• Hawaii, with private-sector participation, opened the Hawaii Telework Center 20 miles outside downtown Honolulu in 1989 (see box). Reasons for exploring the feasibility of remote work included severe traffic congestion, scarcity and expense of office and parking space in the central business district, and potential for increasing employment opportunities for rural residents.

• The Washington State Energy Office (also in partnership with the private sector) is spearheading the Puget Sound Telecommuting Demonstration, with about 250 employees from 23 public and private organizations. The project includes several telecommuting centers in addition to employees who work at home.

• The federal government is conducting a pilot Flexible Workplace Program, which so far involves several hundred employees.

In the public sector, an interactive relationship between telecommuting policy and implementation often exists. Many of the programs described here were begun simultaneously with, or in response to, public policies that support telecommuting. Conversely, increased experience with telecommuting implementation has spurred additional policy development. The first significant policy contribution arose from Southern California. In 1987, the South

Hawaii Telework Center Demonstration Project

The Hawaii Telework Center Demonstration Project, conceived by the Hawaii State Department of Transportation (DOT) to test an innovative way to reduce traffic congestion, is believed to be the nation's first public-private telework project. The facility is in Mililani, Oahu, a suburban community 20 miles from downtown Honolulu.

Private-sector involvement was fundamental to the project. Hawaii DOT planners decided that the project could best be planned, organized, and implemented by a task force of executives from the public and the private sectors and faculty from the University of Hawaii. Private companies provided more than $300,000 of computer and computer-related equipment for the project. A local developer created 2,000 square feet of new office space in a campus-like setting for a lease cost of $1.50 per square foot per month. Telecommunication links and services, modems, and an uninterruptible power supply unit were provided. Part of the $125,000 appropriated by the Hawaii State Legislature for the project was returned because of the generous response from the private sector.

The Telework Center participants at the time of a project evaluation survey (1989–1990) included employees from five private companies: Bank of Hawaii, Hawaii Medical Services Association, IBM Corporation, Title Guaranty of Hawaii, and Inter-Island Legal Services. State government participants included employees from the transportation, agriculture, education, taxation, judiciary, and budget and finance departments.

Hawaii DOT substantially met its project objectives in pilot-testing the telework center concept, gaining valuable experience in remote work concepts and evaluating the results of its pilot project.

Participants were surveyed in four general areas: (a) commuting travel assessment, (b) work productivity, (c) employee satisfaction, and (d) job relationships.

The results showed that 93 percent of the participants (a target group of 15) reported trip reductions to downtown Honolulu, 100 percent reported driving time savings, and 79 percent reported travel savings and reduced fuel consumption. They reported a 76 percent reduction in the number of downtown trips and saved an average of 7.4 hours per week in travel time and $13.26 per week in fuel expenses.

Twelve participants reported an increase in work productivity. Reasons included fewer work disruptions at the Telework Center—fewer phone calls, social and nonwork-related conversations, meetings, and distractions.

The survey results showed significant improvement in employee satisfaction and quality of life. Telework Center participants were surveyed on stress level, happiness, amount of time available to relax and spend with their families, and other factors.

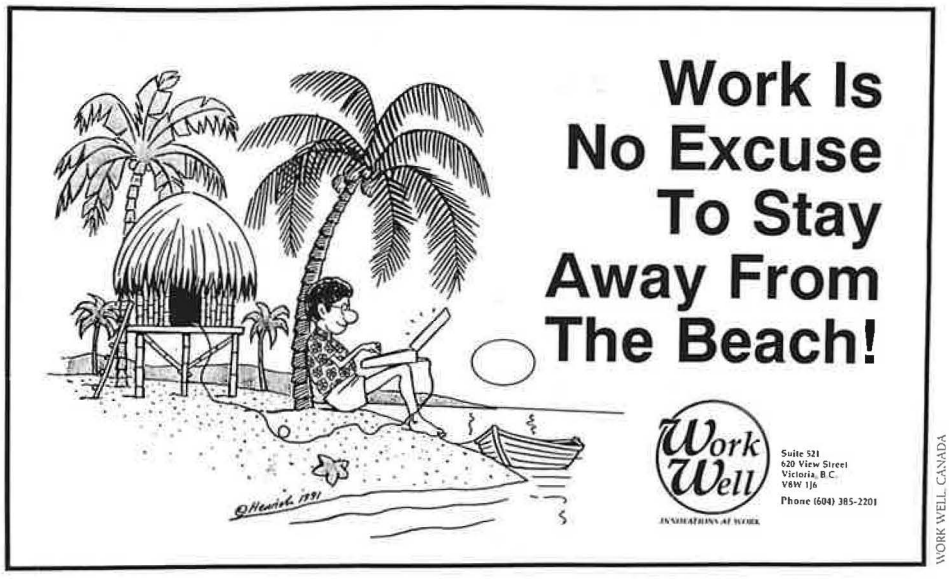
The final survey area on job relationships included questions on relationships with supervisors, missed opportunities, and work location preferences. All 15 employees said they would rather work at the Telework Center than at the main office.

