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THE PROSPECTS FOR TELECOMMUTING

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This paper explores the prospect of trading transportation for communications and the consequences of this trade-off.

The desire to communicate at a distance is as old as legend. Abraham, Moses, and other Hebrew prophets held frequent conversations with a God who was present only in spirit, much to the consternation of their friends, families, and neighbors. The Greeks required their Gods to appear from time to time, often in very odd forms. Prior to the invention of the telephone, literature was cluttered with lovers experiencing each other's presence while separated by hundreds, if not thousands, of miles. Heroines held their breath for weeks awaiting their hero's arrival, spurred by Jungian events of synchronicity, perhaps the most sophisticated tool for communicating at a distance.

It was no surprise that at least five telephone inventors were racing each other to the patent office, with Bell winning by thirty minutes over Gray. Events following the invention of the telephone, however,

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were surprising. Intuition tells us that the telephone and the telegraph satisfy our need to communicate and, while not replacing a lover's kiss, reduce less romantic contact and travel. The evidence, as we shall see, indicates that all forms of communications used in interactions and to complete transactions seem to affect society in counterintuitive ways. For example, the number of trips taken is directly proportional to the number of telephone calls made.[1]

Interest in the trade-off between transportation and communications has grown as a result of increases in air pollution, urban crowding, and concern regarding the cost and availability of energy. It is argued that the substitution of communications for transportation, should it be achieved on an appreciably large scale, would have many widespread effects on housing, plant locations, air pollution, work, and management. This substitution may reduce energy consumption, thereby resulting in lower energy costs.

I. PROSPECTS FOR ENERGY SAVINGS

With the decline of this nation's railroads and the rapid increase in air travel, there is no method of long distance transportation which is not energy intensive. Communicating rather than traveling over long distances may very well save corporate dollars. More than $70 billion per year is now spent for executive and staff travel. The number of firms now offering video conferencing demonstrates the degree of interest in reducing corporate travel. The use of teleconferencing for communications between distant offices and headquarters increased by 86% in 1983 over 1981 levels.[2] There is, however, no indication that the amount of travel has fallen off. Executives enjoy traveling, enjoy the time away from their offices, and enjoy the freedom from persistent telephone calls while in transit. Executives feel they have more control over their time when away from their offices than when in their offices.[3]

It is in the area of urban transportation, 70% of which involves travel by private automobile, where significant energy savings on a national scale might be found. As reported by the Motor Vehicles Manufacturing Association ("MVMA") in 1980, 28% of all motor vehicle trips in the United States in 1977 involved commuting to and from work.[4] According to the MVMA, this constituted 30.4% of total vehicle miles traveled, imposing a high social cost on urban society in terms of con-

1. Gottmann, *Megalopolis and Antipolis: The Telephone and the Structure of the City*, in THE SOCIAL IMPACT OF THE TELEPHONE 303, 308 (I. Pool ed. 1977).

2. 7 TELCOMS, INTERACTIVE TELECOMMUNICATIONS NEWSLETTER No. 3 (Apr. 1984).

3. Security Pacific National Bank, Future Scan No. 394 (1984).

4. MOTOR VEHICLES MANUFACTURERS ASSOCIATION, FACTS AND FIGURES (1981-82).

gestion, air pollution, energy consumption, and land requirements for the concrete freeways or turnpikes.

In their pioneering 1976 study, Nilles, Carlson, Gray, and Hanneman reported that urban automobiles accounted for almost 10% of the nation's total energy consumption.[5] At that time, the ratio of commuting energy consumption by the private automobile to telecommunications energy consumption was about thirty to one. Using ratios developed by Hirst,[6] it had been estimated that the replacement of urban commuting by telecommunications would result in a net energy reduction of more than eight billion kilowatt-hours annually for each percent of the urban commuting work force taking advantage of the substitution. The Nilles Study concluded that "a 1% reduction in commuting would save enough fuel energy to supply the residential electricity needs for a medium-sized city."[7]

There have been significant improvements in the energy efficiency of automobiles and other energy consuming devices. There have also been significant improvements in the efficiencies of our telecommunications systems, with enormous increases in our ability to utilize communications bandwidth at lower costs. But, there has also been an increase in the number of drivers as the babies of the post-war generation have grown up, taken drivers' education, and have, by now, traded their graduation presents for their second automobile.

