

**THE STATE OF CALIFORNIA
TELECOMMUTING PILOT PROJECT**

**FINAL REPORT
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Jack M. Nilles
Los Angeles
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OVERVIEW AND CONCLUSIONS

Telecommuting: sending the work to the workers instead of sending the workers to work; the partial or total substitution by telecommunications technology, possibly with the aid of computers, for the commute to and from work.¹

The California Telecommuting Pilot Project was first planned in 1985. Starting in mid-1987, final selection began of participating State agencies, managers and telecommuters. Training of the first groups of telecommuters and supervisors occurred in January and May 1988. The project also included some individuals who had been telecommuting prior to the official start of the pilot project. The active implementation phase of the project ran until January, 1990. Participants in the project, as well as a "control" group of similar State employees, have been surveyed at intervals through the project (including intensive annual questionnaires) in order to test the impacts of telecommuting. A random survey was made in December, 1989, of more than 500 State employees who were information workers in order to test the applicability of the pilot project data to other areas of State government.

Rationale

There are many stakeholders in the Telecommuting Pilot Project. Stakeholders are individuals or groups who have an interest in, or are affected by, the outcomes of the project. Primary stakeholders² include the telecommuters themselves, their direct supervisors, their families and colleagues, the organizations *in* which they work, the organizations *with* which they work, organized labor groups and State government in general. Secondary stakeholders³ include the communities in which telecommuters live and/or work, various agencies of government at the local, state and national levels (in the U.S. as well as in other countries), manufacturers and the distribution channels for information technologies and office equipment, the business community, the research community, consumer advocacy and other special interest groups, etc. Each of these stakeholders or stakeholder groups has a set of specific interests and priorities for judging the outcomes of the project. Often the interests of different groups coincide; at least some of the time they conflict.

Telecommuting, if it becomes widespread, can affect almost every aspect of contemporary life, from fundamental job patterns, to the physical structure of communities, to broad scale environmental changes such as global warming, to global economic competitiveness. Thus, we have attempted in the evaluation of this project to address as many as possible of the major issues affected by telecommuting.

This attempt was necessarily moderated by the constraints of budget and time — and the patience of the telecommuters and their supervisors. Budget and time constraints dictated investigation by questionnaire rather than the more expensive interview process. Respondents' patience limits constrained the length of the questionnaires (the final, 'abridged' questionnaire contained 466 items) and the frequency of their administration. Considering the time required to complete the questionnaires, the response rate of 100% in many of the agencies is quite gratifying.

¹Although made easier by modern technology, telecommuting is more a new (or revisited) mode of working rather than a physical technology; it is an *organizational* and *management* technology.

²Those who are or can be immediately or directly affected by telecommuting.

³Those who have a broad or indirect interest in some of the impacts, such as air quality, energy use, zoning, the economy, management techniques, etc.

In addition to the annual round of questionnaires, the participants and their driving age family members were asked to complete logs of their automobile use for periods of three consecutive days, once before telecommuting began and at the end of the first year of telecommuting.

The Basics

There are presently about 150 telecommuters participating in the project, mostly located in northern California, mostly from 6 of the 14 participating State agencies:⁴ California Energy Commission, California Youth Authority, Department of General Services, Department of Social Services, Franchise Tax Board, and the Public Utilities Commission. The Public Utilities Commission telecommuters live primarily in the San Francisco bay area, most of the rest of the telecommuters live in the Sacramento area. In January, 1990 another group of telecommuters from the Department of Justice was added, all of whom live in or near Los Angeles. However, test results from that group are not covered in this report.

Most (72%) of the telecommuters consider themselves to be professionals, with jobs ranging from accountant to researcher and including administrative law judges, lawyers, policy analysts and appraisers. Secretaries and clerical workers constitute 3% of the telecommuters, individuals who are primarily managers form another 3%, and those who consider themselves to be both managers and professionals make up 18% of the group. The average telecommuter is 41 years old, has worked for the State 14 years and 64% are male. The control group differs slightly from these figures, averaging 40 years old, with 47% males.

The median commute distance for the telecommuters is 20 miles, covered in 40 minutes (averaging 30 mph). The controls' median commute is 12 miles, covered in 30 minutes (averaging 24 mph). One telecommuter's `commute' is 210 miles, while the most distant control lives 200 miles from work. Almost all of the telecommuters work from home only part of the time, spending the rest of the time in their traditional office. The average in December, 1989 was 1.5 full days and 0.2 partial days per week at home, as compared with 1.2 and 0.3 days per week, respectively, the previous year.

Exactly half of the telecommuters used their own personal computers when they worked at home and only 23% didn't own a computer when we completed the mid-term survey of the participants. By December, 1989, PC ownership had climbed to 84%, with 58% of the telecommuters using their PCs for work. Ninety percent of the telecommuters own their own homes (single family detached structures), the average size of which is 1756 square feet — 134 square feet of which is used generally, and 69 square feet exclusively, for telecommuting. That is, their home offices are about the same size as their current downtown offices.

Results and Lessons Learned

The project has met or exceeded all of its key success criteria⁵:

- â Telecommuter work effectiveness has fulfilled or exceeded expectations.
- â Telecommuting enhances the quality of work life for telecommuters, including those with disabilities.

⁴An additional 7 agencies participated in some or all of the selection and training processes but never began telecommuting.

⁵Details are in the section: *Definitions and Objectives*.

- â Results-oriented management techniques have proven to be effective tool for telecommuting — as well as for non-telecommuters.
- â The techniques used for selection, training and evaluation of telecommuters are successful.
- â Telecommuting has been shown to have significant potential for reducing traffic congestion, air pollution and energy use.
- â Equitable means have been developed for sharing office space and reducing total space requirements (although these have not been fully tested yet).

As expected, many telecommuters experienced 'break-in' strains for a few months as they became acclimated to this new way of working. We expected stable conditions to reign by the end of the first year. Interestingly, effectiveness evaluations and quality-of-life indicators continued to improve after the first year.

Our in-person discussions and our questionnaire surveys and impact analyses during the implementation period lead us to the following key conclusions concerning the ***preconditions to telecommuting***.

- **Top-Down Support Is Vital.** A prerequisite to successful participation of an organization in any innovation is the support of senior management. It is also generally true that the agencies with the largest number of telecommuters (in proportion to their size) have the most active project representatives — or is it vice versa?.
- **Senior Management Support, Although Necessary, Is Not Sufficient.** An active “champion” is needed in each agency to spark participation through the startup period. This and the previous finding underscores our contention that:
- **Telecommuters and Their Supervisors Must Be Volunteers.** If either party feels forced to telecommute — or to supervise telecommuters, performance tends to suffer. This implies that telecommuting must be a management option.
- **Screening is Important.** Not all State employees can telecommute effectively, either because of the requirements of their jobs or because of personal and/or work-social considerations.
- **Training Is the Key.** We see significantly higher performance results when both the telecommuters and their direct supervisors have received telecommuting-specific training before telecommuting began.
- **Major Capital Investments Are Not Necessary.** Few, if any, of the participating agencies were required to make unplanned expenditures for computers or other telecommuting-specific technology. Often, where telecommuters worked frequently from home, their State-provided computer was moved from their downtown office to their homes. Many telecommuters either do not use computers at home or already own suitable machines.
 - ◆ Nevertheless, computers will be an important part of telecommuting in coming years. It is important to begin developing policies for these uses.
 - ◆ Further, no satellite telecommuting office has yet been established, although we have already selected and trained a set of candidate satellite office telecommuters — and desirable satellite office locations; this is partially a result of State facilities budget restrictions.

We can amplify the conclusions stated earlier: when those preconditions are satisfied, as they were for most of the participants, the following results can be expected.

- **Telecommuting More Than Pays Its Way.** There are a number of positive impacts of telecommuting. The average change in effectiveness of telecommuters is greater than that of the control group (a group chosen to otherwise match the characteristics of the telecommuters as closely as possible).

Telecommuters use less office and parking space downtown.

Telecommuting has been found to be very useful for retaining the services of mothers during maternity leaves, as well as keeping or attracting employees with scarce expertise or talents.

The consequence of these and related impacts is that the pilot project, including all the extra planning and training, paid for itself early in 1989. Since those start-up costs are now covered, the State can expect to make a surplus on the continuing telecommuters. Benefit-to-cost ratios could reach more than 20:1 if the experience to date continues to be valid in future years⁶.

There were also non-recurring benefits, not counted on our estimates. For example, telecommuters in the Public Utilities Commission were able to continue working immediately after the 1989 Loma Prieta earthquake even though the PUC was officially shut down for the rest of that week.

- **There Are Societal Benefits As Well.** A number of benefits have been demonstrated to date that can not be measured easily in dollar terms. Disabled telecommuters find the strain of 'getting to' their jobs significantly eased.

Telecommuters generally experienced more positive changes in their personal and their work relationships than did the members of the control group.

Although some automobile trips are taken by telecommuters during their work-at-home days, there are net savings in automobile use — household-wide — over and above the direct telecommuting-induced savings. The energy saved by six or seven telecommuters in one year is equivalent to the average US annual household energy consumption. If large numbers of people were to telecommute there would be proportionate reductions in traffic congestion and associated air pollution.

⁶The estimated actual annual benefit-to-cost ratios at the mid-term and final survey points were 0.9 and 8.0, respectively. Both of these ratios were heavily influenced by the non-recurring administrative costs of the pilot project. Our 1985 estimate was that the benefit-to-cost ratio at the end of the second year would be 3.2.

- **But There Are Restrictions and Possible “Side Effects”.** Some jobs are not ‘telecommutable’, nor are some individual workers’ — or their supervisors’ — temperaments. Our random survey of State information workers leads us to conclude that about 15% of them could not telecommute at all at this time, because of job constraints, and about 30% have jobs suitable for some home-based telecommuting, with the remainder as candidates for satellite-office telecommuting.

In the cases where some of the preconditions were not met, such as inadequate selection or incomplete training, results tended to be poor or negative.

Telecommuting was a statistically significant factor in the decision by 3% of the telecommuters to move farther from work. Clearly, other factors, such as affordable housing, are also major influences, probably the dominant ones. Nevertheless, telecommuting could be perceived as having possible negative long term effects on travel patterns — unless more emphasis is put on establishing regional telecommuting centers in or near areas of affordable housing.

There may be negative impacts on work-group performance if telecommuters are not readily accessible face-to-face (although we have little evidence — and some counter-evidence — of this to date).

RECOMMENDATIONS

The following recommendations focus on the issue of what happens next? First and foremost we strongly recommend that the current group of telecommuters be allowed to continue in that capacity. Most of the agencies involved in the project have already made that decision internally.

Second, we believe that telecommuting should be encouraged to expand within State government, that every State agency should have the option of using telecommuting both as a means of improving its effectiveness and for reducing traffic congestion and air pollution. However, it is also very important that telecommuting be implemented properly — and its utility monitored regularly. A subcommittee of the Telecommuting Advisory Group has developed a set of guidelines covering this and other issues. Our own variant of this is attached as an Appendix to this report. We have additional specific recommendations, as follows.

Establishment of a State Telecommuting Advisory Agency (STAA)

It is important to have a central source of expertise as other State departments and agencies develop their own telecommuting programs. The primary reason for this is to ensure that the lessons learned during the pilot project are available to all State agencies. Additionally, a central organization could continue efforts to improve the usefulness of telecommuting, gather and interpret information on its progress and act as a focal point for interagency coordination on issues affected by telecommuting. In order to function effectively this State Telecommuting Advisory Agency (STAA) should meet the following functional requirements. The STAA should:

- have high visibility and appropriate access to the Governor (therefore policy and action-taking leverage);
- be viewed by the management of other State agencies as: “We’re actually here to help you even though you might have to use your own funds for implementation”; that is, it should be viewed as an invaluable aide rather than a meddler or another hurdle to progress;
- have a highly motivated and politically astute head of the small, but quick and versatile, telecommuting project group (as the way to perform the previous function);
- include or have easy and unequivocal access to qualified trainers, evaluators and technical support personnel;
- have a maximum lifetime, possibly six years or less, but in any case with the goal of transferring its capabilities to the operating agencies, after which it dissolves.

The first four requirements are directed at the need for both leverage, to ensure that each State agency gives telecommuting adequate priority, and competence of the STAA. A large staff is not needed, hence the STAA should not constitute a significant budgetary demand. Funding could be from existing Departmental budgets, legislative appropriation, or gasoline tax revenues. The latter source seems quite appropriate; as gas tax revenues shrink because of increased telecommuting, so does the need for STAA dwindle.

The final requirement is to ensure that the practice of telecommuting is thoroughly diffused into individual agency operations in a relatively short period. Once telecommuting has been tested and adopted by each State agency, (wherever it is appropriate) there should be no compelling reason to maintain the STAA.

The real dilemma is where to locate the STAA. Since it should be small it should probably be incorporated in an existing cabinet-level Department. At the same time, since it should be small, it should overcome the danger of being thrust into a basement somewhere; the Department or Commission should have a demonstrated interest in developing telecommuting *as an integral part of its overall mission*.

Several Departments could qualify on the grounds that their mission is relevant to implementation of telecommuting. These include: Commerce, Department of Transportation, General Services, the Energy Commission, and Personnel Administration. Of that set only the Department of Transportation, General Services and the Energy Commission have had any active participation in the pilot project. Although the Department of Transportation has some mid-level managers who are enthusiastic about telecommuting, senior management has been apathetic at best. We recommend against STAA being placed in the Department of Transportation¹. The Energy Commission is largely directed toward external affairs, rather than interaction with other State agencies. The Department of General Services, on the other hand, has acted as the focus of the telecommuting project since its inception and has demonstrated high level support for it. We recommend that STAA continue to be located within DGS, although the current project office might need to be moved within the Department if it expands to fulfill this role.

Establishment of the STAA should include maintenance and expansion of the multi-agency steering group that has been very effective in the pilot project.

Expansion to New Agencies

The model set up by the pilot project seems to work well. We recommend that all State agencies be given the opportunity to familiarize themselves with the prospects and realities of telecommuting². We further recommend that State agencies considering implementing telecommuting be required to proceed through the planning, selection, training, pilot and expansion processes that were followed in this project. This helps to ensure that telecommuting is adapted to the management style of each agency rather than being imposed arbitrarily from above — and resisted accordingly. That, in turn, is much better suited to the long term success of telecommuting as a management tool. We do *not* recommend that each agency be required to adopt telecommuting. As with all the other aspects of telecommuting, it must be voluntary to succeed in the long term.

One of the first tasks of the STAA should be to inform all State agencies of the possibilities of telecommuting and to help them set implementation agendas. Although the Governor's Executive Order on commuting gives management an incentive to consider telecommuting, there are a number of other prime (and popular) motivations, including the top five:

- Retaining the services of an employee on maternity leave;
- Saving office space (perhaps an item about considering telecommuting on the Standard Form 9: Space Action Request);
- Retaining key, high-expertise employees who are considering leaving;

¹We admit to possible bias consequent to our experiences with the Federal Department of Transportation, which appears to believe that telecommuting is inimical to their mission of improving (but not reducing) transportation. However, CALTRANS had by far the largest proportion of supervisors who answered, during the selection phase of the project, that telecommuting was not suitable for them.

²Assembly Bills 2962 and 2963 were introduced 15 February, 1990, by Assembly Member Klehs. AB 2963, modified March 26, 1990, authorizes State agencies to develop telecommuting programs using the Telecommuting Advisory Group guidelines and model policy. It also creates a unit in the Department of General Services to coordinate the efforts. AB 2962, modified March 27, 1990, requires the Department of General Services and the Office of Emergency Services to develop model telecommuting plans to be used by State agencies for refining their own disaster preparedness plans.

- Increasing employee and management effectiveness (both quality and quantity) and reducing overtime; and
- Reducing the vulnerability of government to natural disasters.

There is a variety of media for disseminating this information: agency newsletters, reports such as this one, briefings or further Executive Orders. But it is important that all levels of management receive sufficient factual information about telecommuting so that they can make operational decisions.

There should also be a second level of pilot testing started at an early date: expansion to include more clerical/secretarial workers and development of several satellite centers throughout the state (possibly in conjunction with each other).

Establishing Satellite Centers

A major unfulfilled objective of the project was the failure to establish one or more satellite offices³. In our selection process we identified a number of telecommuters who could work effectively in satellite centers but the nature of whose jobs was such that they could not work at home often. As telecommuting expands, particularly as it develops in the larger metropolitan areas of the state, the need for satellite centers will grow more intense. Establishment of satellite offices in at least one or two of the areas identified during this project should be a high priority.

The City of Los Angeles has the establishment of at least three satellite centers as one of the goals of its telecommuting pilot project. Considering the number of State employees living and working in the Los Angeles area, it might be worth investigating a joint relationship in that area. Implementation of CALNET should help increase the viability of such facility sharing options.

Selection of Champions

We feel that it is particularly important that each agency developing telecommuting appoint a volunteer "champion" to act as the focal point for the effort. This has proven to be a very effective means of keeping the agency's motivation level high during the often difficult startup period. As is the case for the STAA, the champion needs to be a person senior enough to have the leverage for energizing and developing/maintaining the enthusiasm of some of the slower starters. The volunteer nature of this assignment is equally important. The champion should not view her/his task as just another one added to an already overburdened load.