Teleworking can open opportunities for new job candidates, including parents who need to be employed close to home, the handicapped and less mobile, residents of neighbor islands who wish to be employed with Oahu companies, and residents of rural and other remote areas. Teleworking can also bring new job candidates to the labor market by offering new work options and new work opportunities.

Teleworking, as demonstrated, can be more than a travel and traffic reduction measure. It provides jobs near homes and can bring significant quality-of-life improvements for employees and their families.

—Edward Y. Hirata and Edward K. Uchida, Hawaii State Department of Transportation.

Coast Air Quality Management District adopted Regulation XV, which included telecommuting on a menu of strategies that large employers could use to reduce peak-period vehicle trips. Subsequently, California, Florida, Virginia, and Washington passed legislation supporting telecommuting. The Bush Administration's National Transportation Policy and National Energy Strategy mention telecommuting briefly but positively, and the President himself has endorsed the concept.



WORK WELL, CANADA

What Has Been Learned About Telecommuting and Travel

Early speculation about the impact of telecommuting on travel was optimistic and focused on the potential for significant reduction of commute travel. Indeed, much of the early literature on telecommuting was inspired directly by the energy crises of the 1970s and indirectly by the search for solutions to the congestion and air pollution problems of major urban areas. A more cautionary tone subsequently appeared, however, emphasizing the complexity of travel behavior. It was suggested that nonwork travel might increase to compensate for the savings in commute travel. Additional trip factors could change, including time of day, day of week, destination, mode, pattern of linking to other activities, and person(s) making the trip. In the medium term, potential changes in automobile ownership were hypothesized. In the long term, it was postulated that telecommuting might stimulate further decentralization of residences and jobs, with potentially undesirable consequences.

It has only been within the past five years that a variety of telecommuting programs—mainly in the public sector—have offered the opportunity to test some of these hypotheses empirically. Transportation evaluations have been completed for programs involving the Southern California Association of Governments, the State of California, the Hawaii Telework Center, and the Netherlands Ministry of Transport. Evaluations are in progress for the Puget Sound multi-employer program, Los Angeles County, and several other employers in Southern California. From these programs, several findings are beginning to emerge.

First, commute travel is reduced. This may appear to be a tautological result, in view of the definition of telecommuting. However, telecommuting could conceivably stimulate increases in commute vehicle-miles (caused by residential relocation or shifts from ridesharing to driving alone), while still reducing commute person-trips. Thus it is important to rigorously evaluate the actual impact of telecommuting on commute travel.

The second finding to emerge from the current empirical analyses is that noncommute trips do not increase—contrary to hypothesis. In fact, noncommute trips actually decrease, and in some cases tripmaking has decreased for telecommuters' household members as well. This finding is probably partly due to respondent fatigue, that is, a tendency not to record every trip that is made, especially in later measurement periods. However, other explanations are plausible and are at least partly supported by empirical evidence. These explanations include, for telecommuters, a tendency to anchor nonwork activities to the commute trip and the threshold costs associated with getting dressed to leave the house; for household members, a desire to be at home with the telecommuter; and, for everyone, a heightened awareness of the need for reducing travel and traveling more efficiently.

Third, telecommuters make proportionately fewer linked trips. However, this is not a consequence of less-efficient trip making; it simply reflects that fewer trips are being made altogether (an average of two on telecommuting days, one of which is a return-home trip).