To measure the magnitude of the energy savings which can be expected by substituting communications for transportation, the actions of individuals and their responses to the substitution option must be examined. According to the U.S. Census Bureau, in 1980 the thirty-eight standard metropolitan areas with populations of one million or more represented about 49% of the employed civilian labor force. It is estimated that about 79% of these workers commuted to work in their private automobiles, 62.1% alone and 17.7% in car pools. According to this report, these commuters consumed approximately eighty-two thousand barrels of gas per day.[8]

In 1977, Harkness suggested that 50% of the nation's white collar workers were able to substitute communications for travel.[9] In 1970, this represented some thirty-eight million workers. In 1985, this

5. J. NILLES, F. CARLSON, P. GRAY & G. HANNEMAN, THE TRANSPORTATION - TELECOMMUNICATIONS TRADEOFF 3 (1976) [hereinafter cited as NILLES].

6. E. HIRST, ENERGY INTENSIVENESS OF PASSENGER AND FREIGHT TRANSPORT MODES: 1960-1970 (1973).

7. NILLES, *supra* note 5, at 3.

8. U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACTS OF THE UNITED STATES: 1984 (104th ed. 1984).

9. R. HARKNESS, TECHNOLOGY ASSESSMENT OF TELECOMMUNICATIONS/TRANSPORTATION INTERACTIONS (1977).

number has grown to fifty-four million workers, and the number is expected to reach seventy-two million by the year 2000.[10] Using 1983 data concerning frequency of travel, trip miles, and vehicle energy consumption, Salomon argued that in 1985 fuel savings could amount to about 322 barrels per day, or 1.4% of the total U.S. demand.[11] In 2000, the savings could be almost the same, or 1.3%. In his analysis, Salomon assumed that workers would stay at home or work in a satellite work-site in or near their neighborhood six out of seven days.

If we reduce travel further, assuming that workers work away from their offices four days out of a five day work week, and increase the energy efficiency of the automobiles from Salomon's assumption of twenty-five miles per gallon to twenty-eight miles per gallon, the fuel savings from telecommuting would be quite small when measured in barrels (perhaps less than the 1.4% found by Salomon), but not when measured in dollars or security. While fuel prices appear to be falling today, one must remember that Mid-East politics can dramatically change the picture as they did in the early 1970s. Indeed, a draft proposal to the Federal Emergency Management Administration in 1980 suggested that planning for the substitution of communications for transportation should be seriously undertaken, not only because it saves the nation export dollars, but also because it might be necessary in emergencies.[12]

No one argues that substituting communications for transportation is a panacea for the nation's balance of payments and inflation ills. Yet, even the modest savings achieved to date appear to have had an important impact on the nation's level of inflation. Recent reports over the past year have cited reduced energy costs as one of the primary reasons, if not *the* primary reason, for the dramatic reduction in inflation. It is certainly in the national interest to encourage continued conservation of fuel energy, and one way to accomplish this is by substituting telecommunications for transportation.

Other energy savings may be possible if those who can work away from their offices would actually do so. For example, central office space could be reduced, and heating and air conditioning energy conserved. But, this would increase heating and air conditioning consumption at the remote sites, including the home. The end result may simply be a redistribution of energy costs rather than a savings.

While energy savings associated with the switch to communications

10. U.S. BUREAU OF THE CENSUS, STATISTICAL ABSTRACTS OF THE UNITED STATES: 1984 (104th ed. 1984).

11. Salomon, *Man and his Transport Behavior: Part 1a. Telecommuting — Promises and Reality*, 4 TRANSPORT REVIEWS 103, 113 (1984).