Data Collection

One of the problems plaguing most studies of innovation is that of acquiring the necessary evaluation data. It is important during any implementation to keep an accurate account of changes produced in order to decide whether to expand beyond the pilot phase. The response to date of the telecommuters in this project has been between 50% and 70%. In fact, the members of the control group have been more responsive to the survey requests than have the telecommuters. We recommend that, in individual agency pilot projects of this nature, responsiveness to reasonable survey requests be an absolute requirement of participation. We have generally adopted this rule with corporate clients.

³Ironically, in our 1973 test of telecommuting in Los Angeles we (the research team at the University of Southern California headed by Jack Nilles) concentrated on satellite offices as the probable dominant form of telecommuting.

The issue of data collection was part of the requirements in the *Teleguide* to be agreed to by the participants. Many other points related to telecommuting are included in the *Teleguide*. In several instances during our interviews we discovered existing management problems that already had been covered either in the training workshops, the manuals, the *Teleguide*, or all of them. We recommend that telecommuters be required to read and sign the agreement in the *Teleguide* on an annual basis, and that the agreement be kept in employees' personnel files.

Also, as mentioned above, we feel that it is important to survey a broader sample of State information workers in order to develop an estimate of the generalizability of the concept. This survey should take place in the next few months.

Participation and Work Rules

It is our firm belief that the participation decision priorities must be top down; that is, from the agency director to the specific telemanager. A 'no' — but not a 'yes' — at any point in this chain must be able to override contrary votes among the downward links. A manager must be able to terminate telecommuting for any one of his/her subordinates who does not live up to their mutually agreed upon performance goals.

However, this does not mean that managers should not make serious attempts to resolve output problems before resorting to termination of telecommuting. In some cases during the focus group sessions we noted that job restructuring, rather than termination of telecommuting, might be a significantly better solution.

We recommend that a specific and general program be established to train both managers and their subordinates to think in terms of results rather than work processes. Our positive experience with the results-oriented option for both telecommuters and the few controls who attended the training workshops moves us to recommend serious consideration of results orientation as the primary management and work rule measure. Clearly, this increases the up-front difficulty about job design for both supervisors and subordinates but the results to date seem to bear out its importance.

As to the primary issue of who should telecommute, the screening criteria used thus far in the project have worked effectively. In those cases where telecommuting has not worked out for people, the causes have been either telecommuting at frequencies higher than those recommended or failure to adopt the management and communications practices recommended in the training workshops. It may be desirable in the future to test lower acceptance thresholds for the selection criteria in order to more fully explore the limits.

Information Technology

Although we anticipate that all kinds of information work will be increasingly computer-intensive in coming years, it is also clear that significant amounts of telecommuting can be accomplished without computer use — or even telephone use in some cases. Three-fifths of the final survey respondents reported that they used their own computers while telecommuting from home. This trend can also be expected to increase in the future. Where budget constraints are important (and where are they not?) telecommuting that requires computer use may be limited to those who are able to supply their own equipment, possibly with the State providing modems.

This raises an equity issue: what about people who can't afford their own computer? A partial answer to this is that, in a sense, a personal computer is the equivalent of an automobile and employees are expected to find some way of getting to work — usually by automobile. Only 16% of the telecommuters did not own a computer as of December, 1989. However, since there is no

current computer equivalent of mass transit and most telecommuters have not divested themselves of one of their cars as a result of telecommuting, this is only a partial answer.

Telecommunications cost and capacity is also an important issue. Despite all the high tech visions of computer-based telecommuting the primary need is for good call forwarding, intersite communications and answering machines or voice mail. This need for easy maintenance of communication must be balanced with the need for uninterrupted work periods, as a management issue, but the basic telecommunications need is important. Next in importance is the need for quality telephone conferencing so that telecommuters can join in group meetings. The development of CALNET promises to address these issues economically for both State and local government agencies.

Training

The statistical evidence is that training is quite important, particularly for the supervisors. The training also has benefits beyond telecommuting. One of the side effects of the pilot project, and of the Governor's order to reduce commuting,⁴ seems to be an increase in spontaneous, informal telecommuting ('guerilla' telecommuting). While this is laudable from an intent point of view this has the significant risk that untrained managers and telecommuters will produce negative results. We recommend that **no** further telecommuting by State employees be allowed unless the telecommuters and telemanagers are provided with pre-telecommuting training.

It is also desirable to have gradations of training available. Some individuals will need everything available to learn proper telecommuting techniques. Others will only need brushing up or reinforcement of their existing work or management patterns. For example, it is inappropriate to give the same training to a field engineer as is given to someone who has always worked full time in an office.

One aspect of manager training that may need expansion is that of intra-office work flow and job redesign. Most of the managers' complaints about telecommuting centered on the issue of accessibility to telecommuters in short-reaction-time situations. Related to that is the issue of equitable allocation of the 'fire-drills' among *all* of the staff, not just the ones in the office⁵. Although these issues are readily approached by some relatively minor management changes we found surprising resistance to them on the part of a few supervisors.

Further, it is important for the State to build up its own, or otherwise secure a cadre of trainers experienced in training telecommuters. Our original plan called for turning over the training tasks to State trainers after the first few sessions. This did not occur because of a lack of training resources in the participating agencies — as well as a lack of interest/motivation on the part of the trainers. Since telecommuting is not particularly job-content specific, it might be desirable to have a centralized group of trainers available to all agencies. The STAA is the logical place for this. The one experienced State trainer is the Telecommuting Pilot Project Manager.

Development Of Uniform Guidelines

A uniform set of guidelines should be established state-wide so that participating agencies can develop their own telecommuting programs without the necessity of "reinventing the wheel".

⁴Executive Order D-73-88. Also see Executive Order D-74-88.

⁵For example: "Why do I [her supervisor] have to take care of Sue's tasks when she's working at home?" Answer: "You don't. Use call forwarding, modify the schedule for those times that Sue must be in the office, or redesign her job to allocate those task to others--and vice versa."

Recommendations

These guidelines should serve as a model upon which each agency can build to develop their own version. The key factors to be considered in the guidelines are listed in Appendix B.

DEFINITIONS AND OBJECTIVES

Definitions

Telecommuting needs to be carefully defined to eliminate confusion about what is — and isn't — telecommuting. Here are our own definitions, expanded from the 1973 original version:

1. **Home-based Telecommuting.** In this version, the employee works at home, keeping in touch with the main office mostly by telephone or other telecommunications technologies. Most home-based telecommuters work at home only part time, say, one or two days per week, spending the rest of their work time in the `main' office or at other facilities. Home-based telecommuting is to be distinguished from home-based business in which the entirety of the individual's working time is devoted to his/her entrepreneurial activities; telecommuters are employees of other organizations. The transportation impact derives from their elimination of some trips that would otherwise be taken in a `traditional' information work setting.
2. **Regional Center Telecommuting.** There are three variants of this, known as satellite center, local center and neighborhood center telecommuting. There are the following distinctions among these versions.
 - ◆ **Satellite Centers** are facilities set up by relatively large organizations to house only their own telecommuting staff. Typically they house from twenty to more than one hundred workers, some of whom may still commute several miles to get to the center — as contrasted with tens of miles commute distances otherwise. Branch banks and fast food outlets are well established examples, provided that their employees are local residents. Note that, in the fast food outlet case, not all telecommuters are information workers.
 - ◆ **Local Centers** are facilities that house a number of telecommuters, say 25 or more, from at least two different organizations (companies and/or government agencies) in a single structure. Except for the multiple tenant and decreased organizational representation factors, with their accompanying management issues, they are otherwise similar to satellite centers.
 - ◆ **Neighborhood Centers** are smaller facilities, such as store-front operations. They house just a few workers, less than 25, and can serve either as mini-satellites or mini-local centers. The emphasis here is on neighborhood: each such center would be within a few blocks, walking distance, of the workers' residences.

For all of these the common criterion is that they are close to where the telecommuters live (with the neighborhood center being the closest) and the telecommuters work there instead of at home. Clearly, however, some telecommuters do and will share their work time among two or more of these options, including working at the distant central facility.

3. **Information Workers** are individuals whose livelihood depends mostly upon their ability to create, manipulate, transform or disseminate information, or to operate information machines. The majority of workers in developed countries are information workers. In California, about 60% of the workforce comprises information workers; about 30% of those may not currently have jobs that are suitable for telecommuting, in principle about 20% could be home-based telecommuters.

4. **Telecommuters** are individuals who telecommute with some regularity, typically at least one day per week, on average.
5. **Telemanagers** are direct supervisors of telecommuters.
6. **Telecommutable** tasks are tasks that are *location independent*: the person performing them can perform them almost anywhere. Telecommutable jobs are jobs (such as secretary, lawyer, engineer, judge) that include enough telecommutable tasks so that the job holder might be able to telecommute in full-day increments.

Technological change, particularly advances in information technology, can be expected to increase both the number of information workers and the proportion of telecommutable jobs over the next 20 years.

Objectives

The California Telecommuting Pilot Project had the following primary objectives¹:

1. To assess the impact of telecommuting on the effective delivery of existing State services;
2. To determine the consequences of telecommuting for managers and employees of state agencies, including the quality of work life within state agencies;
3. To explore the possibility of new state services made possible by telecommuting
4. To evaluate the opportunities created by telecommuting for the employment of, and the enhancement of working life for, persons with disabilities;
5. To test a results-oriented management approach as a key tool for successful telecommuting;
6. To develop improved tools for selecting, training and evaluating telecommuters and supervisors of telecommuters;
7. To estimate the impact of telecommuting on reducing traffic congestion, air pollution and energy use;
8. To develop guidelines for expanding telecommuting generally within state government, and;
9. To develop and test ways of equitably sharing office space and reducing total space requirements.

Extent of Compliance

Impacts on the Delivery of State Services

We assessed the impact of telecommuting on the effectiveness of delivery of existing State services by means of evaluation questionnaires administered to the telecommuters, members of a control group and direct supervisors of both groups. All were asked to evaluate their (or their subordinates') changes in effectiveness over the two-year period of the pilot project. The average difference between the effectiveness self-assessments of the telecommuters and the controls was 6.7% at the mid-term and 10.4% at the final survey. Supervisors' assessments of their telecommuter-control effectiveness changes were 2.3% at the mid-term and 6.8% at the final

¹The first four items in this list are as set forth in Section 15276 of the Government Code.

evaluation. That is, the telecommuters have grown steadily more effective over the past two years, relative to members of the control group, in delivery of their services. Earlier fears seem unfounded that the positive impacts of telecommuting would “wear off” over time.

There are also some infrastructural changes that are important. First, telecommuters are more dependent on the use of the telephone, and grow to use it more for such activities as coordinating tasks. Although this growing dependence on the telephone network might seem to be a possible weakness, events have proven otherwise, as demonstrated by the Public Utility Commission's telecommuters to continue working without interruption after the 1989 major earthquake. The latter is a clear case of delivery of State services that otherwise would have ceased.

Second, telecommuters are more likely to become computer adept. Although we did not collect data on the relative levels of computer use between the telecommuters and the control group, our private sector experience has shown this to be the case. Less than 20% of the telecommuters don't own personal computers. To the extent that computer facility improves effectiveness, then telecommuters are likely to be on the leading edge of those improvements.

Impacts on Managers and Employees

The impact of telecommuting on the telecommuters has been very positive, as determined by a variety of measures besides the effectiveness changes. Quality of life changes, both at work and at home, have been particularly important to the telecommuters, with improvements in the ability to concentrate on crucial tasks and to get more done, freedom from interruptions, increased creativity and improvements in personal life steadily increasing over the life of the project.

We did not make as detailed assessments of the impacts on managers, other than asking for self assessments in changes in effectiveness and work load. Most of the supervisors noted no change in their work load, although 3% reported significant increases. While 47% of the supervisors estimated no change in their effectiveness, 40% reported slight to significant improvements in their own performance. Supervisors' and subordinates' self-estimates of effectiveness and work load changes are closely correlated. That is, both parties appear to win when telecommuting is effective.

Possible New State Services

Although we did not test any new State services, the success of telecommuting suggests examination of some possibilities. Those discussed elsewhere in this report are: expansion of Employment Development Department services to take advantage of teleworking arrangements; development of regional telecommuting centers in low income areas as a means of job development and training; development of increased work opportunities for the mobility impaired; and localizing of specialized State services. An example of the latter would be easy tele-access in Yreka or Chula Vista to expertise in Sacramento for bridge design stress analyses.

Opportunities for the Disabled

Telecommuters who had mobility disabilities and were involved in the project found that their work-related stress levels significantly decreased as a result of telecommuting. Their effectiveness changes were positive, like the rest of the telecommuters. We did not specifically explore new job opportunities for the disabled; however, telecommuting clearly appears to benefit the disabled. Few information jobs have inherent restrictions to entry if telecommuting is an option for the employee.

Results-Oriented Management

Telecommuting requires a results-oriented management approach: managing the work instead of the worker. A frequent comment from managers new to this approach (such as during our training sessions) has been: “we should do this for *all* of our employees!” The effectiveness survey results tell the tale: the management-by-results approach produces increased performance for telecommuters and controls alike, when both supervisor and employee have received training in the methods.

Selection, Evaluation and Training Tools

The selection and training and evaluation tools used for the project had already been tested extensively in the private sector and proved suitable for the Pilot Project as well. In some cases where the selection questionnaires were not used, or the resulting recommendations were ignored, employees subsequently quit telecommuting or their performance failed to change. The average effectiveness rating difference was 11% between those telecommuter-supervisor pairs who attended the pre-telecommuting workshops and those who didn't. The evaluation questionnaires have yielded a great variety of data, all pointing toward the clear conclusion that properly managed telecommuting works very well for all concerned. JALA Associates will make all of the tools, questionnaires, manuals and evaluation services, available to the State for program expansion purposes at a reasonable cost.

Environmental Impacts

Both our data and the results of the parallel transportation study conducted at the University of California, Davis show major effects of telecommuting on reducing traffic congestion, air pollution and energy use. The average telecommuter worked at home 1.5 days per week (6.5 days per month), during which time the telecommuter's car was not used for other purposes. Further, total car use decreased in 22% of the telecommuters' households — over and above the decrease due to reduced commuting. If expanded telecommuting follows the same patterns as those of the Pilot Project, then there would be about a 35% reduction in commute car use for each telecommuter.

Guidelines for Expanding Telecommuting

The random survey of State information workers leads us to believe that there is no reason why telecommuting could not be extended to all State agencies. We have provided general guidelines for expansion in Appendix B. In addition, a subcommittee of the Telecommuting Advisory Group is developing a comprehensive set of expansion guidelines.

Potential for Office Space Sharing

We conducted a design study for shared office space, in conjunction with the design firm Sanchez/Kamps. Designs were developed for a variety of work modes and office types. We estimate that office space demand could be reduced by about $\frac{3}{4}$ for typical part-time home-based telecommuters — without inconvenience to the telecommuters. Greater savings were realized by one test arrangement made by the Department of General Services. Unfortunately, budget constraints did not allow testing of other designs. Nevertheless, the potential exists and should be explored further.

The following sections of this report treat the details of the progress made in satisfying these objectives.

CHRONOLOGY

The California Telecommuting Pilot Project formally began with a planning phase initiated in January 1985. The six-month planning phase resulted in a report *Telecommuting: A Pilot Project Plan*, published in June 1985. This plan formed the basis for the current Pilot Project, which was initiated in July 1987.

The current project comprised three phases: pre-implementation, implementation, and evaluation. The pre-implementation phase covered the second half of 1987 and involved the general organization of the pilot project. Roughly in chronological order, this included:

1. presentation of a number of orientation briefings to senior managers, mid-level manager/supervisors and potential telecommuters in prospective participating state agencies;
2. customizing of JALA-developed user manuals and questionnaires for background evaluation and impact analysis;
3. development (by Department of Transportation and UC Davis, with JALA assistance) of additional questionnaires for travel impact analysis;
4. selection of the initial set of participating agencies;
5. selection of the key contact person within each agency;
6. selection of the initial set of telemanagers, telecommuters and control group members;
7. selection of satellite office locations for non-home-based telecommuters; and
8. administration of the pre-implementation impact analysis questionnaires.

The implementation phase covered calendar years 1988 and 1989. It began in January 1988 with the training of the first group of telemanagers and telecommuters in a series of four-hour workshops². A second set of training workshops was held in May 1988. Actual telecommuting was to begin as soon as possible after the training workshops.

The evaluation phase also covers calendar years 1988 and 1989 as well as the first half of 1990. As its title suggests, the evaluation is intended to assess the successes and failures of telecommuting. It was further intended to 'fine tune' the telecommuting process as experience accumulated during the implementation phase. The evaluation phase also included the pre-implementation data collection and evaluation. Consequently, the evaluation information base includes the results of the background evaluations, the baseline, 'first year' and final impact and cost-benefit evaluations.

²A workshop cycle comprises three workshops: one for the telecommuters alone; one for their supervisors (telemanagers) alone; and a joint workshop for both groups.

PARTICIPANTS

As in all projects involving organizational change, reality sometimes differs from *The Plan*. The original plan for the project contemplated having from seven to ten agencies involved, with about 200 telecommuters. Half of the telecommuters were projected to telecommute from home, the other half to work at satellite centers to be established near concentrations of state employees. Most of the participants were expected to be from the Sacramento area. In the original plan, all of this was scheduled to come together by 1 January 1988. However, budget constraints¹ and intra-agency scheduling problems, among other factors, resulted in a staggered beginning of the project. Further, the satellite centers still have not been established — also because of budget, policy and interagency cooperation constraints.