Fourth, telecommuters tend to shift activities to destinations closer to home. Interestingly, after telecommuting has begun, this "contraction of activity space" is observed on commuting days as well as telecommuting days. This suggests a learning process by which new destinations, closer to home, are discovered and permanently adopted. Members of telecommuter households also show a contracted activity space.

Fifth, proportionately fewer peak-period trips are made when telecommuting. However, this tends to be simply a result of the elimination of the two commute trips. Nonwork trips do not exhibit significant shifts in time.

Finally, the evidence regarding the impact of telecommuting on residential relocation is mixed. In the two-year data-

collection period of the California pilot project, 6 percent of the telecommuters indicated that they had moved, or were considering moving, 45 or more miles farther from work since they began to telecommute. Of all those who moved or were considering moving, 28 percent reported that the ability to telecommute played a significant or decisive role in the choice. It is important to note, however, that no significant difference existed between actual moves of the telecommuters and those of a control group—suggesting that on the whole, the moves that did occur would have taken place anyway. In this particular study, any net increases in vehicle-miles traveled because of long-distance moves were more than compensated for by travel savings on the part of others. However, these are only short-term results (for a relatively small sample); long-term residential relocation trends are likely to be more pronounced.

Areas for Additional Research

Although the findings from the current empirical studies just described are valuable, they also make it clear that a great deal still must be learned about the impact of telecommuting on travel behavior. At least eight areas deserve further attention at this point; this list will doubtless evolve over time.

1. How much telecommuting will occur? This is the most fundamental question. Ultimately, will enough people telecommute often enough to significantly affect observed aggregate travel behavior? To answer this question, we need to know who is telecommuting, how much, and how representative these early adopters are. Currently, for example, telecommuting is typically home-based, and as noted earlier, takes place one or two days a week on average. This will change, however (to more telecommuting occasions, but fewer miles and trips saved per occasion), if telecommuting centers become more widespread. Also, the pioneer telecommuters tend to be a small, handpicked, high-performing group. There are doubtless many similar people who have not yet had the opportunity to telecommute, but it is not clear how far into the mainstream that opportunity will ultimately spread.

Although various hypothetical scenarios about the future spread of telecommuting have been advanced, a behavior-based model of adoption is needed. A key component of that model is identification of situational constraints on the choice to telecommute and assessment of the future influence of those constraints. Another important topic for analysis is changes in the amount of telecommuting that an individual performs over time. Underlying these research topics is the need for large-sample data collection on the amount of telecommuting that is already taking place at any given time. National data collection efforts, as well as regional surveys of travel behavior, should include carefully designed questions on this subject.

2. Energy and air quality impacts. The energy and air quality impacts of telecommuting may or may not be as favorable as the transportation impacts. Even if the number of vehicle-miles traveled (VMT) is reduced, fuel consumption and emissions are affected by the number of cold starts (related to the number of trips), the number of hot starts, speed, time of day, and vehicle used. All of these factors can be affected by telecommuting. Preliminary analysis of the California data found that emissions reductions were 83 to 96 percent of the reduction in VMT on telecommuting days, but it is desirable to replicate that analysis in other settings before drawing any firm conclusions. Further, it is important to examine the nontransportation energy and air quality impacts of telecommuting. That is, the extent to which energy consumption in the home or telecommuting center substitutes for, or adds to, that of the conventional office and the air quality implications of producing the energy consumed while telecommuting must be determined.

3. Impacts on mode choice. One fear is that telecommuting will break up car- or vanpools, or make commuters less likely to seek such arrangements. Thus, it is necessary to analyze this aspect of travel behavior more rigorously than has been done to date. In conducting such an analysis, it is important to realize that lower vehicle occupancies alone do not increase congestion. As long as telecommuting simply removes a passenger from an existing car- or vanpool, VMT will not increase and will actually decrease (as a result of reduced pick-up and drop-off portions of the trip) unless the members of the car- or vanpool have the same origin and destination. It is only when telecommuting contributes to the disintegration of the entire ridesharing arrangement, so that multiple vehicle-trips are made, that negative consequences result. Many ridesharing situations already have some built-in flexibility (e.g., carpooling only a few days a week to allow individual activities to be conducted on the way to or from work on remaining days); the impact of telecommuting in these situations could be minimal.

