframe computers. If all of these terminals were to be located in employees’ homes, the costs of telephone service would have been prohibitive. Hence, the satellite office or regional telework center was more attractive; the centers could contain powerful server computers attached to dedicated, high speed phone lines going to the central office.

![Figure 10: Industrial and Dispersed organizations](image-url)

In an “Industrial” organization, all employees physically commute to a common location

In a “Dispersed” organization, employees could sometimes choose between different company facilities
Networked Organizations

As computer and telecommunications technologies advanced, it became practical for the information hardware to be located at individual employees' homes, allowing for the creation of networks connecting employees at central business districts and residential areas. Under this sort of networked organization, businesses could be spread out into the general community, with workers telecommuting to the remaining central offices. Currently, in most of the cases of this type of telecommuting, telecommuters live within typical commuting distance of their principal office, to which they do commute two or more days per week. The rest of the time, they telecommute from home or, in the case of sales or field service personnel, from their clients’ facilities.

Figure 11: The Networked organization

In a "Networked" organization, employees can physically commute (solid lines) or telecommute (dotted lines) using phones, faxes, and other equipment from their homes, telework centers, cars, etc.

The style of management that is most successful for a network organization is one where authority and responsibility are extended as far as possible. In terms of management, performance must be measured in terms of products rather than "face time." Of course, good communications are critical, highlighting the importance of telecommunications systems including telephone, faxes, data exchange, videoconferencing, etc. One of the newer technologies along these lines are intranets:

"... in the past year, more companies have seen that intranets, or internal webs, offer a custom-built approach to work-flow management and project management, and a platform for process redesign. Intranets also help companies get maximum efficiency from various experts and departments, no matter where they work or where they are located. So Web technology offers the kind of application that really fits well with the current trends in business - more coordination, more collaboration, more virtual offices."

An example of a business operating under such an organization is seen in Verifone, a 2000-employee company focused on "transaction automation solutions." At Verifone, "every professional, technical, and administrative employee around the world has a terminal or personal computer on his or her desk, and the entire company communicates 'around the clock' via electronic mail and other information systems and tools. In addition, more than 500 customers use these systems to communicate with the Verifone resources supporting them." Not only are the employees geographically distributed, key aspects of the company’s operations (such as its engineering units)
are globally distributed as well. This arrangement allows Verifone to more rapidly process customer feedback and to update their products in response to evolving demands.

Verifone's emphasis on information products and services make its networked organizational structure a natural environment for its workers. However, the enabling technologies for this sort of structure can be applied in other types of businesses as well. Even "manufacturing" companies can make use of networking concepts to such an extent that it blurs the distinction between information and non-information industries. A local example is MCM Motorcycles of Costa Mesa, which produces off-road racing motorcycles. While it would generally be classified as a manufacturer of motorized transportation, MCM does very little actual manufacturing; rather, it uses a network of manufacturers based throughout the Southern California region for the frame, engine mounts, exhaust systems, etc. Much of MCM's own activities revolve around administration and marketing: information activities. The benefits of outsourcing and network (and "virtual") organizations is described in a recent business article.

"Virtual companies coordinate much of their business through the marketplace, where free agents come together to buy and sell one another's goods and services; thus virtual companies can harness the power of market forces to develop, manufacture, market, distribute, and support their offerings in ways that fully integrated companies can't duplicate."

Temporary Team Groupings and Home Businesses

In addition to those organizational types described above, it is also useful to consider two other growing types of organizations: temporary team groupings and home and mini-businesses.

Temporary team groupings may be formed when a group of businesses and/or individuals decide to pool their efforts on an ad hoc basis for some common, short-term goal. When the particular project of mutual interest is completed, the organization dissolves, possibly to reform later with a different set of contributors.

Although the concept of such "evanescent" organizations has been highlighted recently, these sorts of groupings have been in place for quite some time. The movie production team for "Casablanca" was a temporary group, bringing together the talents of Bogart, Bergman, the director, writer, etc., for one product. Recently, however, these kinds of organizations have been occurring more frequently in other industries due to such factors as the decrease in transaction costs of temporary groupings (due to improved telecommunications) and the growing value of innovation (versus simple production). Clearly, standard production work, where both the production and market processes are well understood, does not need (nor particularly want) temporary teams. However, the process of fast and flexible innovation may often require the use of such teams, be it in car design or marketing.

Home- and mini- businesses have been growing in number. According to the Office of Economic Research in the U.S. Bureau of the Census, the nation's smallest firms created virtually all of the new jobs between 1989 and 1991. This occurred at a time when small-to-medium-sized companies (5 to 500 employees) were losing jobs. The greatest growth was in the service sector (much of which is information work), with a net growth of 1.9 million jobs, 1.1 million of which were in micro-companies. The growth of these small companies is reflected in the growth of self employment in the U.S., as shown below.
Similarly, the table below depicts the growth of various forms of home-based work in the nation. These numbers would seem to be in general agreement with a recent Times Mirror survey, which estimated that 45% of all employed respondents either had a home-based business or worked at home "often" or "sometimes."

Table 2: Home-based work trends

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Job</td>
<td>9.7</td>
<td>9.9</td>
<td>11.3</td>
<td>11.8</td>
<td>12.2</td>
<td>11.3</td>
</tr>
<tr>
<td>Part-time Job</td>
<td>7.4</td>
<td>7.6</td>
<td>9.2</td>
<td>10.6</td>
<td>11.5</td>
<td>12.0</td>
</tr>
</tbody>
</table>

There are a number of factors affecting the growth of these businesses. One is the downsizing movement in businesses: by setting skilled individuals adrift, such downsizing forces them to search for new ways of earning their livelihoods. The increasing power of information tools also fuels the growth, by better enabling workers to successfully run a business without a large support staff. Many of the new World Wide Web-based start-ups are leveraging these sorts of advantages: "By writing applets (stand-alone network-based programs) that can be sold, even rented, over the Net... startups can bypass traditional retail channels where they have little chance of getting shelf space."
3. Potential Impacts of Telecommuting on Business

The preceding sections have described the potential for telecommuting in various businesses and the potential regional benefits from large-scale telecommuting. What are the potential impacts of telecommuting on individual businesses? Recognizing such benefits, many major corporations are seriously encouraging telecommuting programs. "Xerox... expects that nearly 5,000 of its employees will be telecommuting in the next two years. AT&T (before its recent division) expected that one half of its 123,000 managers will be telecommuting within five years." In a recent Bell Atlantic study on telecommuting found that 2 million businesses had formal telecommuting policies in 1995, a significant increase from 1994's 1.3 million.

In the SCTP's survey of employers with telecommuters, it was found that the most important results following the adoption of telecommuting included:

- Increased employee productivity (reported by 42% of surveyed group)
- Improved employee morale (42%)
- Increased employee retention (39%)
- Improved customer service (35%)

These findings are supported by the results of other telecommuting surveys. Below, such issues of telecommuter productivity, employee morale and competition for workers, and employer flexibility and cost containment are considered.