12. R. SOLOMON, TELECOMMUNICATIONS IN AN ENERGY CRISIS, A DRAFT PROPOSAL (1980).

from transportation may not be as spectacular as expected and wished, such savings are sufficient to have important impacts on the nation's economy. These savings play a significant role in stemming the rise of inflation by maintaining price pressures on the oil producing nations. Learning how to substitute communications for transportation is most important if national security is threatened by a major disruption of fuel supply resulting from another Mid-East political incident.

II. PROSPECTS FOR REDUCED ENVIRONMENTAL POLLUTION AND TRAFFIC CONGESTION

Arguments over the degree to which the automobile contributes to environmental pollution are still frequently heard. After all, Jacksonville, Florida, and Albuquerque, New Mexico, have led the list of the most highly polluted cities in the nation, and yet these cities do not rank among the more traffic congested in the nation. There are, however, few arguments over the automobile's contribution to air pollution in Los Angeles. The effects of reduced automobile travel on air pollution should, therefore, be considered city by city rather than on a national basis.

The emission of pollutants from motor vehicles is due to many factors including travel characteristics, such as amount, speed, flow, traffic pattern, and congestion. All vehicles emit pollutants and their impact on the environment depends on the geographic character of the area, the ambient air temperatures, and how well the vehicle is maintained. Reductions in air pollution can be achieved not only by reducing travel, but also by reducing peak loads on the highways and freeways through efficient scheduling of work hours. While on a national scale the benefits would seem marginal, for those cities suffering from high levels of pollution attributable to some considerable degree to the automobile, these benefits may be more than marginal.

For the individual, the time saved as a result of reduced congestion on the highways and roads can be a substantial benefit. If the time saved by not traveling or by traveling fewer hours is used productively, the nation would certainly benefit. Commuters would also benefit by having more time to deal with their lives and improve their welfare.

It is not at all clear that reduced congestion will result in increased travel speeds for long. Altshuler reported that the congestion relief achieved by the introduction of BART in San Francisco/Oakland was quickly filled by new travelers who wanted to take advantage of this relief.[13]

If travel to the central city can be reduced through alternative

13. A. ALTSHULER, THE URBAN TRANSPORTATION SYSTEM (1979).

work arrangements, we might expect a reduction in office space requirements, further reducing congestion on the roads leading to these central business districts. One way of testing this supposition is to examine the impact of the telephone on the central business district.

The telephone was seen by many as the best hope for reshaping cities, for providing a more livable work environment in a less congested central business district, and for providing pleasant suburban work sites. Gottmann pointed out that:

> technology has never been aimed solely at saving human labor and reducing physical exertion. It has also been aimed at making geographical space, the space inhabited by mankind, *fungible* . . . . The fungibility of space would mean that every point in that space would for all practical purposes be equivalent to any other point.[14]

Telecommunications has the ability to allow people to work wherever they might choose to work. It is clear, however, that even with the telephone, people want to work with and near other people. This enables them to communicate easily and inexpensively with other people despite the congestion of "downtown" skyscrapers. When office buildings become vacant there are increasingly large numbers of bankers, financial advisors, salespersons, lawyers, real estate merchants, and insurance brokers ready to fill these vacancies.

III. PROSPECTS FOR ADOPTION

Whether the potential benefits discussed can be realized depends on people; human behavior always muddies the clear waters in which technologists and economists love to swim. The status of working at alternative sites today and the candidates for alternative working arrangements must be examined. This can bring some insight to the prospects for adoption of communications in place of transportation by the commuting public.

Determining the status of working at alternative work-sites is an invitation to a sort of numbers game. The enthusiasts choose definitions of alternative working arrangements in ways that maximize their estimates of that phenomenon. A reasonably accurate picture of just what is taking place requires that we define what we are measuring.