4. Interactions with other demand management strategies. In transportation contexts, telecommuting most often appears on a list of TDM strategies for reducing the demand for peak-period vehicle travel. The interactions among these various strategies are not well understood. Telecommuting could change the effectiveness of other TDM measures (positively or negatively) and vice versa. In particular, strategies intended to shift commuters to higher-occupancy vehicles may affect the adoption of telecommuting or the transportation impacts of telecommuting or both. For example, the provision of child care at the work site is expected to lower a common barrier to ridesharing. However, this strategy could at best discourage some from telecommuting and at worst lead to increased travel. In the Puget Sound project, a worker whose child was in a day care center next to the work site had to make two round commute trips on telecommuting days (one in the morning to deliver the child, one in the evening to pick up the child), compared with one round trip on a normal commuting day. On the other hand, such strategies as parking and congestion pricing will stimulate shifts to telecommuting as well as to transit and ridesharing.

5. Impacts on location and urban form. The impact of telecommuting on residential

location in particular clearly deserves further, long-term evaluation. Historically, transportation improvements leading to reductions in commute times have facilitated decentralization to lower-density or less expensive housing on the urban fringe. With telecommuting functioning as such a transportation improvement, it seems reasonable to expect similar effects, at least in some cases. A primary question is whether long-distance moves properly attributable to telecommuting have the net impact of creating more VMT than are saved through not commuting to work every day. A broader issue is the impact of telecommunications technology in general on the location of all kinds of activities—and in the aggregate, the impact of telecommunications on urban form. A subset of this issue is the role of telecommunications in the economic development of exurban or rural areas.

6. Role of telecommuting and home-based work in the traditional urban travel demand forecasting process. It may be the case that, as a commute mode, working from home already has achieved a share roughly comparable to that of transit in many U.S. cities. Accordingly, it is perhaps time to start thinking about how to incorporate telecommuting and home-based work into the traditional urban travel demand forecasting process. Conceptually, the impacts of telecommuting and home-based businesses could be incorporated into any of the four stages of that process (although probably not into all of them simultaneously), as well as into a land-use model preceding those four stages.

7. Cost/benefit analysis. The costs and benefits of telecommuting can be compared from two perspectives. Although it may be useful initially to focus on one perspective or the other, a comprehensive analysis would ultimately combine them. In the managerial perspective, the employer is naturally interested in whether the alleged benefits of telecommuting exceed the costs. The ability to present convincing evidence —one way or the other—of the impacts of telecommuting on the bottom line will almost certainly influence the degree to and rate at which it is adopted. The second perspective from which to explore the cost-effectiveness of telecommuting is the transportation perspective. At least two questions arise. What would it cost to achieve a comparable savings in vehicle trips or miles through conventional demand management strategies? Further, if telecommuting occurs on a large enough scale, what would it cost to provide the infrastructure that would otherwise be required to accommodate travel saved through telecommuting?

8. Telecommuting centers. These centers actually involve special cases of several of the issues described previously. The two main issues are (a) analyzing the transportation and air quality impacts (especially the extent to which commute vehicle trips, albeit shorter ones, are still made), and (b) assessing the financial feasibility of such centers. Both questions are important to transportation planners. If the transportation and air quality impacts are negative or negligibly positive, this form of telecommuting should not be promoted as transportation policy. On the other hand, telecommuting centers may have considerable transportation benefits, but if they are not self-supporting they become less useful as a policy tool.

Conclusion

Although the focus of this article is on the transportation-related effects of telecommuting, it is worth mentioning that positive evidence on the management and worker benefits also continues to mount. However, the formula for quantifying white-collar productivity has not yet been discovered. The answer to "How do I know they'll really be working if I let them telecommute?" is still "How do you know they're working now?" A successful telecommuting program forces managers to be leaders and coaches, not hall monitors, and typically results in improved management of nontelecommuting employees as well.

At this point, telecommuting appears to be a promising (if only partial) solution to an impressively large set of problems. Nevertheless, there is always more to learn. A number of important transportation-related questions were mentioned previously, and a variety of other research issues remain in areas such as organizational behavior, social psychology, and health. The initial potential shown by telecommuting justifies considerable additional investment of research energy and expenditure for some time to come.

Acknowledgment

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