Agencies

By the end of the implementation phase 22 State agencies had been involved in the project at one point or another. Their status is shown in Tables 1 and 2.

As can be seen from Tables 1 and 2, the agencies with the largest number of telecommuters are the Public Utilities Commission, General Services and the Energy Commission. Although represented in the early stages of planning and implementation, the Capitol Area Development Authority, the Departments of Consumer Affairs, Fish and Game and Personnel Administration, and the Office of Administrative Law never got beyond the planning stages, largely because of lack of interest at senior management levels. The Public Employees Retirement System had several very active telecommuters in the early part of the implementation phase but dropped the project entirely in a reorganization when new senior management took over. The Department of Transportation gave strong senior management support during project planning but did not appoint an active mid-level focus person for the selection and implementation phases; hence, mid-level manager participation was minimal.

A key conclusion can be drawn from this and related experiences: **a prerequisite to successful participation of an organization in any innovation is the active support of senior management.** It is also generally true that the agencies with the largest number of telecommuters (in proportion to their size) have the most active project representatives. Hence a second conclusion is that **senior management support, although necessary, is not sufficient; an active “champion” is needed in each agency to spark participation through the startup period.** This has been amply demonstrated in the private sector as well.

¹Originally, the project was to be funded at a significantly higher level by PVEA funds. When this did not occur the decision was made to ‘bootstrap’ the project with entirely voluntary, that is, unsubsidized, participation by each agency.

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<i>Agency</i>	<i>Entrants²</i>	<i>Completed Prelims³</i>	<i>Recommended by JALA Home-based Total⁴</i>	
Air Resources Board	43	24	23	15
California Energy Commission	178	76	61	43
Capital Area Development Authority	6	0	0	0
Department of Consumer Affairs	1	0	0	0
Department of Economic Opportunity	3	1	1	1
Department of Fish and Game	3	0	0	0
Department of General Services	187	69	56	35
Department of Health Services	10	3	2	1
Department of Justice ⁵	98	77	74	59
Department of Motor Vehicles ⁶	9	3	3	1
Department of Social Services	36	26	25	21
Department of Transportation	101	15	12	7
Department of the Youth Authority	75	28	27	22
Dept. of Personnel Administration	0	0	0	0
Employment Development Department	33	8	8	5
Food and Agriculture	1	0	0	0
Franchise Tax Board	90	50	48	23
Office of Administrative Law	14	4	2	2
Public Employees Retirement System	14	5	4	2
Public Utilities Commission	215	82	68	40
State Personnel Board	1	1	1	0
Teale Data Center	13	2	2	0
Total	1131	474	417	277

Table 1: Summary of the Selection Process

People

There were three main stages in the process of selecting the participants of the project. The first stage consisted of the familiarization briefings given to prospective telecommuters and managers in 1987. These briefings acted to elicit the initial set of volunteers: 1033 potential telecommuters and 413 potential supervisors.

The second stage comprised the administration and analysis of the background questionnaires. Two sets of questionnaires were administered: one for the prospective telecommuters and one for their supervisors. The questionnaires included basic demographic questions (including commute time and distance) and questions related to motivational level, job locational requirements and interpersonal working relationships. The questionnaires given to potential supervisors also asked for their evaluations of their subordinates. The analysis process weighted the answers according to telecommuting success criteria developed by JALA Associates, including a comparison of supervisor-subordinate factors. The results were printed in recommendation reports sent to the agencies via the Project Manager. Each recommendation includes an estimate of the form and duration of telecommuting, if any, most suitable for the supervisor-telecommuter combination.

²These include anyone who was formally mentioned as a possible telecommuting or control candidate. Just under 20% of these individuals failed to complete background questionnaires and were not considered further.

³In many cases the supervisors of potential telecommuters failed to return the requisite background questionnaires. This also resulted in a non-participation recommendation for the pilot. Hence, of the 1131 potential participants, 42% had *all* of their preliminary 'paper work' completed.

⁴This and the next column show the number of telecommuters recommended by our analysis of background data.

⁵The Attorney General's offices in Los Angeles started telecommuting in January 1990, too late for inclusion in this report.

⁶The DMV came into the project early in 1989.

Participants

<i>Agency</i>	<i>Total Completed or Certified⁷</i>	<i>Telecommuters</i>	<i>Controls</i>
Air Resources Board	33	14	4
California Energy Commission	110	52	26
Department of Economic Opportunity	1	1	1
Department of General Services	112	54	47
Department of Health Services	8	3	5
Department of Justice ⁸	77	40	0
Department of Motor Vehicles ⁹	8	3	5
Department of Social Services	35	6	20
Department of Transportation	40	22	11
Department of the Youth Authority	47	23	14
Employment Development Department	8	7	2
Franchise Tax Board	73	15	24
Office of Administrative Law	14	0	10
Public Employees Retirement System	6	0	5
Public Utilities Commission	165	89	57
State Personnel Board	1	0	0
Teale Data Center	8	8	4
Total	738	329	231

Table 2: Summary of Agency Participation

The possibilities were:

- *Form*: Home-based, Satellite, or None
- *Duration* (for home-base telecommuting only): none; up to 1 day/week; 1-3 days/week; or at least 3 days/week

The third stage was the actual selection of the telecommuters. This was done by the supervisors. In many cases JALA's recommendations were followed. In 43% of the selected participant cases the JALA recommendations were ignored, or were not made because of incomplete background data. However, the great majority of the incomplete-background cases were pre-identified members of the control group. Failure by controls to fill out the entirety of background questionnaires was largely due to ambiguities in the background questionnaire format.¹⁰ Tables 3, for managers, and 4, for telecommuters, show the results of the selection process. Note that "selection" means that the individuals were somehow certified to be either telecommuters or members of the control group. Not all of those selected actually served as participants in the project.

⁷This includes those who completed all the background data requirements or were otherwise certified as participants by their agencies at one point or another during the project. Note that several agencies selected telecommuters and controls even though they, or their supervisors, had not completed all the background information requested. This can be interpreted as an indicator of the level of commitment to the project on the part of the senior management of these agencies. In several cases participants switched between telecommuter and control status during the project.

⁸The Department of Justice, attorney General's Office, came into the project in late 1989.

⁹The DMV came into the project in early 1989.

¹⁰These have since been corrected.

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<i>Agency</i>	<i>Prospective Managers</i>	<i>Selected Managers</i>	<i>No. of Subordinates per Manager</i>
Air Resources Board	23	9	1.1
California Energy Commission	57	27	1.7
Department of Economic Opportunity	2	1	1.0
Department of General Services	67	31	2.0
Department of Health Services	4	5	1.6
Department of Justice	24	17	2.4
Department of Motor Vehicles	5	3	2.7
Department of Social Services	12	9	2.9
Department of Transportation	93	4	1.7
Department of the Youth Authority	24	13	2.1
Employment Development Department	12	4	1.3
Franchise Tax Board	46	17	1.4
Public Employees Retirement System	6	3	1.7
Public Utilities Commission	94	49	1.9
Teale Data Center	7	4	1.3
Total	476	196	

Table 3: Participating Agency Supervisor Selection Data

<i>Agency</i>	<i>Total Selected Participants</i>	<i>Telecommuters Recommended by JALA</i>	<i>Telecommuters Selected w/o Recomm.</i>
Air Resources Board	17	8	6
California Energy Commission	75	32	20
Department of Economic Opportunity	1	1	0
Department of General Services	90	32	22
Department of Justice	40	40	0
Department of Health Services	8	2	1
Department of Motor Vehicles	8	2	1
Department of Social Services	26	4	2
Department of Transportation	31	5	17
Department of the Youth Authority	36	16	7
Employment Development Department	8	7	0
Food and Agriculture	1	0	1
Franchise Tax Board	39	11	4
Public Employees Retirement System	5	0	1
Public Utilities Commission	137	50	39
Teale Data Center	8	2	6
Total	522	210	121

Table 4: Participating Agency Adherence to Selection Process

Finally, Table 5 shows the participants who have left the project since its start. One of these, from General Services, had been telecommuting from home at a significantly higher rate than was recommended by JALA. At least one returned to full time office work, having missed the social interaction of the office. One found the new baby at home too distracting. One found telecommuting to be incompatible with extensive travel — and too little time in the office. Several of the discontinued telecommuters were transferred to other divisions, one was promoted to another facility close to home, some retired or left the government. Some telecommuters who were nominally selected by their agency (including a few who had not been evaluated by JALA) never began telecommuting.

Participants

<i>Agency</i>	<i>Telecommuters</i>			<i>Control</i>
	<i>Left or Transferred</i>	<i>Remained but Quit Telecommuting</i>	<i>Not Recommended by JALA¹¹</i>	<i>All Types</i>
California Energy Commission	4	2	1	6
Department of General Services	3	0	0	7
Department of Health Services	0	0	0	2
Department of the Youth Authority	3	0	0	2
Employment Development Department	1	1	0	2
Franchise Tax Board	2	3	0	3
Public Utilities Commission	17	7	5	16
<i>Total</i>	30	13	6	38

Table 5: Participants Who Have Discontinued

¹¹That is, the individuals who quit telecommuting either did not complete the background questionnaires or were not recommended by JALA as home-based telecommuters.

TELEWORK LOCATIONS

The original project plan was to select both satellite office and home-based telecommuters, split roughly into equal sized groups. Since most of the participating organizations are located in northern California so are the telecommuters. The only major exception to that is the set of participants from the Attorney General's offices in Los Angeles. However, that group did not join the project until early in 1990, after the formal evaluation period. The analysis of the background data led to a recommendation that offices be established in these locations:

Phase 1 (for the first groups):

three locations: Orangevale or farther northeast near Route 80 (at least one site); Davis; Southern Oakland.

Phase 2 (as more people come in to the program):

As above plus Auburn, Walnut Creek, Palo Alto, Novato, Stockton (Lincoln Village) in that order of appearance.

Note that these recommendations result from the *current* participant list. Participants from southern California are excluded because of the particular agency/division representation of the pilot project.

In any case, because of budget and office availability constraints, it was not possible to set up satellite offices in State facilities. Hence, **all of the active telecommuters in the project have been home-based workers.**

TRAINING

Upon completion of the selection process, the prospective telecommuters and their supervisors were asked to attend a series of pre-telecommuting workshops. Each series consisted of three sessions:

1. Telecommuters alone. This session emphasized setting up home offices and establishing good working relationships with management.
2. Supervisors alone. The emphasis in this session was on techniques of managing remote workers, particularly the practical aspects of management by objective techniques.
3. Joint session. This workshop concentrated on setting up the specific objectives, schedules, and working relationships for the first few weeks of telecommuting.

Workshops were held in Sacramento in January, 1988 and in Sacramento and San Francisco in May, 1988.¹ Table 6 shows the breakdown on workshop attendees.

<i>Agency</i>	<i>Telecommuters</i>	<i>Supervisors²</i>
Air Resources Board	4	4
California Energy Commission	23	13
Department of Economic Opportunity	1	1
Department of General Services	37	18
Department of Health Services	2	1
Department of Motor Vehicles	0	0
Department of Social Services	13	7
Department of Transportation	7	5
Department of the Youth Authority	12	10
Employment Development Department	8	5
Food and Agriculture	1	1
Franchise Tax Board	10	6
Public Employees Retirement System	5	1
Public Utilities Commission	36	31
State Personnel Board	0	1
Teale Data Center	4	4
Total	163	108

Table 6: Participation in Training Workshops

¹Plus another group of 34 Deputy Attorneys General who were trained in Los Angeles in January, 1990; their progress is not reported here.

²Some 'supervisors' attended these workshops who had not been identified in any of the prior background data collection efforts. These individuals are not included here.

EVALUATION OVERVIEW

During the background review and pre-implementation process a variety of data was collected from the prospective participants concerning general demographic information, work patterns, work social relationships and energy and automobile use. These data were collected by means of:

1. Pre-selection background questionnaires.
2. Post-selection questionnaires: one for general work performance and quality of life information; the other focused on energy use. These were administered twice to the telecommuters and the members of the control group: once just after selection and a second time in January, 1989.
3. A third evaluation questionnaire that combined separate questionnaires and deleted some elements³ of 2 above. This was administered to the same groups in December, 1989.
4. Questionnaires for supervisors to elicit their evaluations of their employees and to determine their evaluation criteria. These were administered during the second and third rounds of the employee questionnaires.
5. The participants *and* their families were asked to complete three-day logs of their transportation usage. This was done twice, in early and mid-1989. The detailed analysis of the latter was done under a grant from Department of Transportation by Professor Ryuichi Kitamura of the Transportation Research Group, University of California at Davis.⁴ Some questions were added to the third evaluation questionnaire (item 3 above) to check some of Kitamura's results.

³Specifically, the portions dealing with information infrastructure and worker role changes. These were found to be invariant both between telecommuters and control groups in the first two rounds.

⁴The report of their study is: Ryuichi Kitamura, et al., *Telecommuting and Travel Demand: An Impact Assessment for State of California Telecommute Pilot Project Participants*; Research Report UCD-TRG-RR-90-8.

DEMOGRAPHY

<i>Factor</i>	<i>Telecommuters</i>	<i>Controls</i>
Number of Responses ¹	107	141
JOBS		
Accounting	3.9%	0.7%
Architect	0.9%	0.0%
Corrections	0.0%	0.7%
Customer Service	1.9%	2.9%
Engineering	17.5%	15.0%
Field Service	1.0%	1.4%
Finance	1.9%	0.7%
General Administration	5.8%	4.3%
Human Resources	0.0%	0.7%
Information Services	8.7%	16.4%
Legal	11.7%	6.4%
Office Services	1.0%	9.3%
Office Systems	0.0%	0.7%
Planning	3.9%	2.9%
Policy Analyst	9.7%	7.1%
Program Management	6.8%	8.6%
Public Relations	0.0%	1.4%
Public Safety	1.0%	3.6%
Research & Development	9.7%	0.7%
Other	14.6%	14.3%
FUNCTION		
Manager	2.8%	5.7%
Professional	72.0%	60.7%
Both Manager and Professional	17.8%	18.6%
Para-professional	4.7%	4.3%
Secretary/Clerk	0.9%	5.7%
Other	1.9%	5.0%
Average Age (years)	41.0	39.6
Percent Male	64.2	46.4
Average Size of Work Unit	11.9	12.2
Average Tenure with State (years)	14.3	14.6
Median Tenure with State (years)	13.0	13.0
Average Tenure in Work Unit (years)	5.7	5.0
Average Tenure in Job (years)	4.7	3.6
Average Annual Salary (\$ thousands)	42.3	38.1

Table 7: Participant Demography, Late 1989

The participants in the project are largely professionals, although of great variety, with only a few percent of managers and secretarial or clerical workers. This is in keeping with the telecommuting situation in most contemporary corporations. It is also to be expected as a manifestation of the second level innovator stage of technological substitution.² That is, the participants have job characteristics that, coupled with the technology available, allow them to adopt this innovation with relative ease. Table 7 shows the primary demographic data from the

¹Discrepancies between the numbers of respondents shown in this (and subsequent) tables and those shown in the preceding tables result from the fact that not all telecommuters and controls returned their questionnaires by our cutoff date of 15 February, 1990.

²Although the innovation discussed here is largely one of management, it is closely connected with the spread of personal computers and personal computing. Typically an innovation of any sort is first adopted by a few adventurous souls, who then act to improve the innovation, then pass it to more slightly-less-adventurous people, and so on. The growth of acceptance of an innovation over time typically follows an S-shaped--or sitting leg shaped--curve. The first adopters were at the 'toe' and this project is currently at the 'ankle' of the curve.

final evaluation round, separating telecommuters and controls. Note that the telecommuters and the control group are fairly closely matched, although there are some unavoidable differences in job types, the control groups has more secretarial and clerical personnel (and fewer professionals) and the control group is slightly younger than the telecommuter group.

Most of the telecommuters and control group members are seasoned State employees. They are also experienced in their jobs, with a slight advantage in that respect to the telecommuters, as reflected in age and salary levels.

PERFORMANCE EVALUATION

Because of the nature of the work performed by most of the telecommuters in the project, quantitative evaluation of performance is extremely difficult. We have approached this issue by using a multi-factor method of assessing the nature and degree of performance changes. Note that the emphasis is on **changes** in performance. We are not attempting to provide any *absolute* performance evaluations, nor do we feel that such evaluations are particularly significant. What *is* important is what has changed during the period of telecommuting.

There is a timing factor to be considered as well. Since telecommuting often involves a change in work and management style, we can expect some initial fluctuations in performance levels. In particular, we can expect decreases in performance during an initial 'break in' period. One question is: how long is this learning period likely to last. Our past experience indicates that it is at least several (four to eight) months, hence the need to continue the pilot until the stable phase of telecommuting is well established. This desire is complicated by the staggered entry — and occasional departure — of the participating agencies.

Information work is highly diverse in its content and goals. There is no simple set of performance criteria that will fit all information jobs, or even the more restricted set of jobs represented in the pilot project. Performance criteria for an administrative law judge are different from those for a real estate appraiser, a secretary or an engineer. In principle we could develop measurement techniques that do explicitly test performance for each of the job types represented in the pilot. In practice it would be prohibitively expensive. Therefore we rely on the following measures:

- *Self Assessment.* In our general evaluation questionnaires we asked each respondent, both telecommuters and controls, how much he/she felt his/her effectiveness had changed over the past year (or over the past two years in the case of the final questionnaire). The validity of the response depends on the memory, honesty and objectivity of the respondent as well as his/her ability to express effectiveness in quantitative terms.