Telecommuting, as coined by the Nilles Study,[15] or telework,[16] is the use of computers and telecommunications equipment and systems to do work away from some central and conventional office. Estimates of the number of workers who teleworked or telecommuted in 1984

14. Gottmann, *supra* note 1, at 306.

15. NILLES, *supra* note 5, at 4.

16. V. GIULANO, TELEWORKING: A PROSPECTUS (1981).

range from about ten thousand workers[17] to between twenty to one hundred thousand workers.[18] It is not necessary to do all of your work away from the office to qualify as a teleworker; the count usually includes those who do so several days a week. Workers-at-home are those whose primary place of business is the home, as well as those who spend several days per week working at home, but not necessarily using computers or telecommunications. The telephone is and has probably been the most useful working tool for those who work at home, and may very well have been the instrument that made this kind of working arrangement possible. Today it is believed that many home workers are using personal computers.

The 1970 Census noted that about 3.5% of workers age sixteen and over reported their home as their primary place of employment. This figure dropped both in 1975 and 1980; indeed, in 1980 the percentage was 2.3%. It should be remembered that a good percentage of workers reporting the home as their place of primary employment were farmers, and the farm population has been steadily decreasing. This illustrates how difficult it is to get a proper count.

Estimates of the work-at-home force (not limited to those who use telecommunications as their primary tools of work) today range from a low of three million to a high of forty million. Electronic Services Limited reports that some two to three hundred companies have formal and informal telecommuting programs (in the broader sense), and claim that their ranks are growing. A 1984 Futurist article cited a U.S. Chamber of Commerce report, which stated that "10 million businesses list home addresses as their place of business."[19] The Wall Street Journal reported a recent AT&T study that found that eleven million Americans work at home.[20] This study further noted that 7% of the total labor force work at home full time, and 6% do part time jobs at home.

Finally, American business has been decentralizing its operations for decades, moving offices away from factories to suburbs, and away from the highly concentrated central business districts of the major cities to smaller cities throughout the nation. Branches of "downtown" offices have been located in suburbs and smaller cities where the tax rates are attractive and the work force is qualified and available. Gottmann points out that the telephone has played a significant role in this development.[21] Furthermore, the evidence is quite clear that the population levels in major cities have decreased since the end of the Second World

17. Private communications with Electronic Services Unlimited in 1984.

18. Krier, *Futurists Compute the Influence of Computers*, L.A. Times, Sept. 21, 1984, pt. V (View), at 1, col. 1.

19. Wolfgram, *Working at Home*, THE FUTURIST 38, 41 (June 1984).

20. *No Workplace Like Home*, Wall St. J., Feb. 23, 1984, at 2, col. 1.

21. Gottmann, *supra* note 1, at 309-10.

War. During this period, telephone penetration rose from less than 50% of the nation's households to almost 100%. Modern telecommunications, with increased ability to provide a greater variety of communications services suitable to the specialized needs of management, will accelerate this decentralization.

There are a growing number of people who are taking advantage of working away from the cores of the nation's larger cities. Management has found it advantageous to locate their expanding operations across the nation in a search for qualified and often lower cost labor, and attractive tax advantages. This may not decrease automobile travel. Indeed, the distance traveled by automobile is often greater in the suburbs and smaller cities than in the larger cities.

There is special interest in employees who take advantage of alternative work-site arrangements, such as the home or the satellite office. The satellite office is distinguished from the branch office in that, while it may be an extension of the branch or main office, it may be an ad hoc arrangement created to provide for remote work rather than an established office of the "downtown" firm.

Candidates for working at home fall into two classifications: professional and technical occupations; and secretarial and clerical occupations. Tasks within these classifications that do not require "assembly-line work" performed on location at all times, or tasks requiring face-to-face contact with others at all times, are especially well suited to alternative work-site arrangements.

Professional work has always been informational in nature and will be increasingly so. Engineers, lawyers and paralegal personnel, computer system analysts, programmers, teachers, professors, writers, editors, accountants, salespersons, real estate brokers, financial analysts, stocks and bonds merchants, and insurance workers and consultants of all kinds often do some work at home. Clerical workers, general office clerks, secretaries, typists, bookkeepers and accountants, auditors, data inputters, keyers, and coders are also candidates for working at home or in satellite offices.