Productivity

As shown in the SCTP survey and case studies discussed above, a primary bottom-line factor related to telecommuting is improved employee effectiveness. Several studies have shown that telecommuters often become more effective than their co-workers. In Southern California, increases in productivity on the order of 10-20% have been found in internal studies of telecommuting programs at United Airlines, Pacific Bell, AT&T, JC Penny, Healthnet, and American Express. In Northern California, a survey performed by the Smart Valley Telecommuting Pilot Project, employees responded that their productivity had increased by 20% after a trial period of telecommuting, meanwhile their managers reported a 12% increase. As stated previously, a survey of telecommuting Los Angeles City workers showed about a 12.5% productivity improvement.

These improvements are largely due to a combination of reduced interruptions, higher ability to concentrate on the tasks at hand, more time spent actually working, and greater focus on performance rather than time spent on the job. In general, telecommuters and, to a lesser extent,
their co-workers and supervisors, become better organized as a result of the telecommuting activity. Supervisors, for example, often state that, although their supervisory duties are the same, they are able to spend less time on such duties and more time on their own professional tasks. However, these improvements do not necessarily come instantly. Since telecommuting usually involves some degree of cultural change in an organization, it can take time for the improvements to be fully realized. At least one study has shown that effectiveness changes were continuing to develop two years after the start of the program.\(^{47}\)

**Competition for Workers**

In traditional companies, the staff generally comprises employees who live within reasonable commuting distance of company facilities. Although it is not often recognized, companies can have implicit commuting expenses in the form of higher wage demands by more distant workers.\(^{48}\) This issue is exacerbated when the prospective employees are in two-earner households, have children in school, simply do not want to move, or are otherwise limited in their residence location options. In a telecommuting situation, these constraints can be much less severe. In addition, many prospective employees view the ability to telecommute as a “perk,” which gives the pro-telecommuting company a competitive advantage in both the local and distant labor markets. Considering that in the information sector, the most expensive resource is people, these sorts of competitive advantages in manpower are often significant for many businesses.

**Cost Containment**

In recent years, a common theme among companies adopting telecommuting has been the need to reduce office space demand. Full-time home-based telecommuters essentially eliminate their need for downtown office space, with the exception of common rooms for periodic meetings. Even part-time home-based telecommuters can allow reductions in office space if they are willing to share space when they are in the office (a practice known as “hoteling”).\(^{49}\) Although telecommuters working at telework centers still use office space, it is usually available at lower costs per square foot than in the central office. These sorts of options may be particularly important for small and expanding companies by giving them more flexibility with regard to increasing the staff without incurring prohibitive up-front costs.

**Employee Benefits**

Of course, telecommuters also get benefits from telecommuting, including the following:

- **Time and Money Savings** - Since most telecommuters would otherwise drive their own cars to work, they save time and money in direct proportion to their reduced commuting. Focus groups held with telecommuters in Southern California\(^{50}\) demonstrated that telecommuting employees could save up to 3 or 4 hours each day they telecommuted, with the time savings including the time necessary to prepare for work. The economic savings comes from reductions in auto fuel and maintenance costs, reduced dry cleaning and lunch bills, etc.
- **Child/elder care** - Telecommuting is not necessarily an effective substitute for child or elderly care; it is not reasonable to expect a telecommuter to work at home and simultaneously care for a preschooler or an infirm family member. However, telecommuters can often hire part-time home helpers for these tasks at lower costs than day care centers or home nursing aides.
- **Flexibility and Control** - Although economic benefits can be substantial, telecommuters generally insist that the primary benefit to them is psychological. This benefit is largely related to their
increased feelings of control over their lives. This impact, rather than the economic advantages, seems to be the most powerful motivator for long-term telecommuters.

The employer also gains from these benefits through improved morale, which can improve retention and decrease absenteeism. The SCTP survey found that improved retention was found to be considered as an "important" factor before and after the implementation of telecommuting programs. Meanwhile, the City and County of Los Angeles found that two to four sick days per year were saved on average per telecommuter after programs were adopted.

**An Example Cost/Benefit Worksheet**

Below, we show a simplified example of telecommuting-related costs and benefits for an employer with a home-based telecommuter. The costing assumes that the telecommuter's annual salary is $26,000 and she telecommutes an average of 1.5 days per week. It does not include potential factors such as reduced parking requirements, changes in organizational effectiveness, energy costs, insurance, etc. Furthermore, human-factors such as the employee's quality of life (which is often the strongest motivator for telecommuting) cannot be truly quantified.

In this example, the one-time costs to equip a home-based telecommuter are recovered within 18 months from a combination of increased productivity, decreased sick leave and office space savings. The net benefits (undiscounted) over three years approach 20 percent of the employee's salary. Of course, actual cost-benefit calculations must be done on a case-by-case basis for individual employers and employees. For example, many employees retain their full office space even after they begin telecommuting, so that there would be no immediate office space savings. While such a situation would differ from the example shown below, it is interesting to note that this case would still show a long-term financial benefit from telecommuting.
Table 3: An example home-based telecommuting cost-benefit analysis

<table>
<thead>
<tr>
<th>COSTS TO EMPLOYER per TELECOMMUTER</th>
<th>One-Time</th>
<th>Recurring (Annual)</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection and Training</td>
<td>$200</td>
<td></td>
<td>For telecommuters &amp; supervisors</td>
</tr>
<tr>
<td>Telecommunications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Installations</td>
<td>$500</td>
<td>$900</td>
<td>ISDN phone line and interface card</td>
</tr>
<tr>
<td>Services</td>
<td></td>
<td></td>
<td>Miscellaneous telecommunications</td>
</tr>
<tr>
<td>Computer</td>
<td>$2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furniture Purchase/Lease</td>
<td>$350</td>
<td>$0</td>
<td>Inkjet printer</td>
</tr>
<tr>
<td>Equipment Purchase/Rental Costs</td>
<td>$350</td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Performance Evaluation</td>
<td>$700</td>
<td></td>
<td>A revised set of performance measures may need to be developed to adequately evaluate telecommuting employees.</td>
</tr>
<tr>
<td>TOTAL DIRECT COSTS</td>
<td>$4,100</td>
<td>$900</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BENEFITS TO EMPLOYER per TELECOMMUTER</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Employee Effectiveness</td>
<td>$2,600</td>
<td></td>
<td>Assuming 10% relative to non-telecommuters @ 1.5 days/week (based on sample productivity increases cited in this report)</td>
</tr>
<tr>
<td>Decreased Sick Leave</td>
<td>$150</td>
<td></td>
<td>1.5 days per year reduction (based on sample decreased sick leaves experienced in various telecommuting programs)</td>
</tr>
<tr>
<td>Office Space Savings</td>
<td>$1,100</td>
<td></td>
<td>150 square feet @ $2/month per square foot proportionally reclaimed</td>
</tr>
<tr>
<td>TOTAL BENEFITS</td>
<td>$0</td>
<td>$3,850</td>
<td></td>
</tr>
</tbody>
</table>

FIRST YEAR NET BENEFITS: $(1,150)  
THREE YEAR NET BENEFITS: $4,750

Undiscounted value. If we assume a discount rate of 8% annually, with the recurring costs and benefits accruing at the end of each year, the discounted value is $4400.
4. Barriers and Incentives to Telecommuting

Primary barriers to telecommuting include management attitudes, inadequate knowledge of telecommuting, and inadequate training. Laws and regulations often pose other barriers, though they can sometimes also provide incentives. Another major factor in the adoption of telecommuting is technology. Developments in the availability, capability, and cost of telecommunications and information systems will strongly influence telecommuting. Telecommuting will also be affected by the robustness of the telecommunications infrastructure, as was seen after the Northridge Earthquake.