We also asked each respondent to rate the importance of a number of performance indicators, such as volume and quality of work performed, feedback from others and career progression.

Confounding Factors. Our assumption was that individuals will tend to overrate their effectiveness changes, at least those in the positive direction. This may be more the case for telecommuters than for controls, since satisfied telecommuters will have an interest in maintaining their status.

On the other hand, we have been informed that some controls were told that, if they performed well, they might be selected to replace telecommuters who dropped out of the project. Hence the controls were given an extra incentive to improve their performance since telecommuting appears to be perceived as a 'perk' given only to the achievers. We do not have a simple way to sort these out.

As it turned out, both the telecommuters and the control group tended to overrate their performance changes (relative to their supervisors' estimates) by about the same amount, with no statistical significance for differences between the groups.

- *Supervisor Assessment.* Separate questionnaires were given to the participants' supervisors, asking similar questions to those just described concerning their subordinates. We also included space for performance comments by the supervisors. A selection of these comments is given in Appendix C.

Confounding Factors. Our assumption was that supervisors' quantitative evaluations would be lower than the subordinates' self evaluations. In addition, we assumed that some supervisors may be biased against (or for) telecommuting and may show differential evaluations for telecommuters and controls under their supervision. We assess the likelihood of biases by comparing the distance (dissonance) between supervisor and subordinate effectiveness change estimates, both for telecommuters and controls.

Finally, some respondents, both supervisors and subordinates, will have difficulty giving quantitative percent change answers. To assess this we also asked whether specific, objective performance criteria were established before telecommuting began. We might be able to correlate quantitative performance measures with the pre-existence of specific criteria.

- *Other Effectiveness Estimators.* Another way of estimating effectiveness is by evaluating the ability of the respondent to identify and perform the tasks that are **critical** to his/her job. These are the tasks that make the difference to ultimate effectiveness. In these days of likely information overload, sorting out the critical tasks from the non-critical ones can be a key performance affecter. Other questions in our evaluation questionnaire get at changes in work style, as discussed below.

Aside from the reported changes in effectiveness there is the issue of why the changes occurred. Is it because of telecommuting or is telecommuting not a factor? How important are attitudes of supervisors, colleagues and of the telecommuters themselves? How important are training and objective performance criteria? These are some of the questions for which we have developed estimates in this report.

Effectiveness versus Productivity

We avoided using the word *productivity* in the questionnaires because of the common bias toward thinking of productivity as directly related to the quantity of one's output. The bias is also toward measuring the number of things produced; such as letters and memos keyboarded by a word processing clerk. Productivity in this sense is closely related to efficiency; to *doing things right* and quickly.

In our use of *effectiveness* as the preferable term we hoped to focus attention on *doing the right things* — and doing them right. A secretary cranking out letters to the wrong mailing list can be very productive but completely ineffective. We did not point out this distinction in any of the questionnaires, but comments from several of the participants indicated that effectiveness was understood in the manner we hoped.

Effectiveness Ratings

The numerical effectiveness ratings come from sets of two different questionnaires, as noted above. Table 8 shows the results for the mid-term and final surveys.

Performance Evaluation

Factor ²	Telecommuters		Controls		T-C ¹
	Mid-term	Final	Mid-term	Final	(Mid) Final
Self Assessment (%)					
Maximum	100.00	200.00	100.00	100.00	
Minimum	-10.00	-25.00	-50.00	-25.00	
Mean (Ö)	17.44 (0.015)	33.65 (0.058)	10.72	23.25	(6.72) 10.40
Supervisor's Assessment (%)					
Maximum	120.00	60.00	50.00	40.00	
Minimum	-20.00	-50.00	-2.00	-10.00	
Mean (Ö)	10.49 (0.128)	9.71 (0.000)	8.18	2.90	(2.31) 6.81
Dissonance (Self Assessment - Supervisor's Assessment) (%)					
Maximum	75.00	200.00	65.00	100.00	
Minimum	-120.00	-55.00	-50.00	-15.00	
Mean (Ö)	7.47 (0.031)	17.48 (0.385)	1.05	22.00	(6.42) -4.52
Annual Dollar Impact ³					
Maximum	23400	45000	22425	24750	
Minimum	-3450	-2550	-11250	-2250	
Mean (Ö)	5503 (0.031)	8833 (0.009)	3517	5676	(1989) 3157
Established objective performance standards pre-telecommuting (%)					
Yes	60.2	60.6	43.3	53.7	
No	35.7	35.4	54.7	46.3	
Worked out specific requirements immediately before telecommuting (%) ⁴					
Yes	54.1	N/A	8.0	N/A	
No	42.9	N/A	77.3	N/A	

Table 8: Assessments of Effectiveness Changes

The last column of Table 8 shows the differences between the telecommuter and control groups. The statistical significances of the differences are shown under the telecommuter mean figures. They can be interpreted as follows:

1. The self-assessment differences between the telecommuters and the controls are statistically significant by the usual standards, although the significance of the final assessment differences is somewhat less than that of the mid-term results. Nevertheless, the difference is greater for the final results.

¹This is simply the assessment difference, (telecommuter score - control score) for the mid-term and final evaluations.

²The Ö values given here are the significance levels for the differences between the telecommuter and control means. Lower values imply greater confidence that the differences are significant.

³This is computed as the average of the self- and supervisor's assessment, multiplied by the annual salary of the respondent. This is a higher figure than we used in the benefit-cost analysis, which uses only the supervisor's estimate.

⁴This question was not asked in the final evaluation round. Instead, the supervisors were asked how often they reviewed their subordinate's progress.

2. The supervisors' assessment differences between the telecommuters and the controls are of marginal significance at the mid-term while the final differences have a high significance (very low Ö) value. Here, too the effectiveness differences increase with time.
3. When it comes to the amount of disagreement between subordinate and supervisor on effectiveness rating, the mid-term results show that the differences between telecommuters and controls are quite significant, although not large, on average. For the final evaluation the differences are not statistically significant — but have grown to about 20% for both groups.
4. When the above differences are translated to a dollar impact, the effectiveness change differences between telecommuters and controls is seen to grow from about \$2,000 to about \$3,200 per year per telecommuter; an annual impact of about \$338,000 for the telecommuters covered by the questionnaires.

Hence, we can conclude that, for this group of mid-level employees, **telecommuting has a positive effect on performance, however rated**. Furthermore, **the effect appears to be increasing with time**, with more than a 50% difference between the mid-term and final round results. This can be interpreted as learning effect on the part of both the supervisors and the telecommuters. One might also conclude from this that *a short evaluation period may lead to an underestimate of the ultimate results*.

Finally, although the telecommuters' supervisors were not extremely diligent in following the advice of the training workshops — jointly set up specific performance objectives and standards *with* each participant — they were significantly more attentive to the telecommuters than to the controls, although that gap was narrowing by the final evaluation round.

Effectiveness Contributors

A variety of measurable factors could be construed to contribute to the effectiveness rating changes observed. These include amount of experience with telecommuting, average number of telecommuting days per month, the length of time supervisor and telecommuter have worked together, the amount of training received, and the extent to which the telecommuter believes that telecommuting is responsible for the improvements. Regression analyses of these factors indicate that the primary contributor to the *supervisor's* estimate of effectiveness change is the *level of telecommuting training* received. The primary correlate of the telecommuter's self-effectiveness change rating is the degree to which the telecommuter feels that telecommuting is responsible for the change⁵. The dollar impact of effectiveness change is also most closely related to the influence of telecommuting.⁶

Impacts of Training

One of the important issues is the extent to which the training workshops influence the outcome of telecommuting. The simplest way to check this is to examine the relationships, if any, between attendance at the training sessions and subsequent effectiveness evaluations. The results to date are shown in Table 9.

⁵ The correlation is 0.45, which is fairly high for a multiple-influence case.

⁶The specific relationship for this particular set of telecommuters is:
Annual dollar impact = $(21 + 18.8 \times \text{influence level})^2$
where the influence level ranges from 1 = no influence, to 5 = a major influence in the effectiveness change.

<i>Factor</i>	<i>Average %: Self-evaluation⁷</i>	<i>Average %: Supervisor's Eval.⁸</i>	<i>Ratio: Self/Super</i>	<i>Number of Cases</i>
Both supervisor and subordinate attended workshops	final (mid-term)	final (mid-term)	final (mid-term)	final (mid-term)
Telecommuters	33.66 (15.29)	15.18 (11.38)	2.22 (1.34)	41 (34)
Controls	32.19 (31.00)	8.50 (11.00)	3.79 (2.82)	16 (5)
Supervisor but not subordinate attended workshops				
Telecommuters	14.80 (30.00)	13.07 (11.43)	1.13 (2.62)	15 (7)
Controls	27.74 (3.75)	2.08 (11.12)	13.34 (0.34)	31 (16)
Subordinate but not supervisor attended workshops				
Telecommuters	34.23 (20.53)	10.77 (7.00)	3.18 (2.93)	26 (19)
Controls	28.93 (6.67)	8.66 (13.33)	3.36 (0.50)	14 (3)
Neither attended workshops				
Telecommuters	44.79 (15.56)	4.25 (0.00)	10.54 (infinite)	24 (9)
Controls	18.29 (10.00)	1.14 (6.43)	16.04 (2.42)	73 (28)

Table 9: Impacts of Telecommuter Training

Table 9 shows some interesting effects. First, at the mid-term evaluation where both supervisor and subordinate attended the workshops, the controls and telecommuters come out about even in the estimate of the supervisors, although the self evaluation of the controls is much higher than that of the telecommuters. At the final evaluation round the self-evaluation of the control group is about the same as for the telecommuters but the supervisors' evaluations show a significant difference between the two groups.

Where the supervisor attended the workshops, whether or not the subordinates did, the supervisor's estimate is basically indifferent to the status of the subordinate at the mid-term point, but the advantage of telecommuter over control is even more pronounced at the final evaluation. Where the supervisor did *not* attend the workshops, the telecommuter is at a clear disadvantage in performance evaluations but the difference is reversed in the final survey. The lowest effectiveness ratings are in the cases where neither party was trained. Ignorance is clearly far from bliss. As was mentioned earlier, the main correlate of the supervisors' rating of his/her subordinate's effectiveness change is the level of training they have completed. As expected, the average employee self-evaluations were all higher than those of their supervisors, with about a 20% difference overall at the final evaluation for both controls and telecommuters.

⁷The differences between telecommuter and control scores are significant at the 0.058 level for the final evaluation.

⁸The differences between telecommuter and control scores are significant at the 0.0000 level for the final evaluation.

One point of uncertainty was that, because of an ambiguity in the final questionnaire to the supervisors, only about half of the supervisors rated their control subordinates. Nevertheless, supervisors did complete the questionnaires for 58 control group subordinates, as contrasted with 90 telecommuter subordinates. For most of the rest of the survey data control group members outnumber telecommuters.

One can draw the following conclusions from these data:

- Results- and communications-oriented training is important for everyone, telecommuters and controls alike. This bolsters our theory that telecommuting-inspired training benefits all managers.
- Training is particularly important for telecommuters in increasing their apparent competitiveness with their non-telecommuting colleagues.
- Put another way, training of telecommuters is particularly important for supervisors of telecommuters by helping to develop their not-in-person evaluation skills.

An unanswered question at the mid-term, because the number of subordinate-supervisor pairs who answered all of the questionnaires was small, was whether the dominant performance improvement effect was from telecommuting or from the training. The answer after analysis of the final round data seems to be that the training is most important to the supervisors as a predictor of performance impact, while the self-perceived impact of telecommuting on the telecommuters' behavior is the most important predictor of the telecommuters' responses. As a "side effect" telecommuting may be important as a precipitator of the results-oriented training.

Impacts on Supervisors

One of the concerns about telecommuting is that it places an increased burden on management. This is of great interest in an era of "downsizing" in which mid-level managers are decreasing in number and the span of control of the remaining managers necessarily increases. Consequently, we asked the supervisors of telecommuters whether telecommuting had an affect on them as supervisors. We asked whether telecommuting had increased their workload and whether it affected their performance. 54.6 % of the supervisors stated the telecommuting had no effect on their workload, 15.7% stated that it slightly decreased their workload, one supervisor said it produced a significant decrease in workload. On the negative side, 28.7% of the supervisors reported a slight increase in workload (such as filling out questionnaires) and 2.8% reported a significant increase in workload. The perceived workload change is related to the supervisors' rating of his/her subordinates' effectiveness changes; that is, supervisors reporting increases in workload from telecommuting tended to score their telecommuters lower (at the $p=0.0001$ level).

The impact on supervisors' perceptions of performance is similar, but more positive. While 47.2 % indicated no change and 13.0% indicated a slight decrease in their performance, 34.3% felt that their performance had slightly increased and 5.6% reported a significant increase in their performance. As is the case with supervisors' perceptions of workload change, there is a relationship between supervisors' estimates of their own effectiveness and that of their subordinates, although it is slightly less intense than the workload-effectiveness relationship ($p=0.017$)

There does not appear to be a significant relationship between the impact on managers of telecommuting and level of training.

Critical Task Issues

One's daily work can be lumped into two broad (often overlapping) categories: critical and non-critical tasks. Sometimes non-critical tasks, left unattended to long enough, become critical; the deadline finally draws near. A frequent result of last minute attention to critical tasks is that they do not receive the care they need. We tested the general situation regarding these task, asking the participants about their ability to identify critical tasks and provide adequate attention to them. We also tried to characterize the critical tasks in terms of their affective traits. Finally, we asked how well the participants were supported in attending to critical tasks by the information technology available to them. The results are as follows.

<i>Factor</i>	Telecom- muters	Controls	T/C⁹
How often do you:	final (mid-term)	final (mid-term)	final (mid-term)
do inappropriate tasks	2.57 (2.76)	2.57 (2.72)	1.00 (1.01)
do appropriate but non-critical tasks	3.03 (3.14)	3.04 (3.06)	1.00 (1.03)
find yourself unable to identify critical tasks	2.53 (2.51)	2.71 (2.54)	0.93 (0.99)
find yourself unable to distinguish critical from non-critical tasks	2.31 (2.26)	2.39 (2.37)	0.97 (0.95)
give critical tasks insufficient attention	2.62 (2.59)	2.70 (2.85)	0.97 (0.91)

Table 10: Critical Task Identification and Support

The scale for Table 10 is: 1 = Never, 3 = Sometimes, 5 = Always. For Table 11 the scale runs from 1 = low value to 5 = high value. There is little difference between telecommuters and controls in critical task identification and support, except that the telecommuters appear to have a slight edge in being able to identify critical tasks and giving them sufficient attention.

<i>Factor</i>	Telecom- muters	Controls	T/C
Level of risk	4.31	4.17	1.03
Difficulty of performance	3.56	3.32	1.07
Importance	3.74	3.57	1.05
Cost of performance	3.35	2.97	1.13

Table 11: Primary Critical Task Characteristics

The major difference between telecommuters and controls in assessing critical tasks is that the telecommuters generally have a higher threshold value of what it takes for a task to be labeled critical, especially for the cost of performance factor. This test was made only during the mid-term evaluation.

Roles and Activities

Jobs can be characterized at several levels of abstraction, ranging from minute descriptions of the daily work process to broad descriptions like 'she's an architect.' At a mid level there is a way of evaluating work by the roles the workers play when they are performing those jobs. One way of assessing the effects of changes in working conditions is by testing for changes in those roles. The

⁹This is the ratio between the telecommuter and control responses. A ratio of 1.00 means no difference.

role characteristics we used in the pre-telecommuting and mid term evaluations, and examples of their components, are:

1. *Brokering*. Allocating and negotiating for resources.
2. *Producing*. Thinking independently, getting the work out, using one's skills, seeing that goals are met.
3. *Innovating*. Solving problems, finding better ways to do things.
4. *Directing*. Indicating clearly what has to be done and directing the work.
5. *Acting as 'Big Brother'*. Knowing and understanding what's going on at work, maintaining stability.
6. *Coping*. Juggling different job demands, doing difficult tasks.
7. *Facilitating*. Managing conflicts, doing public relations, dealing with differences.
8. *Being thorough*. Satisfying everyone, completing everything.
9. *Guruing*. Being an expert, knowing the technical parts of the job.
10. *Supporting*. Assisting others in doing their work, helping people expand their capacities.
11. *Networking*. Keeping informed and telling others about what's going on.

We asked the participants two questions for each of these roles: 1) How important is it to your job; and 2) how much are you helped or hindered in performing this role in your job situation? The scale for importance is: 1 = not important at all to 5 = extremely important. The scale for helped/hindered is: -2 = strongly hindered, 0 = neither helped nor hindered, +2 = strongly helped. Table 12 gives the averages.