While the labor statistics are not organized to track the future growth of informational workers (the statistics were gathered at a time when the economists were quite satisfied with definitions based on the economy of the industrial revolution), the best estimates are that the percentage of workers doing informational work will soon comprise more than 50% of the nation's work force.

The professional-technical category is growing at a different rate than the secretarial-clerical category. Carey estimates that the professional-technical group will grow by 70% between 1978 and 1990, while the secretarial-clerical group will more than double over this period of

time.[22] This latter estimate must be tempered in the light of the rapid introduction of word processors, personal computers, and their integrated programs, which promise to slow this growth. The secretarial-clerical growth will nevertheless be significantly larger than the growth of the professional-technical category. A growing number of workers are candidates for full time and part time alternative working arrangements.

The gender distribution in these classifications is most interesting. In 1981, women accounted for 44.6% of the professional-technical category, but made up 80.5% of the secretarial-clerical work force. It is not yet clear how these ratios are changing as women enter the work force in larger numbers, but recent evidence does not alter the proportions in any significant manner. It seems that the professional-technical work force continues to be dominated by men, while the secretarial-clerical work force continues to be predominately female.

With the secretarial-clerical work force growing faster than the professional-technical work force, and if they are equally likely to be candidates for working at home, one is tempted to speculate that more women will be working at home, albeit a different type of work than is traditionally associated with working at home. It should be noted that clerical work is defined and covered by the Fair Labor Standards Act of 1938, and unions are already taking strong exceptions to clerical work at home.[23]

Increasing numbers of workers are taking advantage of alternative work-site options. Their numbers are not growing as rapidly as the projections made in the 1970s when the cost of gasoline was rapidly rising, and when many observers believed that economically rational behavior would result in large numbers of office personnel working at home. The next question is whether work-site shifts are making a difference and, if significantly expanded, would such shifts make a substantial difference?

As noted previously, even a small reduction in fuel consumption affects the national economy. Conservation has reduced demand and OPEC can no longer maintain its arbitrarily high prices. Lower fuel costs have played a major, if not *the* major role, in reducing the nation's rate of inflation over the past year. Whether the trade-off between transportation and communications will reduce center city congestion and bring with it savings in personal time and clean air is doubtful.

22. Carey, *Occupational Employment Growth Through 1990, reprinted in* BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, ECONOMIC PROJECTIONS TO 1990, at 23 (1982).

23. Keller, *Unions Battle Against Jobs in the Home*, N.Y. Times, May 20, 1984, § 1, at 1, col. 1.

Reference is made to Gottmann and Altshuler quoted above; new commuters seem to fill the offices and crowd the highways.

IV. WHO WINS AND WHO LOSES

When the "chips are down" people do make rational choices based squarely on their perceptions of the benefits and losses to them, be they employees or employers. During the past several years there have been a number of pilot projects or demonstrations to explore the costs and benefits of providing alternative work-sites, and to determine the attitudes of employers and employees towards adopting new work arrangements. A considerable amount of qualitative and some quantitative data has been acquired from which one can speculate about the prospects for the telecommunications-transportation trade-off. Here we are not concerned with the causal activities of academics and other professionals and managers who bring work home with them in the evenings and on weekends. We are not concerned with the part time consultants that use their home as a part time office. Some twenty-five demonstrations and work arrangements that have reported their failures and successes have provided insight into the attitudes of managers and employees concerning alternative work-sites.

Except for the IBM telecommuting "experiment" (IBM's term), which involved over eight thousand professionals, most of the pilots were small, employing six to twenty-six workers either at home or at a satellite facility, with supervision provided by three to twelve managers. In our review of the findings, we have found a remarkable degree of agreement among the reports concerning employer and employee benefits and liabilities.