Workplace Attitudes

Management

“How do I know they’re working if I can’t see them?” This is the one of the most frequently voiced concerns expressed by managers when initially approached with telecommuting. Managers are often worried about losing control and access to their workers; not surprisingly, middle management and senior executive acceptance were listed as the major company barriers to telecommuting by various surveys. Successful management of teleworkers requires a different management style from traditional methods, and the change can be unsettling for many. As stated before, results-oriented management is more appropriate for telecommuters than monitoring.

A closely related concern is that teamwork will fall apart in groups with telecommuters. With the growing emphasis in many organizations on teamwork, this is generally the second largest issue raised by prospective telemanagers. In practice however, many telemanagers of work teams feel that their team’s effectiveness is either unaltered or improved as a consequence of telecommuting. It is important to keep in mind that telecommuting is not a full-time activity for most telecommuters. Most beginning telecommuters telecommute from home only about one day per week (although the average tends to climb toward 2 to 3 days per week); thus, face-to-face team interaction is not precluded.

Employees

Concerns have been raised about isolation among telecommuters; however, surveys of active telecommuters indicate that this is generally a minor factor in most telecommuters’ lives. A larger issue raised by the respondents of various surveys regarded such “image” concerns as recognition by managers and peers, and the attendant impact on career advancement opportunities. Unfortunately, it is still too early to definitively determine whether these concerns are warranted.
In the end, the employee's own preferences and home (or telecenter) environment will determine whether telecommuting is an option for that individual. Some employees prefer the traditional office environment for social reasons or as a means of separating work from the rest of their lives. A more substantial barrier is often the lack of a suitable home office environment, which includes considerations for space, noise, distractions and/or interruptions, and the proper equipment. In most cases where there are workplace issues, work at a nearby telework center may be a suitable alternative.

**Organized Labor**

The Communications Workers of America (CWA) has set up test projects with companies employing union members who are potential telecommuters, and the AFL/CIO has been relying on the CWA for its policy positions. In practice, unions comprised of information workers have been passive or supportive of telecommuting. In the case of the State of California Telecommuting Project, the various unions of state employees were neutral to telecommuting during the pilot project and have voiced support for it since. The City of Los Angeles Telecommuting Project’s participating unions have also been supportive of telecommuting. The County of Los Angeles Telecommuting Program encountered some resistance at first from one union local, on the topics of entitlements and seniority, but that issue was quickly and easily resolved.

**Telecommuting Training and Education**

Although the concept of telecommuting is spreading, many adults are still unfamiliar with its definition and practice. This lack of information can often be a barrier to the acceptance of telecommuting, especially in the face of such misconceptions as:

- It costs too much to support telecommuters.
- Telecommuters never get promoted.
- Those serendipitous hallway meetings disappear.
- Telecommuting is just a form of electronic sweatshop.
- Anybody can be a telecommuter.
- Only a few jobs/people are suited to telecommuting.

If the acceptance of telecommuting is to be accelerated, it is particularly important to increase awareness about the realities of telecommuting among organizational decision makers. Senior executives need to understand the short- and long-term bottom line impacts of telecommuting on their companies or agencies. Mid-level managers, many already unsettled by other organizational changes, need to understand the opportunities that telecommuting can give to their own careers. Finally, employees in general need to become familiar with the potential impacts of telecommuting on their own careers and personal lives.

Since telecommuting often involves a change in an organization’s culture, acceptance can be slow; often two or more years are required before an organization makes even the first tentative steps toward testing telecommuting (on the other hand, the SCTP Survey found that employers who have actually considered telecommuting were more likely to implement telecommuting in the next two years (40%) than those who have not (20%)). Better and more widespread familiarization efforts can materially help accelerate this process. However, familiarization is often not enough. Several studies have shown that employees and managers need specific training about telecommuting
management principles. The SCTP’s training sessions were found to be fairly popular, drawing an average of 15 people per training session.58

Legal and Regulatory Issues

Zoning Ordinances

Many cities have zoning ordinances that, directly or indirectly, restrict home-based work. The primary motivation for these ordinances is to keep residential areas clean, quiet and relatively traffic-free. However, these city zoning ordinances were enacted at a time when most people worked in factory or store-based jobs. Today, many professionals and white collar workers do at least part of their work at home, oftentimes in technical violation of the existing local ordinances which are rarely enforced. Still, even without enforcement, such regulations can discourage employers and employees from initiating telework or telecommuting programs that would place them technically in violation of local ordinances.

Fortunately, local governments increasingly view telecommuting as a valid “ancillary” home use, including within the Southern California region. Thousand Oaks and West Hollywood are among the many cities in the region that have amended their zoning ordinances to permit telecommuting and non-intrusive work at home. The City of Long Beach, for example, passed an ordinance in September 1992 which explicitly allows home-based work (though under fairly strict standards).59

In July 1996, the Los Angeles City Council issued a request to the City Attorney to draft an ordinance that would allow home-based work;60 the ordinance was passed by the City Council in October 1996. In order to counter opponents’ worries about noise and traffic in residential areas, a distinct set of businesses are prohibited under the ordinance, including adult entertainment, garment manufacturing, retail sales, and machine shops.

Tax Incentives and Disincentives

Federal, state and local tax laws and regulations can also pose incentives or obstacles to telecommuting.61 Decisions by the Internal Revenue Service (which have been upheld in federal courts) make it quite difficult for telecommuters to take income tax deductions for their home office expenses. Only those whose home office is their principal place of business, and who do not have office space available elsewhere for their work, can qualify for a home office deduction. Few telecommuters meet these criteria. Theoretically, employees who telecommute can deduct certain home office costs as Employee Business Expenses, but these costs must exceed 2% of adjusted gross income before they are deductible. Again, relatively few telecommuters can take advantage of this deduction. However, bills to provide tax incentives for telecommuting have been introduced in recent sessions of both the U.S. Congress and the California State Legislature.62

Other Regulations

Concerns over liability for injuries to an employee working at home are often cited as a barrier to expanded telecommuting; in reality, such concerns are readily resolvable. Employers and employees should sign a telecommuting agreement that covers use of home facilities and equipment.63 If such an agreement is in place, work-related injuries at home are treated under Workers’ Compensation no
differently than injuries at the office. The agreement should also cover work-related injuries to third parties (e.g., express package delivery persons) at the telecommuter's home.