<i>Factor</i>	<i>Telecom- muters</i>	<i>Controls</i>	<i>T/C</i>
<u>IMPORTANCE</u>			
Brokering	2.42	2.47	0.98
Producing	4.20	4.07	1.03
Innovating	3.71	3.65	1.02
Directing	3.14	3.29	0.95
Acting as 'Big Brother'	3.43	3.50	0.98
Coping	3.69	3.70	1.00
Facilitating	3.20	3.24	0.99
Being thorough	3.77	3.77	1.00
Guruing	4.30	4.25	1.01
Supporting	3.07	3.14	0.98
Networking	3.58	3.43	1.04
<u>HELPED OR HINDERED</u>			
Brokering	0.07	0.06	1.17
Producing	0.52	0.32	1.63
Innovating	0.51	0.27	1.89
Directing	0.16	0.14	1.14
Acting as 'Big Brother'	0.25	0.18	1.39
Coping	0.20	0.21	0.95
Facilitating	0.18	0.14	1.29
Being thorough	0.22	0.13	1.69
Guruing	0.69	0.51	1.35
Supporting	0.29	0.27	1.07
Networking	0.23	0.31	0.74

Table 12: Job Roles

In short, the differences between the telecommuters and controls are small, none of them statistically significant. Therefore, telecommuting appears to have little effect on job roles. Looked at in another way, this could also be interpreted as a test of the basic comparability of the telecommuter and control groups. Because of these results we did not test for role changes in the final evaluation.

To perform these roles, workers engage in a series of activities. These activities can be grouped into two primary categories:

1. *Processing Information.* Gathering, storing, transforming and evaluating information; and
2. *Using Information.* Acting on the information at hand, communicating, negotiating and deciding.

The two groups report their activities, in terms of how often they engage in these activities (1 = never to 5 = always), as shown in Table 13.

<i>Factor</i>	Telecom- muters	Controls	T/C
	final (mid-term)	final (mid-term)	final (mid-term)
Processing Information	3.80 (3.90)	3.67 (3.91)	1.027 (0.997)
Using Information	3.54 (3.57)	3.53 (3.67)	1.002 (0.972)

Table 13: Job Activities

As in the case of job roles, there is no significant difference between the activities of the telecommuters and the members of the control group.

We also asked the telecommuters about the specific activities they performed while telecommuting. On average, 40.5% of telecommuters' tasks are reserved specifically for telecommuting (an increase from 36.8% at the mid-term). The responses for types of activities are as follows, in order of popularity (mid-term score first):

- Just thinking/planning: 78.9%, 80.4%%
- Reading: 70.4%, 76.6%
- Text/word processing — with a computer: 63.4%, 70.1%
- Coordinating by telephone: 56.3%, 70.1%
- Research: 57.7%, 57.9%
- Writing — without a computer: 47.9%, 47.7%
- Record keeping: 31.0%, 35.5%
- Working with data bases: 33.8%, 32.7%
- Computer programming: 21.2%, 27.5%
- Coordinating via computer: 21.1%, 25.2%
- Having meetings: 7.0%, 6.5%
- Doing graphics/layout: 7.0%, 0.9%

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The greatest change is in coordinating by telephone, up almost 25% from the midterm value. Telecommuters learn that they can accomplish many tasks by telephone that once were felt to require face-to-face meetings.

BENEFIT-COST ANALYSIS

Over the years we have developed a generalized and detailed benefit-cost model as a means of tracking the impacts of telecommuting in considerable detail. The intent of the model is to be as quantitative as possible — and in dollar-based terms. The model covers both direct and indirect costs and benefits. It includes such explicit terms as employee salary levels and costs of office space, as well as imponderables such as changes in traffic congestion and improvements in organizational effectiveness.

The basic cost data were derived from questionnaires given to the project coordinators in each participating department, from employee questionnaires, and from general data available from the Department of General Services. As it turns out, information concerning many of the detailed factors in our model was not available. Hence, a more limited, aggregated model has been used for this report. Further, since the number of telecommuters varied throughout the program, we have used an average number of 150 as the population for estimating the results.

In addition to including the known or estimated costs and benefits for the period through 1989, the model estimates costs through 1992 for a set of 150 telecommuters. This enables a fairer estimate of the operational as well as the start-up costs of telecommuting. The results are as follows.

Direct Costs

This category includes all charges that we felt could be ascribed directly to telecommuting. In many cases we have tried to assess the *marginal costs* of telecommuting; that is, the portion of total costs that can be ascribed solely to telecommuting. In some cases, where no easy distinction could be made, we have chosen to take the more conservative approach by allocating all of the costs to telecommuting. This may result in an overestimate of the costs of telecommuting.

Additional Training

This category includes all of the costs of the two sets of training sessions held in 1988. The model includes a factor for routine selection and training by state personnel or an independent contractor after 1988, conservatively estimated at \$300 per telecommuter-supervisor pair.

Telecommunications

This category includes the cost of new telephone installations for those requiring them, as well as the cost of additional home telephone charges. We found that most telecommuters did not require separate telephone lines at home in order to telecommute. Those who did need separate lines either were telecommuting three or more days per week on average or required dedicated lines in order to be continuously connected to a large computer elsewhere.

Apparently no State agency has a good idea of the detailed composition of their telephone bills. We were not able to get clear estimates of the telephone charges attributable to typical (telecommutable) employees while they are in the office. As one agency respondent said: “[Of] concern are the methods, or absence of methods, the State uses to account for its telephone services. The methods are fragmented and would take inordinate time and personnel resources to decipher data necessary to give an intelligently accurate answer.” This should not be taken as a condemnation of the State’s phone bill analysis techniques; few large corporations with which we

have dealt are any better than that. The general attitude is that the charges will be incurred in any case and that it takes more effort to dissect them than it is worth in cost attribution improvements.

Given this basic imponderability, it is equally difficult to assess the extra operating costs of telecommuting. Some telecommuters need off premise extensions of the central office Centrex^a system (at \$105 to \$120 per month, mileage dependent) while others use State-supplied telephone credit cards or bring in the marked-up monthly phone bills for reimbursement. A few may simply absorb the telephone charges into their family budgets if they are sufficiently infrequent. Since telecommunications charges account for most of the operational costs of telecommuting, it may be worth spending more effort on unraveling this mystery.

We were able to get data on household telephone expenses, finding that the average telecommuter pays \$9.43 per month more than the average member of the control group; about the cost of nine gallons of gasoline — or fuel for almost 8 one-way commutes. 36.4% of the telecommuters (and 17.7% of the control group) have multiple telephone lines at home and 29.9% have telephone lines used only for work (compared with 5% of the control group). In any case, for purposes of the benefit-cost analysis we estimated telecommuting-attributable monthly telephone charges to be \$30 per telecommuter.

Computers

When we prepared the project plan in 1985 we made the assumption that most of the telecommuters would have personal computers for their use either at home or in their satellite offices. We assumed further that the State would provide the computers. These assumptions have proven to be invalid. 91% of the participants have access to computers in the main office, although access doesn't necessarily mean they have PCs on their desks. 60% of all participants (and 83% of the telecommuters) have computers at home. Almost all of the home-based personal computers are owned by the employees rather than the State, largely as a matter of personal preference.

Further, several participating agencies provide laptop computers for some of their telecommuters, allowing the telecommuter to use the same machine at home and in the office. Finally, the in-office computers on telecommuters' desks are frequently used by their colleagues when the telecommuters are at home. Similarly, telecommuters with home-based computers generally share a pre-existing computer when they are in the office. The net result is that the marginal costs of telecommuting related computers is a small fraction of the total computer cost. In turn, the number of State-supplied computers for telecommuters is significantly less than the number of telecommuters. Since we haven't been able to get details about all of these permutations we set computer costs at an average sum multiplied by a small fraction of the number of telecommuters.

Of related interest is the fact that many employees also own other office-related electronics. Of the telecommuters, 78.5% own answering machines, 4.7% own copy machines and 1.9% have facsimile machines. For the control group, the numbers are 61.7%, 2.1% and 0%, respectively.

Computer Maintenance

Similarly, estimated maintenance costs for personal computers range from 0 to \$275 annually, but with several agencies stating the costs were unknown. We have taken the conservative view and assessed a charge of \$250 for each of the computers.

Moving Costs

This category covers all marginal/differential costs of office moves, either from office to home for telecommuters or intra- and inter-office moves. Unlike many corporations, State employees do not seem to make many internal moves. Nor were any costs found for moving computers and/or furniture to homes.¹ We were also unable to discover costs for renovation of offices, although one office did rearrange (and reduce) space for four of its telecommuters. We assessed this cost as 0.

Facilities Leasing

Although the original plan included one or more satellite offices, none was established at the time of this report.

Construction

Nor were any satellite offices built during this period.

Furniture Purchase/Lease

Unlike some corporations, the State does not supply office furniture for home-based telecommuters.² Hence this cost is 0.

Insurance

The State is self insured. There have been no recorded loss claims of any sort by telecommuters.

Rental Costs

Similarly, no equipment or facilities were rented as part of the project.

Administration

This includes a number of factors. Largest is the administration of the Pilot Project itself, including all consulting services, the Shared Office Space study and the UC Davis transportation Study. We first assessed the consulting costs from 1987 through July, 1990 for the estimates for those years. We also added the cost of the project plan development (in 1985) to the cumulative cost factor for 1987. Further, we added a fraction of the State Project Manager's salary to the Project Administration category.

Our model includes a factor for system changes. This refers to the costs of changes in the way the State does things (increased coordination paths, work rule accounting, project promotional expenses, etc.). We have not yet uncovered any such costs.

Administrative duplication was another concern. This includes such factors as the necessity to have multiple stores of forms and reports. Since most telecommuters come in to the 'main' office regularly, this cost has been set at 0.

¹Most telecommuters using State supplied personal desktop computers at home simply picked them up and transported them themselves. In some cases, department technicians were sent to the telecommuter's home to help install the equipment and/or software. This probably would have happened even if the computer were in the main office but the extra travel time for the technician could be charged as a cost.

²One telecommuter is reported to have insisted on taking an office desk chair home. As far as we know, this chair was not replaced. Most telecommuters prefer *not* to have standard office equipment in their home offices; a fact that the office furniture industry has yet to assimilate.

System integration costs include such factors as the cost of telecommuter-specific electronic messaging systems and other operational coordination costs. So far, no electronic messaging or other new coordination systems are in use in the project, except for the system at JALA Associates (included under project administration). This factor does not include the costs of standard telecommunications software (e.g., Carbon Copy³, Crosstalk⁴, Procomm⁵), since those costs are included in the telecommunications category.

Increased coordination costs include the costs of meetings for the Telecommuting Advisory Group. We have included estimated salary costs for the participants at Group meetings, as well as the time spent by the key agency contact persons (champions) in project coordination (questionnaire distribution and collection, developing participant lists, etc.).

Additional Travel

In this category we were concerned with uncovering additional work-related travel initiated by telecommuting. This would include travel by supervisors to employee homes for meetings, extra travel by telecommuters, and the like. We have not found evidence to date of such travel. Reduced travel demand is covered under benefits.

Indirect Costs

There are three main areas of indirect cost. The first is increased building energy consumption. This would be produced by use of home heating and/or cooling systems by telecommuters if there was no change in the use thereof in the main office. That is, if the main office uses a constant amount of energy, regardless of the smaller number of people in the office, while the telecommuters are using more energy at home, then there is a net energy cost. We tried to approximate this effect by asking the telecommuters and controls about the size of their gas and electricity bills, attributing any difference to the energy costs of telecommuting. This makes the very conservative assumption that the in-office energy cost is unaltered. This is clearly just a first approximation to the impact. In fact, over the long term office heating and cooling cost savings should equal the increased costs of home heating and cooling, given equivalent insulation efficiencies

The average difference in electricity bills for telecommuters (over that of the control group) is \$9.47 per month while the gas bill difference is \$1.41 per month. Neither difference is statistically significant. However, assuming a conversion factor of \$0.08 per kilowatt-hour, the total household energy cost of telecommuting may be estimated at about 136 kilowatt-hours per month. Although these are costs borne by the telecommuters, we are including them in the model as costs of telecommuting³. From the employer's point of view they are benefits; costs now borne by the employee that were previously incurred by the employer.

Increased local traffic congestion is the second main 'side effect'. We were concerned that satellite offices may generate their own traffic congestion problem as traffic by telecommuters is diverted to local streets rather than arterials. Since no satellite offices exist as yet, we have no data for this effect.

Finally, telecommuting may divert some people from ride sharing. This is a mixed effect, extremely difficult to sort out. Ride sharing acts to reduce traffic volume, in proportion to the increase in passengers per vehicle. How should a telecommuter who would otherwise ride share be

³The rationale is that, even though the costs are first borne by the telecommuters, they eventually show up as increased wage demands for the employer. For the sake of conservatism we assumed no lag in this transfer.

counted? Does telecommuting inspire more ride sharing, in replacement of single occupant automobile commuting, by the telecommuters on days when they go to the main office? The study by Professor Kitamura's group⁴ indicates that there is no apparent change in the telecommuters' commuting habits: 84% of the telecommuters' commuting is by car with no passengers (other than the driver).

Direct Benefits

The list of benefits, while shorter than the list of costs, has some large-valued categories. As in the case of cost estimation we have tried to be conservative and err on the anti-telecommuting side.

Increased Employee Effectiveness

Possibly the largest factor in assessable benefits is increased employee effectiveness. As described earlier, the task of assessing effectiveness is fraught with possibilities for endless debate. We have a number of qualitative estimates, as described earlier. Our one quantitative estimate is based on the assessments of effectiveness changes made both by the telecommuters, the controls and their supervisors. The dollar impacts of effectiveness changes are made by multiplying the supervisor's estimates by the participant's salary⁵. Since the self estimates are generally higher than the supervisor's estimates this gives us a conservative value. Averaged over the group of those respondents who returned questionnaires we develop an average per telecommuter. This number, multiplied by the number of known telecommuters, gives us an overall impact estimate. This, of course, makes the further simplifying assumption that the effectiveness improvements are immediately reflected in organizational performance as well; that is, that they have a direct effect on the 'bottom line' of \$3,815 per telecommuter in 1989.

Decreased Sick Leave

Of comparable significance, possibly, is the effect of telecommuting on reducing use of sick leave. We estimated the impact of this in a matter similar to that of the effectiveness changes. Where effectiveness changes influence the overall level of performance, reduced (or increased) sick leave increases (or decreases) the number of days worked. At the mid-term evaluation survey the telecommuters reported an average decrease in sick leave (from 1987 to 1988) of -.5 days versus an average increase of 1.3 days reported by the control group, for a difference of 1.8 days relative improvement by the telecommuters. This led us to report at that time that telecommuters use less sick leave since the average reported for the entire sample was 9.3 days; a difference of 1.8 days is 19%. The difference did not have high statistical significance ($\hat{O}' = 0.2$) when all the entries were assessed, but when the analysis was confined to sick leave totals of less than 30 days the difference remained at 1.8 days and the statistical significance improved to 0.002.

To complicate matters, in the final round evaluation results neither the overall telecommuters' nor the controls' report averages for 1987 and 1988 were the same as those in the mid-term reports; the differences worked out to 0.5 days in favor of the control group, but with very low statistical significance. Confining the analysis to reported sick leave less than 30 days again improved the results, giving a 1.1 day improvement for the telecommuters in 1988 ($\hat{O}' = 0.075$).

⁴Kitamura op. cit., p. 59.

⁵More specifically, we multiply the difference between telecommuter and control average effectiveness estimates, as estimated by their supervisors (which is 8.81% as contrasted to the self-estimate difference of 10.40%), by the average salary of the participants.

In 1989 the average use of sick leave was about the same for both groups. However, the median sick leave use was 1 day less for the telecommuters while the average use of sick leave by the lower 90 percentile of the two groups showed 1.16 fewer days for the telecommuters. In terms of differences between 1989 and 1988 sick leave use the telecommuters again came out ahead overall by 1.9 days. As for the mid-term case, the difference for the full data set did not have high statistical significance ($\hat{O} = 0.16$). Confining the data to less than 30 days leave taken again showed a 1.1 day advantage for the telecommuters ($\hat{O} = 0.055$). Note that limiting the analysis of sick leave use to less than 30 days only drops about 5% of the cases.

The statistical variability points to the influence of long-term sick leave use, either for extended illnesses or parental leave. For both the 1988 and 1989 periods, several telecommuters reported that they would otherwise have been on even more extended leave because of illness or maternity. Similarly, many telecommuters report (in interviews) that doctor and dentist visits now do not require taking sick leave since they can be fitted in to the regular telecommuting schedule without reducing effort.

Having said all that, we maintain the conservative view and take only the 'routine' sick leave impacts for the cost-benefit model. Therefore we use the 1.1 day per year improvement in the model, equivalent to about 0.5% of average salary or about \$200 per telecommuter. We suggest that, if the sick leave benefits are to be measured more exactly, actual time charges be used rather than the telecommuters'/controls' recollections.

Decreased Medical Costs

We have not been able to track changes in medical costs, due to the complexity of the process. Both our survey data and interviews show reduced stress for the telecommuters. However, we cannot attach a numerical estimate to the effect. Therefore, although we believe that the reduced stress felt by the telecommuters should act to lower long term medical costs, we set this category at 0 in the model.

Increased Organization Effectiveness

We have not included questions on overall effectiveness changes in work units in this round of surveys. However, our focus group sessions with telecommuters and their supervisors lead us to believe that there is a positive effect in most organizations (although some report negative effects resulting from intra-unit coordination problems). As in the medical and sick leave benefit cases, however, we could not get quantitative data for the impact. Therefore, we set the value at 0.

Decreased Turnover

This is a problematic category. Our reasoning is that the organization avoids costs if it can retain useful employees. The cost avoided — hence, the benefit produced — is that of locating, recruiting and training replacements. Our focus group activities gave us the impression that about 10% of the telecommuters felt that telecommuting was the primary reason for their *not* leaving State employ. However, responses from the agency contact persons gave a value of 0 for net differential turnover; that is, as many telecommuters as controls left the State during 1988. Hence we set this factor as 0 for 1988.