A. BENEFITS TO EMPLOYERS

Teleworking increases the productivity among managers and clerical workers by 15% to 25%.[24] The oft referred to Blue Cross/Blue Shield Cottage Keyers in South Carolina reported that more claims are processed with fewer errors by the remote workers than by those working in the home office. Mountain Bell reported that their remote course writers prepare more courses more quickly than do course writers at the headquarters offices, and this results in faster processing of students through training and on to jobs. The U.S. Army claimed that programmers work more rapidly and efficiently away from the office, at home or at some remote facility. A major insurance company found that adjusters and inspectors operated as effectively out of their homes

24. NATIONAL ACADEMY OF SCIENCES, NATIONAL EXECUTIVE FORUM: OFFICE WORKSTATIONS IN THE HOME (1983).

and visiting the regional office no more than once or twice a week, as they did working out of the regional offices. A firm in Tarrytown discovered that it reaped public image benefits by allowing some of its employees to work in or close to their neighborhoods.[25]

In analyzing these findings, it must be remembered that except for the Cottage Coders, these demonstrations ran for relatively short periods of time. The reporting was primarily anecdotal and qualitative, and the workers were carefully selected and highly motivated. The excitement of participating in a demonstration project may parallel the experiences that took place in the famous Hawthorne Works in 1924.[26]

Several firms were pleased that alternative work-sites opened job opportunities for employees that would not otherwise have been available to them. Cottage Keyers, employed women with young children, were able to earn additional money while not leaving the home and paying for child care.

B. COSTS TO EMPLOYERS

Employer problems were primarily due to managerial difficulties. Managers do not feel they have the skills to manage workers at home or at satellite offices, and were troubled by their isolation from the employees. Managers often doubted worker loyalty. They had difficulty defining employee identity and, consequently, evaluating the performance of employees who required periodic reviews for their promotions and salary increases.

The costs of remote work were higher when modems and transmission costs were borne by the employer, as in the IBM case. Many employees who chose to work at or near home wanted to keep their desks or offices at the main office.[27] This did not lower employer facilities costs as was hoped. Firms also found that additional documentation and instructions were necessary, which were not required for similar workers at main offices. When the tasks performed at remote sites were linked to follow-up activities at main offices, such as completing sales and other transactions, employers often encountered training and coordination problems.

These are not serious barriers; managers can learn to deal with remote workers, especially as new telecommunications facilities provide more flexible and integrated voice, data, image, and video services. As

25. DIEBOLD, OFFICE WORK IN THE HOME: SCENARIOS AND PROSPECTS FOR THE 80'S, at 19-23 (1980-81).

26. J. BROWN, THE SOCIAL PSYCHOLOGY OF INDUSTRY 69-70 (1954).

27. Baer, Information Technologies in the Home, Information Technology and Social Transformation (1985) (available from National Academy of Engineering, Washington, D.C.).

noted by Chandler, modern managers have learned how to increase their managerial reach and to coordinate efficiently highly decentralized operations.[28] This is evidenced by the remarkable degree to which firms have decentralized their operations across the nation and the world. These remote locations, however, are established branch offices, which often have well-ordered political structures, rather than satellite facilities and homes.

C. BENEFITS TO EMPLOYEES

For those who would otherwise not have been able to work, working at home or at a neighborhood site was viewed as a distinct benefit. For some the ability to choose periodically to remain at home offered opportunities to share household burdens with partners and to restructure family relationships that may have gone awry. The increased flexibility with which they could deal with their lives was also seen as an important advantage associated with working at home or at a neighborhood site. Usually these reports came from professionals who saw no risk in this option since they had other alternatives, and created their home offices in order to earn extra income from consulting and writing.

With growing congestion on the roads leading to downtown offices, avoiding the journey several times a week saved time (on the average this amounted to one hour per day for the roundtrip journey) and fuel. These part time alternative work-site individuals also saved wear and tear on clothing, and the costs of eating out during the work day.

Finally, professionals enjoyed the ability to concentrate in an environment of reduced work stress, while secretarial workers often enjoyed the reduced supervision under which they worked.