Federal and state government employees, as well as employees of government contractors, may find themselves working under more rigid rules concerning telecommuting than do employees of private firms. Although there appears to be no specific mention of telecommuting in the Federal Acquisition Regulations (FAR), federal government auditors require a written company policy for contractors, showing at a minimum:

1. Criteria for authorization of telecommuting;
2. Approval authority;
3. Job categories that qualify for telecommuting;
4. Controls in place to assure that services are received; and
5. Verification procedures.\textsuperscript{64}

These requirements do not seem unduly burdensome and are probably similar to those which many corporations have put in place themselves. However, private sector firms generally have more flexibility in interpreting or modifying such rules in specific situations.

Air Quality regulations have also been had an impact on the adoption of telecommuting because of their restrictions on vehicle emissions. For example, for several years the South Coast Air Quality Management District's Regulation XV (later changed to Rule 1501) mandated employers' efforts to increase the Average Vehicle Ridership of their employees; telecommuting was among the options listed for meeting this rule. Recently, such laws have been undergoing significant change,\textsuperscript{65} however, there is a trend for new regulations to continue to support the adoption of telecommuting.

**The Role of Technology**

Future developments in the availability, capability, and cost of telecommunications and information systems will strongly influence telecommuting. The importance of technology was demonstrated in the SCTP survey, which found that 65% of all employee telecommuters (as opposed to self-employed) used computers, 48% had printers, 51% had FAX machines, and 44% had modems.\textsuperscript{66} Meanwhile, the American Information User Survey found that 20% of the nation's telecommuters used email in 1995, doubling from the previous year.\textsuperscript{67} Increased performance and lower prices of such technologies will encourage many forms of telework.

The technologies most critical to telecommuting are microelectronics and computers, telecommunications, and networks. While these technologies are treated separately below, it is important to note the greatest returns from these technologies often come from their integration. Greater microprocessor speed, by itself, does not make a home computer a worthwhile alternative to coming to the office; rather, it may be the speed along with the networking, applications programs and computer peripherals that make telecommuting a viable option. It is also important to note that advanced technology is not necessary for all types of telecommuting. Many telecommuters can get by with just a telephone, pen, and paper. Conversely, the availability of relevant technologies to potential telecommuters does not guarantee that the employee will telecommute successfully; as discussed, there are still a number of non-technical barriers to the acceptance and proper implementation of telecommuting.
The impact of these technologies on telecommuting stem from their capabilities for handling information. Telecommunications and networks are important insofar as they allow information to travel from point to point, such as from a central office to an employee's home or telework center. Computers and computer software are necessary tools to process this information and empower the employee to perform tasks without having to depend on the infrastructure at some office. Finally, microelectronics are the enabling technology which has allowed advances in all of the above areas. Developments in these technologies are discussed below.

**Computers and Microelectronics**

Moore’s Law predicts that the number of logic elements on microchips doubles about every 18 months, thereby ensuring a steady increase in personal computer power. This steady increase in the performance of microelectronics, demonstrated below, has been paralleled by corresponding improvements in other components of computer systems. Typical capacities of PC data buses have increased from 8 to 64 bits in the last decade, hard-drive capacity from 20 to 1000 megabytes, and flat-panel displays have gone from passive matrix black and white LCDs to active matrix color. The improvement in the price and performance of these systems has prompted many more household purchases of computers. A regional survey of households in Los Angeles and Orange Counties found that 46% of those sampled had a household computer, and 19% used a modem on a regular basis. The utility of such equipment for telecommuting was demonstrated by the fact that 40% of the surveyed owners of home computers reported that job-related tasks were the main reasons they had their computers.\(^{68}\)

![Figure 13: Growth in the number of transistors per chip](image)

**Telecommunications**

Telecommunications technology has also experienced strong growth, including advances in telephone switches, fiber optics, microwave transmissions, and data communications. Telecommunications technologies making inroads into households include Integrated Systems Digital Network (ISDN), Asymmetric Digital Subscriber Loop (ADSL), wireless modems, telephone service over utility or cable TV lines, etc. The impact of these high bandwidth, multipurpose
technologies will be to further enhance and interlink the telecommunications capabilities of information systems. Further changes should be expected as a result of the recent federal government decision on telecommunications deregulation.

Telecommunications enables a variety of activities central to telecommuting; these include audio conferencing, videoconferencing, electronic and voice mailing, faxing, group editing of documents, and database use. Improved performance and decreasing prices in the technologies used for these tasks have allowed more and more telecommuters to make use of them with modems, faxes, etc. An example of this expanding use is seen in a projection of the increasing sales of videoconferencing units, as displayed in the figure below.

Figure 14: Growth in videoconferencing

![Figure 14: Growth in videoconferencing](image)

Networks

Wide area networks (WANs) and local area networks (LANs) connect computers together to allow file transfer, information sharing, remote commands, electronic mail handling, etc. While WANs and LANs have been around for many years, they have become increasingly more powerful and pervasive. Groupware such as Lotus Notes™ and Microsoft Exchange™ have increased functionality and simplified use, with some companies now using World Wide Web browsers to distribute information on their own company-wide "intranets." Companies such as Morgan Stanley and Turner Broadcasting have used such intranet systems as a relatively cost effective and secure means to share information between employees.

Although LANs and WANs are usually associated with computers in offices, these networks also provide strong incentives for increased telecommuting. Most directly, these networks can easily be extended into the homes of employees by simply supplying telecommuters with the telecommunications equipment and a password for remote access. Indirectly, these networks encourage the use of computers and networks to perform work, so that the transition to a home or telework center office becomes more natural.

Company WANs or LANs may also be connected to the worldwide Internet through a gateway. While the Internet was originally designed for use by the national security, research, and educational sectors, its phenomenal growth has spurred business interests to connect. With such Internet connectivity, the potential for telecommuters to exchange data with the "home office" is extended to anywhere an Internet connection can be obtained.\textsuperscript{71}
Robustness of the Telecommunications Infrastructure

Besides the capabilities of the above technologies, the robustness of these technologies is also a major factor in the adoption of telecommuting. For the most part, both the telephone network and the regional power grid are more likely to survive an earthquake unimpaired than the overall highway system. They are certainly more likely to be restored to full functionality quickly after a disruption.

After the Northridge Earthquake, both Pacific Bell and GTE experienced significantly increased call volumes and some damages. Pacific Bell experienced three Central Office outages, affecting 188,000 lines. GTE suffered the loss of one Central Office due to damage to a generator; this caused a loss of telephone service for 28,000 customers. Despite these problems, it is important to consider that only a handful of the hundreds of Central Offices were knocked out of commission, and further that these Central Offices were back in operation within short order (GTE’s was operating within 13 hours). There were no reported problems with any of the underground or aerial cables, or with the emergency lines. In order to guard against problems in future earthquakes, both companies have undertaken new initiatives; for example, GTE has strengthened the mounts to its generators and has also phased in a new design for its battery racks.