For the 1989 evaluation we specifically asked the telecommuters whether they had *seriously* considered leaving State service during the year and, if so, what role telecommuting had played in their decision to stay. Of the 107 telecommuters who completed the questionnaire, 21 stated that telecommuting had been a moderate to decisive influence in their decision to stay.

Aside from the issue of turnover numbers, it is clear that most agencies do not have a good idea of the costs of replacing employees. Most agencies answered our replacement cost question with an average monthly salary number for managers/professionals and/or secretarial/clerical workers. This figure is significantly below the estimated replacement costs given by most private organizations for these levels of personnel.⁶ However, in keeping with the agencies' estimates we placed the value of the retained telecommuters in 1989 at half their salaries.

Decreased Move Rates

As noted in the cost area, move rates in the State are quite low. Therefore we did not assign a benefit for this category.

Reduced Parking Requirements

This category concerns reductions in parking space requirements resulting from the absence of telecommuters. Although parking spaces do not necessarily disappear, they become available for other uses. For example, the four telecommuting real estate appraisers in the Office of Real Estate Services now use one less parking space. This factor is calculated as a composite of the number of telecommute days, the auto use fraction of telecommuters, the level of State subsidy of parking and average parking space costs in Sacramento (even though a significant number of spaces are in San Francisco).

Office Space Savings

As reported in the section on the Shared Office Space study, there are potential benefits in reduced space demand. This saving is estimated as a product of the average space saved per office (in square feet) and the average cost per square foot of office space. Since actual savings were not made until mid-1988, this factor is set at 0 for 1987 and 1988. However, some telecommuters have essentially moved entirely out of their central offices while others have reduced their office space use by up to 50%. We expect this factor to stabilize at about 30% average space saving in the future. Since the savings are not yet widespread we have set them at 5% in the model.

There are two ways (at least) to realize the benefits of space savings. The first is simply to reduce total demand for space; this is the long term goal. The second impact is to reduce overcrowding in existing facilities; the impact of this is indirect — improved morale and effectiveness — rather than in net space savings.

Reduced costs of office space for satellite offices also fall into this category. Since there are as yet no satellite offices, this aspect of the factor is set at 0.

Indirect Benefits

Like the indirect costs, these benefits fall into the class of broadly applied impacts, not necessarily appearing in any one individual's or organization's accounts.

⁶Typical values from corporations for replacing mid-level people are in the range of \$100,000 to \$150,000. The highest agency estimate was \$80,000 to \$100,000, with most placing the cost at less than \$20,000.

Decreased Energy Consumption

The major factor here, since heating and cooling related to telecommuting are covered in the costs section, is reduced automobile fuel consumption. Our estimates are derived from the energy use questionnaire administered to the telecommuters and the analysis provided later in this report. We multiply the actual reported annual commute miles saved by the average automobile fuel mileage and fuel cost figures to get a rough estimate of this factor. We do not include the additional household trip reduction, over and above the commuting reduction, reported by 22% of the telecommuters in the 1989 evaluation questionnaire. This latter benefit is particularly interesting, apparently a result of better trip planning by telecommuters which, in turn, is the result of their increasing ability to organize their time. This retains our conservatism in benefit estimates. Note that this benefit is gained by the employee rather than the State and significantly outweighs the extra costs of electricity, heating and cooling now borne by the employee (see earlier section on Indirect Costs).

Decreased Air Pollution

Air pollution reductions are directly related to diminished automobile use. However, the cost impact of air pollution is significantly less well established. At this stage we are not assessing a dollar benefit to this category.

Decreased Highway Costs

This is a long term impact factor. Substantial telecommuting will produce some combination of reduced absolute demand and reduced rate of increase in demand for new roads, as well as reduced maintenance needs for existing roads. Current new construction costs average \$40 million per mile in California for new freeways, as high as \$100 million per mile in large cities. However, we have not yet developed an algorithm relating travel pattern changes to these costs so, at this point, we have set this value at 0.

Decreased Traffic Congestion

One major effect of increasing congestion is to increase air pollution, covered earlier. Another is the effect on productivity of the congestees. This might be as high as 5% or 10% in areas such as downtown Los Angeles. However, since we do not yet have a method of explicitly estimating the effects at this time, we set them at 0.

Results

The results of the above, as derived from the data received to date, are shown in Figures 1 through 4 and Table 14. Note that the cumulative costs include the cost of the pilot project plan (developed in 1985) as well as the costs of the pilot implementation and evaluation. Cost estimates also include estimates of the time of the Project Manager and of the State employees participating in the Advisory Committee, as noted above. The basic conclusion is that the break-even point on the project (where cumulative benefits equalled cumulative costs — with no internal rate of return imputed) occurred early in 1989. The remaining costs of the pilot project were covered (in advance) later in 1989. After the project costs are covered, and telecommuting becomes simply a case of telecommuter/supervisor selection and training, benefits should significantly outweigh costs. The figures show these effects by assuming a constant number of telecommuters (specifically, 150 since that appears to be the average number of active telecommuters during 1988 and 1989).

Benefit-Cost Analysis

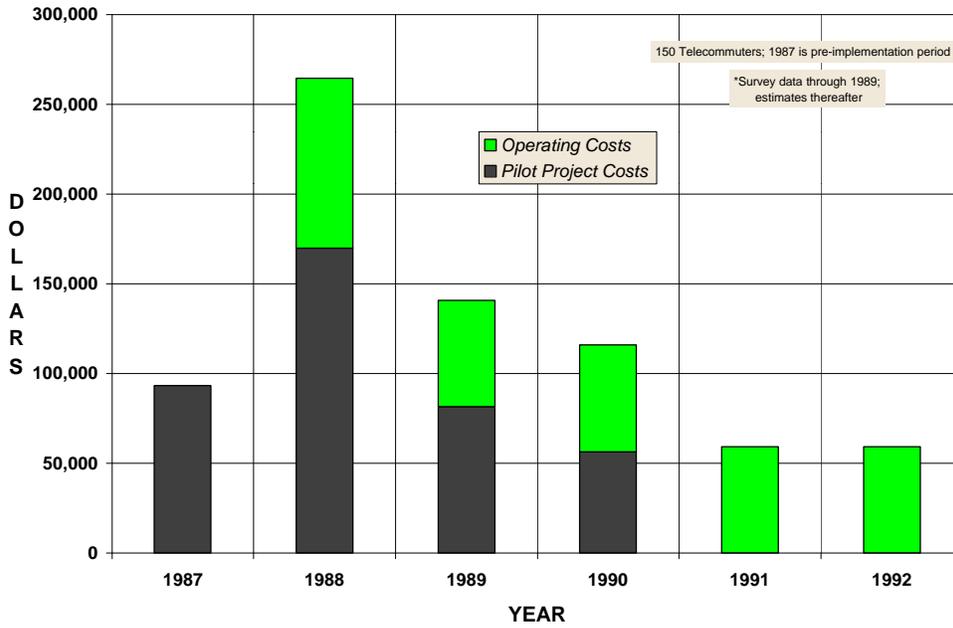


Figure 1: Cost Summary

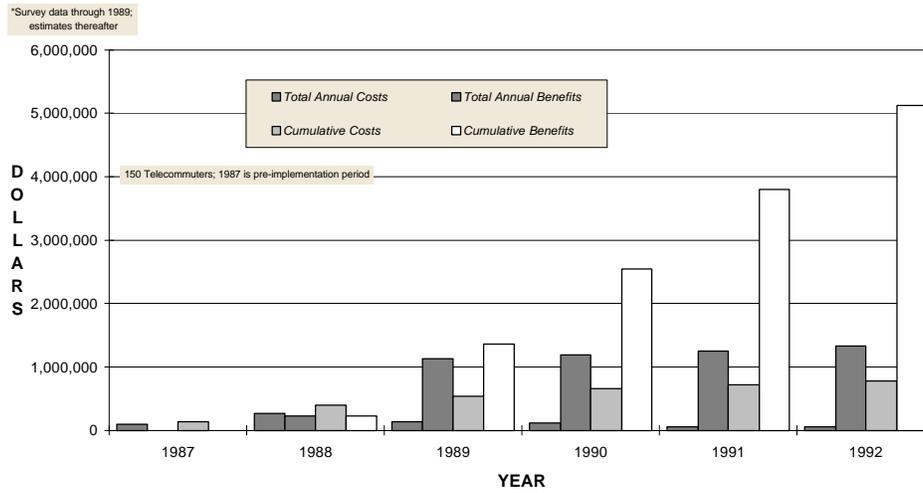


Figure 2: Cost and Benefit Breakdown

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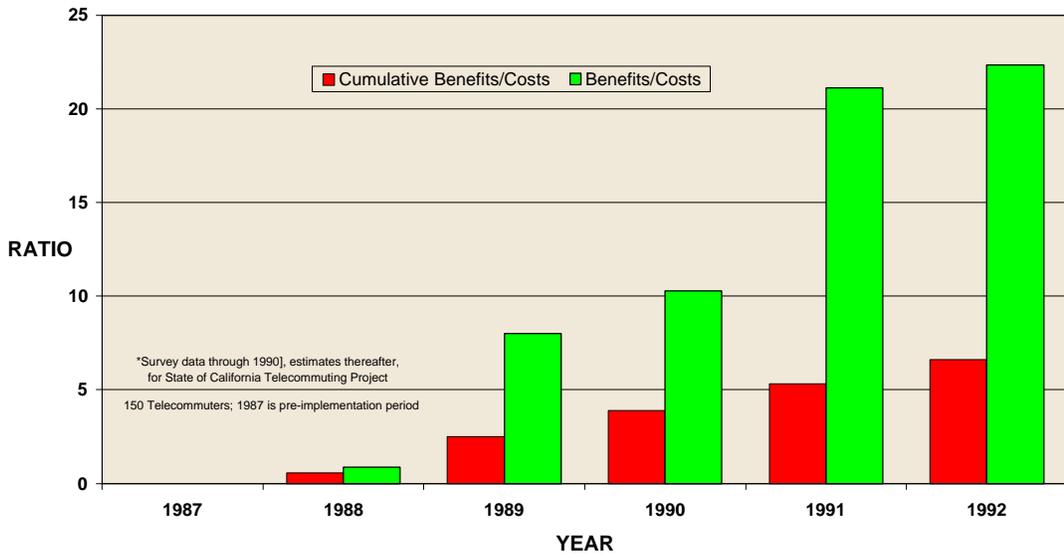


Figure 3: Benefit to Cost Ratios

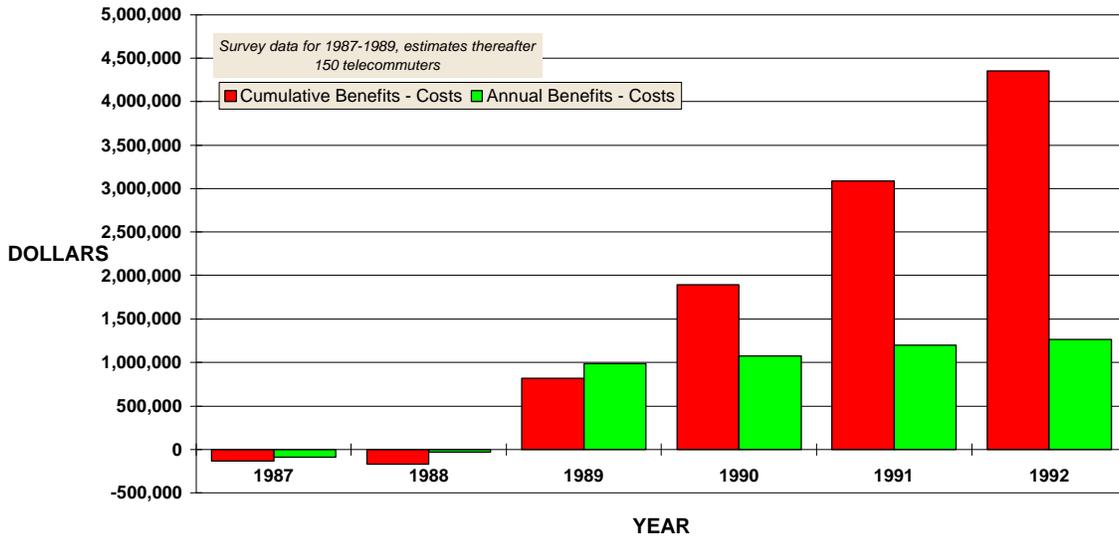


Figure 4: Benefits minus Costs

YEAR	1987	1988	1989	1990	1991	1992
Total Annual Costs	93,542	264,509	141,049	115,883	59,431	59,431
Total Annual Benefits	0	230,919	1,128,252	1,189,580	1,253,865	1,326,664
Cumulative Costs	134,542	399,051	540,099	655,982	715,413	774,844
Cumulative Benefits	0	230,919	1,359,171	2,548,750	3,802,615	5,129,280
Benefits/Costs	0.00	0.87	8.00	10.27	21.10	22.32
Cumulative Benefits/Costs	0.00	0.58	2.52	3.89	5.32	6.62
Pilot Project Costs	93,542	169,960	81,618	56,452	0	0
Operating Costs	0	94,549	59,431	59,431	59,431	59,431
Cumulative Benefits - Costs	-134,542	-168,132	819,071	1,892,768	3,087,203	4,354,436
Annual Benefits - Costs	-93,542	-33,589	987,203	1,073,697	1,194,434	1,267,234

Table 14: Benefit-Cost Analysis Summary

CHANGES IN WORKING RELATIONSHIPS AND QUALITY OF LIFE

A major controversy in academia about the impacts of telecommuting — and a major focus of our evaluation — concerns the nature and direction of changes in the quality of life of telecommuters and their households. These changes do not necessarily have directly identifiable effects on 'bottom line' performance but they are clearly of interest to most workers. Among the main concerns expressed in the literature were isolation of the telecommuters from their co-workers, reduced loyalty to one's organization, blooming workaholism, and decreases in self esteem.

In order to identify and evaluate such effects we included a section in our evaluation questionnaires specifically oriented toward these impacts.¹ Common factor analysis of the questionnaires allows us to break a number of the work/social impacts into 11 categories, as follows:

1. *General Work Life.* This relates to changes in the individual's relationships with his/her supervisor, self assessment of job skills, feelings of job responsibility, influence, versatility and scope.
2. *Personal Life.* This factor includes changes in quality of family relationships, discretionary time, feelings of control of one's life, ability to separate work and home life, success in self discipline, coordination of family and work time, and knowing when to quit work.
3. *Visibility.* Do telecommuters feel out of their supervisor's and co-workers' minds when they're out of sight? This factor includes changes in one's influence on organizational strategy, understanding of what others are doing, how well one's suggestions are received and self assessment of visibility in the organization.
4. *Environmental Influences.* This includes changes in home office space, stress from environmental noise, ability to match work and biorhythms, and feelings of self empowerment.
5. *Belonging.* Do telecommuters feel themselves to be loners? Here we have changes in involvement in office social activities, amount of job-related feedback, career advancement, job stability and relationships with fellow workers.
6. *Creativity.* Changes in: creativity in one's work, the amount of flexibility in job performance and feelings of self empowerment; are in this factor.
7. *Stress Avoidance.* Changes in work related costs, ability to bypass physical handicaps and avoidance of office politics are grouped here.
8. *Liberation.* This factor includes changes in ability to concentrate on crucial tasks, the need to cope with traffic, and the ability to get more done.
9. *Apprehension.* Changes in uneasiness about equipment failure and feelings of guilt about "not really working" constitute this category.
10. *Interdependence.* This factor relates to changes in the quality of meetings with colleagues and dependence on others to help perform one's job.

¹We had developed this component of the questionnaire in earlier studies of telecommuters and other information workers. It contains 50 questions about the extent and importance to the respondent of any impacts.

11. *Continuity.* The final factor calibrates changes in freedom from interruptions.

Note that the emphasis is on *changes* in these categories. We asked the participants what had changed over the past year (or since January, 1988, in the case of the final questionnaire). We asked how much, if any, change there was and how important each issue was to them. We have developed composite values (amount of change multiplied by importance to the participant) for these factors, as shown in Table 15. The scales for *amount* of change are from -2 to +2, with -2 signifying much worse, 0 meaning no change, and +2 signifying much better. Importance ranges from 0 (not important at all) to 4 (extremely important to the participant). Thus, the composite factor can range from -8 to +8.

Factor	Telecommuters		Controls		Difference (T - C)	
	mid-term	final	mid-term	final	mid-term	final
Liberation	3.58	3.66	0.25	1.09	3.33	2.57
Continuity	2.81	2.72	0.19	0.71	2.62	2.01
Creativity	2.56	3.16	0.74	1.16	1.82	2.00
Personal Life	1.87	2.25	0.37	0.57	1.50	1.68
Environmental Influences	1.74	2.02	0.02	0.44	1.45	1.58
General Work Life	1.60	2.04	0.99	1.28	0.61	0.76
Stress Avoidance	0.99	1.16	0.06	0.23	0.93	0.93
Interdependence	0.92	1.03	0.47	0.45	0.45	0.58
Visibility	0.70	0.89	0.38	0.86	0.32	0.03
Apprehension	0.51	0.74	-0.05	0.42	0.56	0.32
Belonging	0.39	0.47	0.22	0.55	0.17	-0.08

Table 15: Work/Social Factor Changes

The telecommuters are generally more positive about these factors than are the members of the control group. In fact, in no case did the control group score higher than the telecommuters at the mid-term evaluation. However, at the final evaluation the telecommuters *did* feel a smaller increase in the “belonging” factor than did the controls. This is due less to any significant difference in changes of feelings of belonging (0.16 for the telecommuters versus 0.17 for the controls) than to a decreased importance of this factor to the telecommuters (3.44 versus 3.50, respectively, where 3.0 means ‘moderately important’). Therefore one might conclude that the telecommuters have developed slightly higher, but not very intense, ‘loner’ tendencies than have the members of the control group.