D. COST TO EMPLOYEES

Professional and clerical workers, part time and full time, reported that social isolation was the most pressing and anxiety-producing problem associated with working at home. There are many who have sought periods of privacy and freedom to complete important reports at home. Some academics, who looked longingly at a sabbatical during which they could concentrate on their great works, have found that isolation can create considerable anguish and strange phenomena, such as terror when the phone rings, or when there is a knock on the door.

Clerical and professional staff workers fear that long periods of isolation from their peers and their supervisors will result in lower visibility, which removes them from the network and costs them promotions.

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28. A. CHANDLER, THE VISIBLE HAND: MANAGERIAL REVOLUTION IN AMERICAN BUSINESS (1977).

Several professionals, who for personal reasons found it necessary to work at home, reported that their career paths were seriously short-circuited.

Clerical workers at home or in neighborhood offices are often paid by the "piece" and have no benefits, and certainly no opportunity for collective bargaining. These workers recognize that they have given up these benefits in order to work at all. Finally, because so many of these workers are women, there is a growing belief that women may, once again, be segregated to working at home, or as one worker reported, "in the basement."[29] Unions have begun to object to the trend toward working at home recognizing that, especially for clerical workers, the possibilities of abuse can be very great.[30]

V. PROSPECTS FOR THE TRADE-OFF

There is a question concerning the degree to which alternative work-sites can be used by workers, with or without the use of computers and telecommunications. To the extent alternative worksites can be used, the national economy could benefit considerably, and the shape of our cities could be transformed.

For the nation, conserving fuel contributes significantly to the reduction of inflation because it creates pressures on the oil producing countries to lower their prices, or at least not to raise them. For some cities, the congestion relief that could be achieved through significant reductions in center city traffic could result in personal time savings. In turn, these savings could result in increases in productivity of value to the nation. Reduced travel and congestion may also reduce environmental pollution. However, flex-time work arrangements, such as those instituted during the 1984 Olympics in Los Angeles, may do more for congestion relief, if they can be arranged and maintained over time, than would attempts at overall travel reductions. The attractiveness of the core city as a site for informational work, however, may fill the space created with new informational businesses and workers.

Informational work is highly transaction-based, and people like to talk and work with other people. "Downtown" space is highly valued for this reason, and we will probably continue to use this space for highly valued work. In the information economy, informational work is high priced. Consequently, any significant transformation of the city is highly unlikely.

For the employer, working at alternative work-sites (not at branch offices) seems to have only marginal benefits. While higher productiv-

29. DIEBOLD, *supra* note 25, at 23.

30. Keller, *supra* note 23, at 1, col. 1.

ity can be achieved if the workers are carefully selected and remain motivated, there are costs of dual office space, increased training requirements, and decreased coordination by managers who have not yet mastered the art of remote management. Employers may be required to provide the telecommunications equipment for their home workers, and pay the transmission charges incurred by these workers. They must prepare for higher transmission costs over the next several years.

For the employees, the social costs appear to outweigh the economic benefits. Indeed, recent studies on the sociology of work point to the importance of separating the home environment from the work environment, and to the importance of maintaining an appropriate balance of roles in the home to the maintenance of healthy family relationships.[31] When this balance between the various subidentities in the home (husband-wife, employee, mother-father, maintenance worker-housekeeper) is lost, serious problems are created that lead to stress and unhappiness. The social interactions employees experience in the work-site are equally important to their lives.

The most extreme versions of trading telecommunications for transportation, that of working at home or at neighborhood sites, are not very likely to be implemented. There is the potential for abuse among those workers who are most likely to be home workers, such as married women with children who do clerical piece-work, an abuse about which the unions are fully aware. Recent attempts to modify the Fair Labor Laws of 1936 to legalize home knitting were overturned by the United States Court of Appeals for the District of Columbia Circuit as "arbitrary and capricious," and the same argument might be made about home-based data inputters should the demand for these workers increase.[32] It is interesting to note that Blue Shield/Blue Cross is already reducing the number of its Cottage Keyers by introducing more sophisticated information technology that can eliminate portions of that work.