Business and Telecommuting Issues after Disasters

Obviously, other businesses also suffered considerable losses due to the earthquake. Such losses resulted from various causes: 1) structural damage to business buildings resulting in denied access, 2) inability or impairment of workers to get to their normal workplaces, 3) disruption of normal business activities because of degraded transportation. A recent study by Peter Gordon and Harry Richardson estimated that job losses from the Northridge earthquake amounted to a total of 60,000 person-years in the region, of which at least 35% were information sector jobs. This amounts to an information sector loss of about $1.5 billion.

All three types of losses listed above can be reduced by suitably designed telecommuting. A significant advantage of telecommuting in situations like an earthquake is geographical dispersion: because the resources of a telecommuting network are widely dispersed (in homes and telework centers) damage or destruction at one node is not likely to have a major effect on the network as a whole.

Not surprisingly, the SCTP survey found that a number of surveyed telecommuters began telecommuting as a result of the disaster. A similar boost in telecommuting was seen in the San Francisco Bay area after the Loma Prieta earthquake. The California Public Utilities Commission (PUC) was coincidentally participating in the State of California Telecommuting Pilot Project at the time of the disaster, and several of its employees had fortuitously switched their office phones to forward their calls to their homes before the quake. The PUC’s offices were seriously damaged by the quake and were out of commission for at least a week. The telecommuters were able to continue working during that period, while their co-workers were shut out of their offices. As a consequence of this graphic demonstration, Governor Deukmejian signed an executive order requiring all state agencies to include telecommuting in their disaster planning. The California legislature subsequently passed a law, signed by Governor Wilson, with the same requirement.

While earthquakes might be the most conspicuous sort of natural disaster that could interfere with commuting, we should note that in other regions of the country, other events play into the telecommunications versus freeways comparison. For example, blizzards in the Northeast in January 1996 made it difficult to travel; many workers had a hard time going to offices, as indicated by a 15% decline in the use of the Internet by business users. However, dial-up home users' assess
to the Internet rose 60%, while long-distance calls rose 35% and conference calling rose 15%. While it is impossible to know the content of all of these calls, it would seem reasonable that many were work-related; that is, workers were using the telecommunications system as a substitute for the transportation system.
5. Expanding Telecommuting in the Region

Based on the demographic, economic and other trends documented in this report, we expect telecommuting in Southern California to increase in the coming decades. The number of information-work jobs, which are particularly well-suited to telecommuting, is increasing as a percentage of the total workforce; furthermore, continuing developments in technology are enabling workers to accomplish more outside the traditional workplace. In many instances telecommuting is a "win-win-win" option for businesses, communities and individuals, so that it will be adopted even without external promotion. On the other hand, telecommuting is a new paradigm for many, and resistance to it can arise because of uncertainties about its consequences for both individuals and organizations.

Government agencies and organizations such as the Southern California Telecommuting Partnership (SCTP) can help to accelerate the adoption of telecommuting through public marketing-educational campaigns. In such campaigns, care should be taken not to ‘over-hype’ the concept, since telecommuting will not equally benefit all businesses and workers. Market segments with the highest potential for telecommuting success should be identified, and specific information about telecommuting should be directed toward employers and employees in those segments. Helping decisionmakers understand how to manage telecommuting in their organizations is also an essential part of any such marketing-educational campaign. Cost/benefit worksheets could be worked out to determine approximate financial returns from telecommuting programs.

Given good information about benefits and costs, employers and employees should be able to make sensible decisions about whether, and how quickly, to adopt telecommuting. However, some existing laws and regulations enacted in an earlier era may impose unnecessary burdens on telecommuting or working from home. As a consequence, local governments may want to review zoning and other ordinances to see whether they are consonant with the employment patterns of today, including telecommuting.
Appendix 1: The Telecommuting Model

The Logistic Model

A scenario was developed to see how telecommuting might be adopted in the region and what effects such telecommuting might have. This scenario was generated by a model developed by JALA International in the late 1970's and subsequently refined several times. It assumes a logistic model for the rate of acceptance of telecommuting by the general population. Logistic curves have been used extensively to track the penetration of innovations into society. In such models, the two key parameters are 1) the long-term (asymptotic) level of diffusion of the technology, and 2) rate of diffusion of the technology after it has been introduced. Examples of logistic curves based on actual data are shown below, applied to the penetration of radios, televisions, and personal computers.\textsuperscript{27} For radios and televisions, the asymptotic level of diffusion is apparently just under 100\% of U.S. households. The asymptotic value for today's form of personal computers is still not clear (we have not yet reached a leveling off), though we should not necessarily expect it to approach 100\% of households. The diffusion rate for radios and televisions is such that the penetration level reached 80\% of saturation after roughly 20 years; again, it is difficult to estimate the rate for personal computers without further data.

Figure A1: Technology diffusion patterns

In this analysis, the key parameters are the maximum percentage of information workers who telecommute (using any one of a number of different categories of telecommuting) and the rate at
which telecommuting is accepted. The values for these parameters can only be based on estimates; there are no hard data or rigorous means of analysis.

The parameters chosen are shown below. Our assumed maximum percentage of information workers capable of telecommuting is 47%. For sake of comparison, a recent survey estimated that 40% of the San Francisco Bay Area’s total working population (information workers and otherwise) could telecommute.\textsuperscript{78} Presumably, the percentage of information workers who could telecommute is higher than that of the total population. The term CBD in the table refers to Central Business District. In this context it simply means the "traditional" office center where the telecommuter would be working if not for telecommuting. Similarly, TC refers to any one of the forms of local telework centers mentioned earlier, including both inter- and intra-organization shared facilities.

Table A1: Telecommuting growth parameters

<table>
<thead>
<tr>
<th>Mode of telecommuting</th>
<th>Maximum % of information workers capable of telecommuting</th>
<th>Number of years to attain 90% of the maximum %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part-time TC/CBD</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Part-time Home/TC</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Part-time Home/CBD</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Full-time TC</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Full-time Home</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>47</td>
</tr>
</tbody>
</table>

Regarding the diffusion rate of telecommuting, the model assumed that the concept of telecommuting would have diffused into society after roughly one generation after inception. An additional 30 years were given to telecenter-based modes since preliminary estimates indicate that the rate of acceptance of this sort telecommuting is slower than home-based (in the SCTP’s survey of 53 employers with telecommuters, all but one were home-based modes).

We can compare our values with related estimations and values. In a recent WIRED article, five specialists were asked at what year 20% of the US workforce would be telecommuters, the average value was 2003.\textsuperscript{79} Using our assumptions about the percentage of information workers in the workforce, 1980 as the base year for the popular inception of teleworking, and maximum percentage of teleworking information workers, this gives an equivalent diffusion rate of about 20 years. To compare our numbers with related available data, the growth in the percentage of U.S. households with personal computers and the number of home offices are shown below.\textsuperscript{80} Of course, not all of these home offices translate directly to telecommuters; the point is that the technology and concept of home offices are penetrating into society at a rate faster than the given estimates.
Figure A2: Home office-related growth factors

Other Assumptions

In addition to the maximum percentages and growth rate parameters, the model also takes various demographic data as input. These demographic data and projections were obtained from sources such as the census data and SCAG projections described in the first chapter. In addition, it assumes certain workforce data such as the percentage of information workers, average distance between workers’ homes and offices, and average number of days per week spent telecommuting. Some of these values are shown below.