The greatest differences between the groups, in terms of both importance and amount of change, are generally identified with ‘hassle reduction’ and self esteem. Aside from the impacts on effectiveness of these factors, we believe it also relates to the higher stress thresholds of telecommuters described earlier. That is, telecommuters are generally less stressed and this shows up in several forms, including the effectiveness increases noted above.

None of the worries about possible negative social effects of telecommuting, as expressed in the academic literature and the popular press, seem to be justified by the experiences of this group of telecommuters. The worst effects, if they can be called that, seem to be that some of the major quality of life advantages detected at the mid-term evaluation are somewhat less intense after two years². Office mates have learned that telecommuters are still at work when they are at home, so are less constrained about interrupting them at the home office. Therefore the continuity advantage is perceived to be slightly less than it was in the early days. Note, though, that with the

²This may be a manifestation of the Hawthorne Effect. After the telecommuters have gone past the novelty of the new work style, the excitement wears off and it becomes “business as usual”. This is what we hoped to see by the end of the project.

exception of the continuity factor, all of the telecommuters' quality of life factors have increased since the mid term evaluation. The difference is that the controls' quality factors have increased even more in some cases. Hence one could conclude that the quality of life for both groups has increased and that the increase is related to telecommuting and the shift in management styles from process to product orientation.

Informal Surveys

We conducted two sets of five focus group discussions since the active part of the project began. The first set was focused primarily on telecommuters' experiences, although some supervisors attended some of the sessions. The second set of sessions was exclusively for supervisors. The main emphasis in both sessions was on surfacing operational problems and developing approaches to their solution. No serious problems were exposed during any of the sessions. Those that were brought up tended to group into these areas:

- *Scheduling and work unit interaction.* This area was brought up mostly by supervisors who were having difficulty interleaving the schedules for telecommuter at-home time with demands for their services in the office. This was the case mostly for instances in which telecommuters needed to be on hand for examining equipment or for attending meetings. The general approach to solving these problems was some combination of job task restructuring, rotation of 'on deck' assignments, and the use of teleconferencing.
- *Assignment changes.* This issue occurs when telecommuters transfer to different organizational units. In some cases the telecommuters went to units supervised by a manager unfamiliar with the project. In other cases experienced telemanagers were faced with new (to them) telecommuters. In both cases the recommended approach was to hold a mini training workshop in order to develop the necessary supervisor-employee rapport.
- *Attitude issues.* The central issue here, as expected, was development of a comfortable level of trust between supervisor and employee. Both telecommuters and supervisors contributed a number of approaches to resolution of this issue. Most common was the telecommuters taking the initiative to make sure that their supervisors were informed about their progress. This was complemented by supervisors making extra effort to insure that telecommuters were kept informed about relevant in-office activities. Both of these approaches engender a "we're in this together" attitude.

We also conducted telephone interviews with telecommuters and one ex-telecommuter. The latter served as a check of the pre-telecommuting screening and training process. The telecommuter in question was recommended for telecommuting at home *at most* 1 day per week. The telecommuter and supervisor decided to begin telecommuting 3 days per week — a recommendation given only to a few. The telecommuter began to miss deadlines, was unhappy with the work situation at home — including inadequate equipment for the job, and felt left out of office activities. The telecommuter subsequently (after two months) went back to the office full time.

All of these danger factors were either part of the screening recommendations or were covered in the training sessions, which both telecommuter and supervisor attended. One or both of the pair apparently ignored the recommendations.

TECHNOLOGY USE

Telecommuting is often characterized in the press as “high tech”. Consequently, eligibility for telecommuting often is considered to be confined to individuals within a relatively narrow range of job types. Therefore, one of the goals of the project was to test technology usage of the participants and compare the telecommuters with the members of the control group. Table 16 shows the data over the entire project span¹.

The Table is divided into two parts: the electronic technologies (computers, and telecommunications-related technologies) and the traditional technologies, including meetings and face-to-face conversation. From this welter of numbers some central conclusions can be drawn:

- ý **There is little difference in technology use or importance between the telecommuters and the control group**, except in the areas where one would expect contrasts, such as call forwarding, answering machines, and some computer uses.
- ý **Both usage and importance to the telecommuters of these technologies increased over the period of the pilot.** That is, even though ownership or availability of personal computers and answering machines was not a prerequisite for telecommuting, it is becoming more important as time goes on.
- ý **Use and importance of the traditional “technologies” are essentially unchanged**, with no significant difference between telecommuters and members of the control group except for the expected small decrease in use and importance of face-to-face communication by telecommuters.

TECHNOLOGY	How often do you use it? (means)			How much does it contribute to your job? (means)		
	TCers/Controls			TCers/Controls		
	Pre-start	Mid-term	Final	Pre-start	Mid-term	Final
Telephone	5.8/5.8	5.8/5.8	5.8/5.7	4.3/4.4	4.5/4.5	4.5/4.4
Telephone Conferencing	2.8/2.9	3.1/2.9	2.8/2.9	2.4/2.3	2.5/2.5	2.4/2.3
Call Forwarding	2.8/2.9	3.2/2.8	3.1/2.8	2.3/2.3	2.6/2.1	2.6/2.0*
Answering Machines	2.7/2.5	3.7/2.7	4.3/3.6*	2.2/2.0	2.9/2.1	3.1/2.4*
Voice Mail	1.5/1.3	2.2/2.0	2.5/2.2	1.6/1.2	2.1/1.9	2.3/2.0
Electronic Paging	1.1/1.1	1.2/1.2	1.2/1.4	1.2/1.1	1.2/1.1	1.2/1.3
Cellular Phone	1.1/1.0	1.0/1.1	1.1/1.2	1.3/1.1	1.2/1.2	1.1/1.2
Facsimile	2.3/2.5	3.0/3.1	3.0/3.0	2.3/2.3	2.8/2.9	2.9/2.7
Personal Computing	4.6/4.6	5.1/5.0	5.2/4.4 *	3.9/3.8	4.3/4.2	4.3/3.7*
Text Processing	4.2/4.3	5.0/4.6	4.5/4.4	3.9/3.7	4.2/4.0	3.9/3.9
Specialized Computer Programs	4.0/4.0	4.2/4.0	4.1/3.8	3.6/3.5	3.7/3.5	3.6/3.3
Spreadsheet Analysis	3.1/3.2	3.6/3.4	3.5/3.0*	3.0/2.7	3.2/3.1	3.2/2.7*
Graphics	2.6/2.6	3.0/2.6	2.8/2.6	2.5/2.3	2.7/2.4	2.5/2.4
Database Development	2.8/2.8	3.3/2.9	3.1/2.6*	2.8/2.6	3.0/2.8	3.0/2.6
Electronic Mail	2.9/3.1	3.7/3.8	3.8/4.1	2.6/2.6	3.0/3.1	3.2/3.4
Computer Conferencing	1.3/1.2	1.4/1.5	1.5/1.4	1.3/1.2	1.2/1.4	1.4/1.3
Slow-scan Teleconferencing	1.1/1.0	1.1/1.1	1.1/1.1	1.2/1.1	1.1/1.1	1.0/1.1
Full-motion Teleconferencing	1.0/1.0	1.1/1.1	1.1/1.1	1.2/1.1	1.1/1.1	1.1/1.1
Outside Database Searching	1.8/1.6	1.9/1.8	1.8/1.6	1.8/1.7	1.9/1.7	1.9/1.4*
Internal Mail	4.9/5.0	4.8/5.1	4.8/4.9	3.8/3.8	3.6/3.8	3.7/ 3.8
External Mail - Regular Delivery	4.8/4.8	4.7/ 4.9	4.7/4.7	3.8/3.9	3.8/3.9	3.8/3.8
External Mail - Overnight Delivery	3.0/3.2	3.0/3.3	3.1/3.1	2.8/2.9	2.9/3.2	3.1/2.9

¹Higher values mean more frequent use (a maximum value of 6) or a greater contribution to one's job (maximum 5). The top 5 technologies are in boldface and those with significant ($p < 0.05$) final evaluation differences between telecommuters and the control group are asterisked.

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Meetings	4.5/4.6	4.5/4.5	4.3/4.3	3.5/3.7	3.7/3.7	3.6/3.7
Face-to-Face Conversation	5.4/5.5	5.3/5.5	5.0/5.3 *	4.0/4.2	3.8/4.2	4.0/4.3 *

Table 16: Technology Use Patterns

For an interesting socio-technological insight we asked both groups about their needs for face-to-face communications. The average telecommuter spends 12.2 hours per week communicating with others (by whatever means), while the average member of the control group spends 14.5 hours per week communicating. Of these hours, the telecommuters thought that communication *should be* face-to-face 35% of the time and *should not be* face-to-face 39% of the time; the control group's final averages for these options were 42% and 38%, respectively — a greater dependence on face-to-face communication. Some of the control groups' needs for face-to-face communication may be job related, although analysis of the technology use data by job type shows that the differences are just marginally significant ($p = 0.056$).

There are overall group differences in technology use and importance as well. For example, managers are the most intensive and para-professionals the least intensive telephone users, although all use the phone at least several times a week. Personal computing, as might be expected, is most intensively used by professionals and those who feel themselves to be both managers and professionals; it is also most intensively used by those employees doing planning, policy analysis, R&D, finance, engineering and program management - and by males more than females. There is no significant difference among these categories in use or importance of text processing. For both usage and importance of internal mail and regular external mail there are significant differences among job types (R&D, finance, etc.) but no significant differences among job functions (manager, professional, etc.) or sexes.

TRANSPORTATION, ENERGY USE AND GENERAL TELECOMMUTING RESULTS

Trip Patterns

Both the telecommuters and the control group were asked to complete a questionnaire on their basic uses of transportation. The results are summarized here.

Factor Averages	Telecommuters		Controls		% Not Answering	
	mid-term	final	mid-term	final	mid-term	final
Total distance to work (miles)	33.2	28.1	20.1	17.2	0.0	0.0
Distance on surface streets (miles)	6.6	7.2	5.6	4.7	0.0	0.0
Miles of congested surface streets	4.1	3.5	2.8	2.2	0.0	0.0
Distance on freeways (miles)	19.8	20.1	12.9	12.9	0.0	0.0
Miles of congested freeway	1.5	9.5	0.9	6.4	0.0	0.0
Trip time TO work (minutes)	48.3	45.6	38.5	33.2	0.0	0.0
Trip time FROM work (minutes)	50.2	49.4	41.3	36.4	0.0	0.0
Length of work day (hours)	8.4	8.8	8.7	8.5	0.0	0.0
Days/week going to work by:						
Driving alone	1.6	1.9	2.0	2.1	0.0	0.0
Taking the bus	0.3	0.3	0.5	0.4	0.0	0.0
Taking the train (light rail)	0.1	0.4	0.3	0.3	0.0	0.0
Walking or running	0.0	0.1	0.1	0.1	0.0	0.0
Carpooling	0.5	0.7	0.8	1.0	0.0	0.0
Vanpooling	0.3	0.1	0.2	0.1	0.0	0.0
Driving a motorcycle or moped	0.0	0.0	0.0	0.0	0.0	0.0
Bicycling	0.0	0.0	0.1	0.1	0.0	0.0
Number of commute side trips/week for:						
Work related business	2.6	1.0	1.7	1.0	89.0	51.4
Personal business	1.5	0.8	1.5	1.1	83.5	58.9
Eating meals	1.0	0.2	1.8	0.9	94.0	65.4
Shopping	1.9	1.2	1.6	1.4	72.0	62.6
Picking up or leaving a child	3.0	0.5	4.0	2.2	86.7	68.2
Visiting friends/relatives	1.0	0.5	2.0	0.8	96.8	75.7
Education	2.0	0.1	1.8	0.4	96.3	77.6
Medical/dental visits	1.1	0.5	1.1	0.6	90.8	70.1
Recreation	1.8	0.1	1.5	0.5	95.4	81.3
Number of lunchtime trips/week	1.2	2.2	1.6	2.4	0.0	36.4
Number of lunchtime trips/week for:						
Work related business	1.3	0.7	1.0	1.2	94.5	74.8
Personal business	1.3	0.8	1.6	0.9	79.8	73.8
Eating meals	2.1	1.7	2.8	1.8	71.1	67.3
Shopping	1.4	1.3	1.1	1.1	89.9	72.0
Picking up or leaving a child	5.0	0.0	1.0	0.6	99.1	85.0
Visiting friends/relatives	0.0	0.1	1.0	0.2	99.5	86.9
Education	2.5	0.0	3.0	0.0	98.6	86.9
Medical/dental visits	1.0	0.3	1.0	0.7	98.2	83.2
Recreation	3.3	0.3	2.3	0.7	96.8	86.0

Table 17: General Trip Data

As Table 17 shows, the primary differences between the telecommuters and the control group are related to commute length (both distance and time) and in some side or lunch time trip purposes. More importantly, the telecommuters do not appear to be taking more side trips than do the controls. That is, trips saved by telecommuting are not being made up in other ways, at least not by the telecommuters. The major real differences in side trips taken is in a reduction by telecommuters in picking up or leaving children and a reduction in the number of personal business

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trips by controls¹. To check further into that issue we asked the telecommuters about their telecommuting and related transportation patterns. Table 18 shows the results for a sample month.

Factor	Mean		Median		Percent	
	mid-term	final	mid-term	final	mid-term	final
Number of entire days/month telecommuting from home:	5.2	6.5	4.0	5.0		
0					12.5	1.9
1 to 4					52.5	45.3
5 to 8					16.7	23.6
9 to 13					11.7	18.8
14 to 17					4.2	9.5
18 to 23					2.5	0.9
Number of partial days/month telecommuting from home:	1.5	1.0	0.0	0.0		
0					67.5	72.0
1 to 4					21.7	19.4
5 to 8					5.0	7.5
9 to 13					3.3	1.1
14 to 17					1.7	0.0
18 to 22					0.8	0.0
Because of telecommuting, the car is available to others in the household					28.2	36.4
Household vehicle use: ²						
decreased <i>over and above</i> commuting decrease					n/a	21.5
decreased because of commuting decrease					n/a	14.0
overall decrease but increased non-commuting use					n/a	1.9
non-commuting use increased to cancel commuting savings					n/a	1.9
New trips resulted from the car availability ³					22.5	4.8
How many?						
1					11.3	n/a
2					5.6	n/a
4					1.4	n/a
5					2.8	n/a
6					1.4	n/a
Length, in <i>round trip</i> miles, of trip No.:						
1	11.8	n/a	7.0	n/a		n/a
2	13.6	n/a	4.0	n/a		n/a
3	13.3	n/a	8.0	n/a		n/a
4	15.8	n/a	5.0	n/a		n/a
5	17.7	n/a	10.0	n/a		n/a

Table 18: Telecommuting-Specific Patterns

Note a key factor: **the number of telecommuting days per month increased by 25% from 1988 to 1989**, although the number of partial days telecommuted decreased by ³/₄. This

¹Note that there appears to be a significant reduction, from 1988 to 1989, in reported side trips by both telecommuters and controls. However, this is largely illusory, since there is also a significantly higher level of reporting in 1989. The 1989 reports give a more realistic picture of actual side trips taken. When we compare 1988 and 1989 responses on an individual basis, rather than statistically, the major changes are as just stated.

²This question was not asked during the mid-term evaluation.

³This question was not asked during the final evaluation.

can be considered a clear improvement⁴ since partial telecommuting days have a smaller positive effect on reducing energy consumption and air pollution. We interpret this as another indication of continued learning and adaptation on the part of the telecommuters and their supervisors. We expect that the number of full-time telecommuting days per month will continue to increase over the next year or so.

Hence, the availability of the car to the rest of the household does result in its use for some telecommuter households. Clearly, however, these trips are significantly shorter than the commute trips that would otherwise be taken. The dominant trip purposes mentioned at the mid-term evaluation were personal business, medical/dental trips, eating out, serving passengers and “other”. Furthermore, there was a substantial decrease in reported extra trips from the mid-term to the final evaluations.

Professor Kitamura's data from the travel pattern study performed at UC Davis⁵ indicated that, at least for some telecommuters, household automobile use actually decreased *beyond* the trip reductions from decreased commuting. We decided to check that conclusion during the final evaluation by asking the respondents about their overall household car use. Kitamura's conclusions were confirmed. **More than one-fifth of the telecommuting households claim that their non-commuting car use has decreased — in addition to the decrease due to telecommuting.** Our own experience and interviews with some telecommuters lead us to believe that this additional decrease results from the increased level of organizing ability that telecommuters experience; they organize their car trips better because they organize the rest of their activities better.