Barring a major effort by government to make automobile travel very unpleasant and expensive, it is highly unlikely that commuters will change their habits. How unpleasant or expensive automobile travel must become before commuters turn away from the automobile has often been hypothesized, but events seem to show that the American (and, increasingly so, the world's) automobile commuter is willing to suffer a great deal of cost and inconvenience to stay in the automobile. The commuter in the United States has few if any alternatives to

31. Salomon & Salomon, *Telecommuting: The Employee's Perspective*, TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE 25, at 15 (1984).

32. Keller, *supra* note 23, at 32, col. 1.

the automobile. The future is not likely to bring new alternatives because mass transit programs are being severely curtailed, if not entirely eliminated, by the federal government.

VI. ORGANIZATIONAL TRANSFORMATION AND THE TRADE-OFF

An important change in our society is taking place that could accelerate the telecommunications-transportation trade-off. In his important work, *The Visible Hand*,[33] Chandler traces how management has learned to coordinate and efficiently manage many complex operations so firms can increasingly internalize operations that previously were performed by separate entities. In this way management, the visible hand, replaces the invisible hand of the marketplace for the coordination of that marketplace. Now that firms can acquire telecommunications and computer networks designed to meet their specialized management coordination requirements, the invisible hand will increase its span of control.[34] These networks are the ideal carriers of information and increase the potential for control and efficient coordination of far-flung enterprises. Evidence of this trend can be seen in the increasing number of mergers, domestic and international, that have taken place, and the extent to which the holding company model of business organization is growing in popularity among industries that heretofore have not used that structure.

Firms have been decentralizing their operations ever since the telephone became a necessary information management tool for business. Mergers and acquisitions of firms will continue to take place as managers learn to utilize the new telecommunications/computer networks for coordination. In the past, the complexity of these domestic and multinational businesses would have required relocating the newly acquired holdings and their managerial staffs in or near the headquarters offices. Today's integrated voice, video, data, and image telecommunications, coupled with multi-function programmed computer workstations, may eliminate the need for physical centralization. These managerial efficiencies have led to a reduction of middle level management staffs in several large corporations throughout the country. Recently, Business Week reported a decline of white collar jobs in the high-tech and smokestack industries.[35] While this transformation of business and in-

33. A. CHANDLER, *supra* note 28.

34. H. Dordick & D. Neubauer, Organizational Restructuring Under the Impact of the Information Revolution (Dec. 15, 1984) (available from the authors; to be published in KEIO J. COM., Keio University, Tokyo, Japan).

35. *Suddenly, The World Doesn't Care If You Live or Die*, BUS. WK., Feb. 4, 1985, at 96.

dustry may not reduce core city travel, it may succeed in slowing its growth.

CONCLUSION

Transportation and telecommunications may be substitutes for one another or they may be complements of one another. Telecommunications does replace some trips, but often creates the need for trips. Forecasting the impact of technology is difficult. There are few outstanding technological assessments of the automobile. No one forecast the contribution of the automobile to environmental pollution or the resurgence of the Arab world.

One-to-one telecommunications such as the telephone and the computer are transactional systems. They are facilitating systems with many uses. They can be used to magnify whatever process is taking place in society at a given time. When our nation was expanding westward, the telephone was used to maintain ties between family members. When the great urban centers of the nation were being constructed with their many-storied skyscrapers, the telephone was used to facilitate communications in crowded urban spaces. If society is prepared to accept large scale decentralization of its working environment, and if the cost of travel means society is willing to accept innovative working and living arrangements, then transactional communications technology will facilitate the decentralization. If travel and traditional single-family dwellings cease to be economically viable, people may be forced to live in ever higher concentrations close to work, and the telephone and other transactional telecommunications will facilitate this concentration. The substitution of communications for transportation can be encouraged through the use of incentives and management decisions followed by procedures and directives. It is not unknown for a manager to direct staff to communicate while he or she travels, if travel remains a perquisite in the future.