Table A2: Forecast starting point (1990) assumptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total population</td>
<td>14,500,000</td>
</tr>
<tr>
<td>Population annual growth rate</td>
<td>1.05%</td>
</tr>
<tr>
<td>Total area work force</td>
<td>7,400,000</td>
</tr>
<tr>
<td>Total information workers</td>
<td>4,500,000</td>
</tr>
<tr>
<td>Commuters</td>
<td>7,200,000</td>
</tr>
<tr>
<td>Commuters using private vehicles (including car/van pools):</td>
<td>91%</td>
</tr>
<tr>
<td>Commuters using mass transit:</td>
<td>8.8%</td>
</tr>
<tr>
<td>Average information worker daily commute (round-trip miles):</td>
<td>36</td>
</tr>
</tbody>
</table>

Each of the various inputs are allowed to change in value over time. For example, the fraction of the total work force that comprises information workers slowly increases from 1995 to 2015. Other changing parameters include the commuter modal selections (private auto versus bus versus rail); distribution of passengers between single occupant cars and higher occupancy vehicles; energy efficiencies of the vehicles; and the various factors in telecommuting (distribution between full-time home-based to full-time telework center-based, average hours per week telecommuting, etc.).

Finally, the model assumes a set of parameters relevant to various impacts of telecommuting on society. These impacts include automobile fuel savings, energy expenses (for computers and other
home office equipment), and emissions reductions. These values are also subject to change over
time; for example, automobile fuel efficiency is assumed to increase at a rate comparable to EPA
total fleet standards. The number of telecommuting hours per week increases with time. The
average distance to telework centers decreases as the assumed number of centers increases.
Nevertheless, as population grows, so does traffic congestion (and commute times) together with
average commute distance. The scenario assumes that telecommuting will peak at almost 50% of the
information workforce (distributed as shown in Table A1) sometime in the mid-21st century.
Appendix 2: New Business Paradigms

Information technologies are changing many of the basic paradigms of business. A business can be considered as an organization that makes a transaction with the customer and delivers some product or service; information technologies are causing changes in each of these areas, and these changes are having impacts on the adoption of telecommuting.

New Products and Services

New products and services have been introduced to fill new needs and exploit new opportunities in the evolving information economy; not surprisingly, many of these products and services are information intensive. Of course, all businesses have some component of information work (in administration, finance, etc.); however, the growth of the information economy and significant improvements in the enabling technologies to process and distribute information have made information products and services a steadily growing business sector. Examples of new products and services are given below.

Example: Computer Software - Computer programming is a rapidly growing business sector in which the final product is basically information (software code). The phenomenal growth in the number of computers and networks promises a corresponding growth in the number of programmers; a recent report estimated that the number of computer engineers and scientists in the country would increase by 112% from 1992 to 2005. This rise in the number of software-related jobs is particularly significant in the Southern California region, which contains the largest number of multimedia programmers in the nation (greater than the San Francisco Bay Area or state of New York).

Example: Telemedicine Services - AT&T's consulting arm offers its medical industry clients the GlobalMed Telediagnosis Station, a hardware and software system designed to enable doctors to practice telemedicine using advanced techniques of videoconferencing and electronic data exchange. GlobalMed enables physicians to communicate electronically with patients and other doctors, obviating the need for all of the individuals involved to be present in one location at the same time. It has the capability to store all patient records (including text, images, audio, and video), thereby facilitating quick and easy transfer of information among physician, patient and specialist.

Relation to Telecommuting - The common factor between these two and other examples of new information-economy products and services is their primary focus on the handling (creation, processing, and dissemination) of information, rather than physical objects. As such, jobs involved with these kinds of products and services often are well suited for telecommuting, since the handling
of information often can be done just as easily at home or a telecenter instead of a traditional office. For example, software distribution and support services can be all done electronically, without any need for physical movement of goods or people.

**New Methods of Transaction**

New technologies are enabling new methods of transaction over the telecommunications infrastructure. The actual product or service being traded may not necessarily be information-related; however, the mode of interaction with the customer may be very much information intensive. While mass patronage at "virtual malls" may not occur anytime in the near future, numerous business are already performing much of their business on-line. At this early stage, it is impossible to predict all the ramifications of these new modes of transactions; however, some researchers have predicted higher efficiencies through shortened value chains between suppliers and customers:

"There will be an evolution from single-source sales channels to electronic markets. And electronic markets may lower coordination costs for producers and retailers, lower physical distribution costs, or eliminate retailers and wholesalers entirely, as consumers directly access manufacturers."

**Example: Financial Transactions** - Many banks are exploring ways to allow financial transactions to take place electronically, such as balance inquiries, account transfers, and bill paying. Such services allow consumers to bank at home at all hours, avoiding the inconveniences of physically going to a branch office or ATM. Furthermore, straightforward interfaces between the banking programs and personal finance programs could facilitate consumers’ record keeping. In addition to providing the customer with more service, on-line banking could also save banks 75% of the cost of transactions. Not surprisingly, more and more major banks are expected to offer on-line services in the near future, as shown in the table below.

Table A3: Percentage of major banks allowing on-line transactions by various electronic devices.

<table>
<thead>
<tr>
<th>Device</th>
<th>1994</th>
<th>1997</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone</td>
<td>70</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>LCD-screen telephone</td>
<td>14</td>
<td>66</td>
<td>70</td>
</tr>
<tr>
<td>Personal digital assistant</td>
<td>2</td>
<td>34</td>
<td>46</td>
</tr>
<tr>
<td>Personal computer</td>
<td>38</td>
<td>82</td>
<td>84</td>
</tr>
<tr>
<td>Interactive TV</td>
<td>2</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>

Of course, there are still major hurdles to be faced by on-line banking. Security remains a large issue, as does standardization, price, and ease of use. However, many in the industry believe that these problems are transitional, and finance and networking companies are forming alliances to ensure themselves a long term niche in this market.

**Example: On-line Shopping and Catalogs** - The Travel & Entertainment Network - Internet Operations (TEN-IO) is a firm that now allows network users to get information about domestic and international flights, make booking requests, and link to cruise line companies, hotels, and other travel-related sites. In a similar vein, 1-800-FLOWERS and Internet Flowers are offering their
flower sales and delivery services over computer networks. These sorts of services have been available by telephone for many years; however, the use of computer networks has allowed these businesses to expand and diversify to new levels (for example, the Boston Girl Scouts recently opened a cookie-order Web site). The relative returns might be greater for small companies than for larger ones, since the creation and maintenance of a promotional or transactional web site is relatively inexpensive.91

**Relation to Telecommuting** - In these examples, the mode of interaction with the customer has become information intensive. In such cases, there is often little reason why an employee assisting in such a transaction should be constrained to work at any given location; for example, an associate working on a financial transaction with an on-line customer could work anywhere as long as he has a networked computer. Thus, the growth in the number of transactions performed on-line could lead to a simultaneous growth in the number of employees in such businesses who can telecommute.
References

1 Los Angeles Times, 27 October 1995, D1.
2 There are over 20 current and proposed telecenters in the Southern California region; for more information, contact 1-800-COMMUTE.
3 Business Week, 19 February 96, p. 20.
5 Projections are from the Southern California Association of Governments (SCAG) from December 1995.
8 Los Angeles Times, 22 April 1996. Southern California held 266 firms, compared with 236 in Northern California, and 76 in the state of New York.
12 “Blue collar” including the categories “operatives”, “laborers”, and “farm-related” in the census, and “white collar” including “managerial”, “sales”, and “service”.
15 Many employees using computers on the job on a regular basis could be considered to be information workers. Even in 1989, there were a high number of such workers in a number of industries. The percentage of workers using computers by industry, as given by the Census Bureau (see Business Week, The Information Revolution, 1994), is shown below.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finance, insurance, real estate</td>
<td>71%</td>
</tr>
<tr>
<td>Public administration</td>
<td>62%</td>
</tr>
<tr>
<td>Transportation and utilities</td>
<td>40%</td>
</tr>
<tr>
<td>Services</td>
<td>39%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>16%</td>
</tr>
<tr>
<td>Mining</td>
<td>31%</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>28%</td>
</tr>
<tr>
<td>Construction</td>
<td>13%</td>
</tr>
</tbody>
</table>

16 “Operatives, Laborers, and Farm-Related” include those categories listed in the 1960 census as farmers, craftsmen, foremen, operatives, farm laborers and laborers. “Service” includes the categories service workers and private household workers. In the 1990 table, “Operatives, Laborers, and Farm-Related” includes those workers listed under farming, forestry, fishing, precision production, craft, repair, machine operators, assemblers, inspectors, transportation, material moving, handlers, equipment cleaners, helpers, and laborers. “Professional and Technical” includes technicians and related support, and “Service” includes service, private household, and protective service.
17 While sales workers includes retail sales clerks (who would generally not be information workers), the category also includes advertising agents, brokers, real estate agents, sales representatives, etc., who generally are information workers.
In comparison, Michael Pittas estimated that 53% of American workers were information workers (see "The Planning Report," September 1995).

"Telecommuting Survey of Orange County Employers," presented by the Telecommuting Advisory Council, Orange County Chapter. Copies available from the County Administrative Officer, Hall of Administration, P.O. Box 22014, Santa Ana, CA 92702-2014.


In the Orange County Survey, 23% of the telecommuters telecommuted one day a week, and 41% telecommuted two or more; 97% of the programs were home-based. In the Smart Valley Project, an initiative undertaken by eight San Francisco Bay Area companies, employees telecommuted an average of 2.3 days per week. The U.S. Department of Transportation projected that half the nation's telecommuters would work from telework centers, and telecommuters would telecommute an average of 3-4 days per week (see "The Technological Reshaping of Metropolitan America," p. 170). Nationwide surveys estimate that 85% of telecommuters work from home.

In other data, the 1994 State of the Commute survey estimated that 11% (about 750,000) of the employees in the region telecommute. The SCTP estimated 630,000 telecommuters in the Southern California area in 1995 (see Los Angeles Times, 27 October 1995, D1).

In terms of national projections, Link and Pelorus estimates for the number of telecommuters in 1994 was 16 and 18 million respectively; these were projected to grow to 22 and 28 million by 1998. Find/SVP's survey estimated a 1994 national total of 9.1 million telecommuters; the difference may be attributed to a stricter definition of the term. The U.S. Department of Transportation projected 7.5 to 15.0 million telecommuters by the year 2002, telecommuting an average of 3-4 days per week (see "The Technological Reshaping of Metropolitan America," Office of Technology Assessment, Congress of the United States, Report OTA-ETI-643, September 1995, p. 170). Corresponding numbers can be estimated for the region by considering that the population in the five county area is roughly 6% of the nation's total.

In comparison to these national and Southern California results, a study by the Institute of Distributed Work in Oakland estimated that 40% of the Bay Area's population could telecommute.

To get an idea of the range of possibilities, it is possible to perform a Monte Carlo analysis of various scenarios. For this process, we use demographic trend data to estimate the likelihood of various rates of growth of each of the five types of telecommuting, providing a probability distribution function for each. We also use a range of possibilities for the upper limits of growth of telecommuting. We then run a number of individual scenarios, each time with a different, randomly selected, combination of growth rate and upper limit assumptions, as governed by the assigned probability distributions.

The time saved is not simply proportional to the number of telecommuters because of assumed increasing commutes and decreasing average speeds over time.

This figure does not include benefits accrued through reductions in government disability payments.

Information obtained from the Los Angeles MTA.

Further information about vehicle emissions in California may be found in "California's Ozone-Reduction Strategy for Light-Duty Vehicles," Lloyd Dixon and Steven Garber, RAND Institute for Civil Justice, MR-695-ICI, Santa Monica.

Since the pollution reduction data were calculated using a constant ratio of pollutants per vehicle-mile, the results are somewhat understated for the 1990s and, most likely, overstated for the years past 2000 due to steady decrease, over the mid-1980s levels, in the quantity of pollutants emitted by cars.

Los Angeles Times, 9 May 1996, A1. In addition to the air pollution factors, there are also energy conservation consequences of telecommuting. The model calculates the net effect of telecommuting on energy conservation derived from the reduction in automobile fuel use by telecommuters, combined with the increased use of home computers and telecommunications. Other energy considerations stem from the fact that telecommuters tend to use slightly more home heating and cooling energy while they are telecommuting. At present, there are no data to show an offset of this energy use by a comparable reduction in the heating and cooling of the downtown offices of the telecommuters.

Fortune, 4 April 1994, p. 77.

For further discussion of the evolution of business organizations, see "The Technological Reshaping of Metropolitan America," Office of Technology Assessment, Congress of the United States, Report OTA-ETI-643, September 1995 (particularly chapter 3) and Los Angeles Times, 10 December 1995, D1.

Interview with Mary Cronin, professor at Boston College’s Carroll School of Management, Fortune, 18 March 1996, p. 72.

From Verifone Web page.

Los Angeles Times, 8 October 1995, “Scent of Success.”


On the other hand, in a recent article (Fortune, 19 September 1994, p. 62), one author has gone so far as to state that "as a way of organizing work, it (the job) has outlived its usefulness... In the place of jobs, there are part-time and temporary work situations... Today's organization is rapidly being transformed from a structure built out of jobs into a field of work needing to be done."


Fortune, 4 April 1994, p. 787.


From the Bell Atlantic www home page.

“State of Telecommuting in Southern California 1995,” prepared by Transportation Management Services, 959 East Walnut Street, Suite 200, Pasadena, CA 91106


For example, see Nilles, et al., ”The Telecommunications-Transportation Tradeoff: Options for Tomorrow,” John Wiley and Sons, New York, 1976, chapter 3.

For example, only 400 of Tandem Computers' 700 employees have traditional offices.


Accessibility was the main concern voiced by managers in the Orange County survey.

In the Smart Valley survey, 47% of the responding telecommuters reported no change in workgroup productivity, while 44% reported an increase in productivity by 10% or more.


Telecommuting’s first appearance in a dictionary was in the 1987 unabridged edition of "The Random House Dictionary of the English Language.”

58 SCTP Final Report.

59 City of Long Beach, Ordinance C-7032, Section 21.51.235, 1992 states...

"permitted home occupation uses may be conducted as small, unobtrusive uses in any residential dwelling unit, subject to the following... standards [which] shall be complied with at all times:
1. No person other than a resident of the dwelling unit shall be engaged or employed in the home occupation, and the number of residents engaged or employed in the home occupation shall not exceed two.
2. No sign shall be displayed in a manner visible from outside the dwelling unit. Vehicles with signs identifying the home occupation shall be parked so that they cannot be seen from the public right-of-way.
3. No mechanical equipment shall be used except that which is necessarily, customarily or ordinarily used for household or leisure purposes. Such equipment shall not generate noise higher than the noise standards established for residential uses.
4. No toxic, explosive, flammable, combustible, corrosive, etiologic, radioactive or other restricted materials shall be used or stored on the site.
5. There shall be no outside operations, storage or display of materials or products.
6. Total storage of materials or products used in the business shall not exceed one hundred twenty-eight cubic feet.
7. The residential appearance of the premises shall not be altered. Creation of a separate entrance to the dwelling or use of an existing entrance exclusively for the business shall not be permitted.
8. No process shall be used which is hazardous to public health, safety or welfare.
9. Visitors, customers or deliveries to the dwelling shall not exceed that which normally and reasonably occurs for a residence. Visitors and deliveries shall be limited to no more than two business visitors an hour and eight visitors a day, and not more than two deliveries of products or materials a week.
10. The home occupation shall not displace or block the use of parking spaces required for the residential use including any business storage in required garage parking areas.
11. No advertisement shall be placed in any media containing the address of the property.
12. Not more than two vehicles shall be used in the business. Only one vehicle may be commercially licensed."

60 Los Angeles Times, 11 July 1996, "City Council Backs Home Businesses."

61 The Cortese Bill (AB2592), which would have allowed for tax credits to the employer, was recently rejected by the Senate Tax and Revenue Committee.

62 For example, the Telecommuting Tax Credit Act of 1995 (H.R. 1316), introduced by Representative Baker of California, would provide tax credits of up to $500 for telecommuters who work at home, and up to $250 for those who work at telecommuting centers. Various bills introduced in Sacramento would provide telecommuting tax credits up to $500, permit telecommuters to take home office deductions, remove the 2% floor for telecommuting expense deductions, authorize a 25% tax credit for telecommuting equipment and training, and exempt from California income taxes compensation for employee travel to and from telecommuting centers. See California Legislature AB 736, introduced February 22, 1995; AB 2378, introduced February 16, 1996 and SB 2157, introduced February 23, 1996.

63 For an example of such an agreement, see the SCTP Employer Implementation Kit, 1996.

64 The Department of Defense reportedly is in the process of formulating a FAR amendment that will deal with telecommuting. Private communication from Armin Scharff, RAND, September 1995.

65 In December 1995, the SCAQMD scrapped Rule 1501 and substituted a capitation tax, the proceeds of which were to go into a fund to be used for combating air pollution. Also, SB 772 modified the requirement for employers to provide ride sharing and other traffic reduction alternatives.

66 SCTP Survey, page 40.


For certain occupations, especially in the defense and financial sectors, security of network communications and transactions remains a concern. A number of software and hardware companies are currently working on technologies such as encryption and data packaging to address this concern.

Fortunately, the emergency 911 network operated virtually unimpaired.

In general, Central Offices are generally built with four times the normal earthquake standards as other buildings (this is an industry standard in California). Two levels of earthquake protection are provided for these buildings: reinforced flooring and mechanical braces above equipment frames (naturally, the necessary level of earthquake protection is dependent upon local ground conditions, proximity to fault lines, central office site, etc.). Furthermore, all cables running between floors and in ceiling frames are fire-proof, and back-up generators and batteries are available to guard against power failure. Outside the central offices, underground cabling is pressurized to guard against leaks (as in floods), and fiber optic installations have 25 feet of slack to absorb pulling strain during earthquakes. Also, certain critical networks use a fiber ring, which can tolerate a cut in the line and still function. Of course, no system is completely robust. For instance, a fire could take down aerial cabling. More commonly, construction workers, cable installers, and others could inadvertently cut an underground line while digging. However, compared to the physical transportation infrastructure, the telecommunications infrastructure is both more robust against disasters and easier and faster to fix (the Central Offices were functional after a matter of days, whereas many of the freeways were out of commission for months).

Gordon, Peter and Harry W. Richardson. "The Business Interruption Effects of the Northridge Earthquake" Research Report No. LCR1-95-01, University of Southern California, School of Urban and Regional Planning, Los Angeles, April 1995.

In fact, precisely this robustness advantage of dispersion was the primary reason for creation of the ARPANET.


_Wired_, April 96, p. 70.

1995 Institute of Distributed Work, from the Smart Valley report.

Estimates given by Franklin Becker, director of the international workplace studies program, Cornell University; Joe Carter, Managing director of Andersen Consulting Center for Strategic Technology; Fredric Crandall, founding partner of the Center for Workforce Effectiveness; Tom Newhouse, principal of Thomas J Newhouse Design; and Van Romine, director of the Institute for Telework. In _Wired_, October 1995.

Electronic Industry Association and IDC/Link, from 1996 Los Angeles Times article, “Home Sweet Home Office.”


See, for example, _Business Week_, 3 June 1996, p. 114.

Business to business transactions have taken place electronically since the advent of Electronic Data Interchange (EDI) in the early 1970's. Up until recently, however, such networks were only used by large corporations such as GM. The development of new telecommunications technologies will allow for more firms, particularly smaller firms, to participate. Not surprisingly, the Web commerce software market is predicted to hit $750 million in 1999 (Forrester Research, from _Business Week_, 10 June 1996). The benefits of such systems for purchase orders and invoicing are clear; for example, Campbell Soup Company estimates that it reduces its costs by $18 million annually with its system.


Towards this end, Microsoft attempted to purchase Intuit Inc. (the producer of popular finance software packages such as Quicken); failing to do so because of antitrust issues, both companies have gone in search of other partners. Meanwhile, BankAmerica and NationsBank have bought Meca Software (the producer of another finance program called Managing Your Money).


_InfoWorld_, 6 November 1995, p. 64.

Forrester Research estimated that a company's costs for a promotional and transactional web site would be about $300,000 and 3 million respectively (Business Week, 12 February 1996, p. 8). However, simpler and less expensive sites can be created and maintained, especially if the company already is making use of a server. Various enterprises have created sites for well under $1,000 and have been able to maintain them for <$50/month.