Household Location Changes

We also investigated the possible influence of telecommuting on home relocation decisions. Specifically, there is a concern that telecommuting might simply act to increase commute distances by making it easier to live farther from work. The primary motivations for moving farther from work are probably affordability of housing and spousal job moves (although we did not ask the participants *why* they moved). Of the telecommuters who responded to the questionnaire, 83.2% have *not* relocated since the project began (although 11.2% are considering it) and 16.8% have relocated. Of those who have either relocated or are thinking about it, 48.4% said telecommuting had no influence whatever on their decision, 9.7% said it had a slight influence, 12.9% indicated a moderate influence, 19.4% a significant influence and 9.7% said that telecommuting was decisive in their move decision. In two-thirds of the completed move cases the move was farther from the central office, with one-third moving nearer⁶. The median move distance was 1 mile farther away. In both the “considering moving” and the “have moved” groups the majority of the moves changes (or would change) the commute by ten miles or less. The remaining moves were more than 45 miles; one was 200 miles. That is, telecommuting appears to be prompting these individuals (3% of all the telecommuters) to move entirely out of town, not just a little farther (or closer)! The correlation between distance moved (for those who have actually done it) and the influence of telecommuting is significant at the $p=0.03$ level.

⁴Pun intended.

⁵Kitamura op. cit., p. 52”

⁶One of those was 300 miles nearer, from Los Angeles to the San Francisco Bay area, while the job remained in Sacramento.

Note that, in our opinion, these moves are responses to other motivating factors⁷. Telecommuting is not the motivator; it simply eases the change by partially reducing the pain of commuting. This inspires our recommendation to continue pursuing the development of satellite centers to support these individuals. In the longer term it portends a future in which residence location and "office" location are only loosely correlated for many information workers. Hence, the need for an extensive network of regional telecommuting centers will continue to grow.

Energy Use Impacts

If we make the conservative assumption from the trip pattern data that the telecommuters' household auto use is reduced exactly in proportion to their telecommuting, then we can estimate the fossil fuel energy conserved by this reduced car use. A gallon of gasoline contains about 36.64 kilowatt-hours (kWh) of energy. If we further assume that the average telecommuter car gets 21 mpg while commuting and the telecommuter drives alone, then the gross telecommuting saving is 1.74 kWh per commute mile. The 107 telecommuters who responded to the final survey⁸ save a total of 39,128 commute miles per month. Not all of the telecommuters' commuting is by automobile or single-passenger, however. Analysis of travel mode data from the questionnaires suggests that at least 80% of commuting by telecommuters is in a single passenger (the telecommuter's) car⁹. Since most of the other modes (trains, car pools, van pools, etc.) also use energy we conservatively estimate an equivalent car use of 80%. This results in a gross energy saving of 54,470 kWh per month or about 650,000 kWh per year (or 6,110 kWh per year per telecommuter)¹⁰.

The next question is, how much of those savings are offset by increased use elsewhere. In the worst case the major potential offsetting energy use is in home electricity and gas consumption produced by the telecommuter working at home while the office is heated/cooled and lit as usual. The average telecommuter reports a monthly household electricity bill of \$83.93, while the gas bill is \$30.72. The average member of the control group reports a monthly household electricity bill of \$74.46 and a gas bill of \$29.32. Hence, the difference between the telecommuters and the controls is \$9.47 for electricity and \$1.40 for gas each month. If we stick to the worst case assumptions that all of this difference results from telecommuting (at an average cost of \$0.08 per kWh¹¹ in the Sacramento area) this works out to about a 136 kWh per month, and 1600 kWh per year additional energy use by the telecommuters. So the worst case net energy saving is about 4,510 kWh per year per telecommuter. That is, up to one-third of the energy saved may be lost because of additional heating, cooling, lighting and other electricity demand increases on the part of the telecommuter¹². Note that this is a cost borne by the telecommuters, not the employers.

A more reasonable assumption is that at least some of the electrical and gas energy used by home telecommuters is not also used elsewhere. For example, a telecommuter using a computer at home is not simultaneously using one at work. Nor is the telecommuter using the desk lamp at work or imposing an additional demand for heating or cooling of the office.¹³ Our experience has been that telecommuters are

⁷The author was recently in Phoenix, AZ, and heard of a group of Phoenix residents, all professionals, who commute to Los Angeles, either daily or several times per week. The differential in housing costs outweighed the commute costs, in their opinion.

⁸Not all of the participating telecommuters answered all the survey questionnaires.

⁹As mentioned earlier, Kitamura's study puts the figure at 84%.

¹⁰That is, (39,128 vehicle miles/month) \times (1.74 kWh/mile) \times 0.8 = 54,470 kWh/month; 12 \times 54,470=653,640 kWh/yr. This is a conservative estimate since it neglects the energy costs of the mass transit and car pool options that constitute the other 20% of telecommuter transportation use. It also neglects the indirect energy costs of producing and distributing the gasoline. In his report *Direct and Indirect Energy Requirements for Automobiles* (Oak Ridge National Laboratory, ORNL-NSF-EP-64, 1974), Eric Hirst estimates that the indirect costs are an additional 68.7% of the direct gasoline energy use. Counting this in, the gross energy saving per telecommuter-year is 1.687 \times 6,110 = 10,307 kWh!

¹¹Recent Sacramento Municipal Utilities District rates were \$0.084 per kWh.

¹²If we include the source costs for electricity and assume an overall system efficiency of 30% (power plant plus distribution losses) the overall electrical energy cost grows to (9.47 \times 12)/(0.08 \times 0.3) = 4735 kWh/yr. If gas mining and distribution is 50% efficient, the annual gas energy costs are (1.40 \times 12)/(0.08 \times 0.5) = 420 kWh/yr for a total gross energy tab of 5,155 kWh/yr. The net is then 10,307 kWh/yr - 5,155 kWh/yr = 5152 kWh/yr.

¹³We were not able to get data from the participating agencies on changes in office energy use.

more likely to live with greater extremes in temperature at home than they do (or can) in the office if for no other reason than their greater ability to match clothing to temperature.

In any case, we feel confident in concluding that the net energy savings for this group of home-based telecommuters are at least 4,500 kWh per year per telecommuter or about 15% of the average annual energy use per U.S. household.¹⁴ That is, the annual energy saved by six or seven average State telecommuters could power the average U.S. household for a year. Note, however, that the average commute distance of the State telecommuters is 63% greater than that of the controls; if telecommuting were to be used by all the controls, their net energy saving would drop to about 2750 kWh per telecommuter-year.

Generalization Issues

The primary objective of this project was to explore, test and develop management techniques and policies for effective telecommuting. As such, the project development has concentrated on the success factors for telecommuting, rather than cataloging the myriad ways to do it wrong. This presents some statistical considerations when the test data are analyzed.

The group of telecommuters involved in the project obviously constitute a biased sample. The participants were preselected for their likelihood to telecommute successfully rather than being randomly selected from the entire group of State employees. The selection procedure was also biased in favor of those living farthest from work. Nor do the participants even constitute a representative sample of State employed information workers. The bias turns out to be in favor of professionals, rather than entry-level, routine workers or of managers of people because of the generally greater ability of professionals to work without continual face-to-face interaction with other people. How, then, is it possible to extrapolate from this sample to State employees in general, or from State employees to those in the private sector?

Strictly speaking, it is not possible to make forecasts for these other areas with the same accuracy as the group in hand or for similarly constituted groups. However, it is possible to come to some general conclusions that apply to many of these other areas. It is also possible to describe what may be necessary in the way of new information in order to make those forecasts more reliable.

To this end we developed a short survey consisting of a portion of our background questionnaire for telecommuters. The questionnaire focused on job content issues and did not include the psycho-sociological component. This was administered to a random sample of State information workers (just under 1,000) during January 1990. Slightly more than half of those who received questionnaires returned them. The returns were subjected to the same screening criteria as were the participants in the pilot project. However, the screening was incomplete since we did not survey the supervisors of the employees. Hence the results represent only the prospective telecommuter portion of the tests and only the job task related factors. Further, none of the participants in the general survey was given a briefing on telecommuting prior to completing the questionnaire. Therefore, there may have been some confusion on some of the fine points of job restructuring that lowered their scores.

The original selection process produced responses from 614 prospective telecommuters, primarily in the Sacramento and San Francisco Bay areas. The general survey covered a broad array of agencies (more than 35 agencies) and 513 information workers from all over the state. One apparent difference between the two groups is in commute distance; the average one way commute for the respondents to the general survey was 16.0 miles, as contrasted to 19.8 miles for

¹⁴At 105 million BTU per year per household, according to the 1988 Statistical Abstracts of the United States, Table 913.

the applicants to the pilot project. Average commute speeds were not substantially different, however: 28.4 mph for the average state employee versus 28.3 mph for the average pilot project applicant. The average State employee has worked for the State about 6% longer than the average pilot project applicant (12.2 versus 11.6 years, respectively) and has held his/her current position about 5 months longer (4.6 versus 4.2 years).

Our evaluations of the pilot project applicants, based solely on the questions in the general survey, would have been that 15% of the applicants would not have been able to telecommute at all, 54% would have been able to telecommute from a satellite center, and the remaining 31% would have been able to telecommute some of the time from home. The comparable results for the respondents to the general survey are that 31% would not be able to telecommute at all¹⁵, 52% would be able to telecommute from a satellite office, and 17% would be able to telecommute part time from home. That is, the pilot project applicant group comprised 85% potential telecommuters, while the general pool of State information workers includes 69% potential telecommuters. This number is slightly higher than our expectations, which were about 60% at this stage of development of telecommuting.

These results lead us to the following conclusions.

- 1. There is no reason to believe that telecommuting can not be widely applied throughout State government. At least at the job content and experience level the proportion of State employees who could telecommute is high.**
- 2. Because at least half of these employees can telecommute only from satellite centers it is extremely important to begin testing the satellite office concept as soon as possible.**

Shared Office Space (SOS) Study

As a separate part of the project, and with supplemental funding from the Department of Transportation, we began a study of the possibilities for reducing the amount of downtown office space used by telecommuters. Early in the implementation stage of the project it became clear that some telecommuters were using less office space; a few have given up their central office spaces entirely. The purpose of the special study was to investigate and test various low-cost options for reducing the amount of office space used by telecommuters without damaging the telecommuters' sense of belonging to their work groups.

To this end we enlisted the aid of a design team from Sanchez/Kamps, of Pasadena, CA, to explore various SOS options. A set of interviews was held in Sacramento late in September 1988, with telecommuters from five State agencies¹⁶. The purpose of the interviews was to examine the work communication patterns of the telecommuters and to define the physical and budgetary constraints for the prospective designs. On the latter topic, the basic constraint was: use existing building layouts and minimum to zero outlay for new furniture. One of the sites visited, the Office of Real Estate Services, already had developed a shared space for four of its telecommuting real estate appraisers.

After the September visit most of the telecommuters in the five agencies were contacted by phone to elicit their space and communication needs. The results of this survey were incorporated in a "shopping list" of SOS components (desks, storage spaces, floor layout options, etc.) that could

¹⁵23% replied that their job required them to be in the 'regular' office every day. Of that number, more than 40% had secretarial, clerical, technician or operative jobs. It is likely that at least some of these could be performed at a satellite office. A few, such as automotive mechanic, and registered nurse, turn out not to be information jobs in the first place.

¹⁶The agencies were: California Youth Authority, Department of General Services (two different divisions), Department of Transportation and the Franchise Tax Board.

be combined in various ways to serve the needs of a variety of telecommuters, from largely self contained experts to highly communicative managers — and in a variety of main office-home work patterns. These designs were presented to representatives of the agencies in May, 1989.

Further discussions with the potential participants led to development of a set of specific layout options for offices in the Department of the Youth Authority and in General Services, Telecommunications Division. The Office of Real Estate and Design Services in the Department of General Services independently developed a shared space design for some of their real estate appraisers. That design was quite effective and resulted in a 50% reduction of office space for the four telecommuters participating in the project!

Designs for other Departments were not developed because the density of telecommuters was too low. That is, there were too few telecommuters in specific organizational units to make the designs feasible. If office sharing is to work there must be a “critical mass” of telecommuters in a particular organizational unit. Otherwise, telecommuters from different units are lumped together in the same area, with the danger of consequential feelings of isolation from their co-workers.

Since the two groups with potential for office sharing had no budget for even the relatively small amount of furniture and partition changes required, the SOS project was suspended in the summer of 1989. Nevertheless, it is our firm belief that office sharing will work effectively where there is a sufficient number of telecommuters in an organizational unit. The basic concepts have been developed as a result of the study. Implementation and testing of them should proceed as soon as possible.

The Loma Prieta Earthquake

The 1989 Loma Prieta earthquake, centered near Santa Cruz, caused great destruction in the San Francisco Bay area and southward along the coast. Among the organizations in San Francisco that were effectively closed after the earthquake was the California Public Utilities Commission. Several of the PUC telecommuters were already working at home that day and several others had already switched their office phones to call forwarding when the earthquake struck. These employees were able to continue working the rest of the week, unimpaired by the consequences of the earthquake. The telephone system continued to work — although interrupted for the first few hours by local outages and heavy local traffic — even though the transportation system was severely damaged. Several private computer network services organizations quickly formed ad hoc nationwide information networks to link worried out-of-state relatives with people living in the affected areas via electronic mail.

It is not the purpose of the pilot project to engage in wild speculation. However, the experiences of the aftermath of the earthquake certainly point out the possibilities of telecommuting as a disaster mitigation tool. The telecommunications network is inherently less vulnerable to earthquake damage than the highway and road system, provided that there are no major disruptions in electrical power. Repair of damaged telephone lines is generally much faster than repair of damaged roads. A properly designed telecommunications network easily can be programmed to route message traffic around severely damaged areas (although increasing centralization of telephone switches increases this vulnerability). If many more organizations had adopted telecommuting prior to the earthquake it is likely that the economic impact of the earthquake would have been materially diminished. This is particularly worth considering for areas where there is substantial risk of comparable disasters, such as the dreaded “Big One” in southern California or floods in and around Sacramento. Assembly Bill 2962 calls for the Department of General Services and the Office of Emergency Services to develop a Model Telecommuting Plan to be considered by each State agency in its own emergency plan development.

In short, telecommuting should be considered as a serious option in all disaster planning.

Development of New State Services

One of the objectives of the pilot was to investigate the influence of telecommuting on the development of new State services. To the best of our knowledge, no new services were developed during the pilot project. However, the experiences of the pilot suggest the following possibilities, in the author's opinion:

1. *Expansion of Employment Development Services.* Some of our more distant telecommuters have demonstrated that it is not necessary to live close to your 'office' in order to work effectively. One of the key strategies for decreasing both traffic congestion and its attendant air pollution is to improve the jobs-housing balance. The usual interpretation of this is to get companies to move their facilities, or create new ones, into the areas where there is still affordable housing, thereby opening up local job opportunities and reducing commuting.

We propose the following variation on that approach: telecommute the jobs to where the workers live, by increasing home-based telecommuting and establishing a network of regional telecommuting centers. One way the State can develop a leadership role in this area would be by encouraging development of, or developing, a State-wide database that would match jobs with employee capabilities, irrespective of the location of the two. Thus, if text processing jobs are going unfilled in Fresno and there is a surplus of skilled text processors in Santa Cruz, the State might try to encourage a suitable teleworking arrangement that would satisfy the labor demand without requiring the employees to change residences. Other State agencies could adopt this practice for their own needs.

2. *Urban Human Resources Redevelopment.* A variation on the above is to encourage the development of satellite or local telecommuting centers in low income areas of major cities or in rural areas of high unemployment. The purpose of the centers would be twofold: to bring jobs into the areas and to upgrade the work skills of the local population. This would give the local communities a chance to develop themselves rather than being captives of a growing welfare system. One of the clear benefits of telecommuting has been the increased pride in, and responsibility for, their work that is assumed by experienced telecommuters. The clear linking of jobs with learning in the local community might be the proper catalyst for revitalizing these areas.
3. *Aid for the Mobility Impaired.* Yet another variation on this theme is the development of capabilities for sending the work to workers who have difficulty *going* to work. One possibility is to expand the services of such agencies as the Rehabilitation Engineering Center at Rancho los Amigos Hospital in Downey to develop work-at-home facilities, probably involving computer use, that would allow severely handicapped people to re-enter the work force. Another is to give preference in telecommuting acceptance to State employees who are handicapped¹⁷. A third is to provide information to employers about telecommuting as an alternative work mode for the handicapped.

None of this should be taken as a means to curtail the ability of handicapped individuals to "mainstream", to become integrated with the rest of the working world. On the contrary, telecommuting may allow many to end their isolation from the rest of the working world.

¹⁷Handicapped employees in the pilot project state that telecommuting has produced a major reduction in their stress levels.

4. *Localizing State Agencies.* Because of the complexities of government, and the limited availability of experts, it is often not possible always to have the expertise located physically in the community where it is needed. Major cities in California generally have clones of central State offices but smaller communities do not. In many cases teleworking can allow the State to provide expert services to local communities, regardless of where the expert is located. This will become increasingly economical as, and if, the telecommunications networks develop more sophisticated services, such as lower cost digital data and voice transmission, teleconferencing, and the like. The Department of Transportation, as an example, has centralized its detailed bridge engineering analysis activities in Sacramento but makes the results and drawings available to any State facility via data communications.

APPENDIX A: SUMMATIVE EVALUATION METHODOLOGY AND CONSTRAINTS

Evaluation constituted a major element of the project and about two-thirds of the project effort. The project evaluation process consisted of two major components:

1. a set of *formative* evaluations (that is, focus group meetings and interviews) designed to test progress and correct operational problems; and
2. a set of *summative* evaluations, generally by means of formal questionnaires, to summarize the impacts of telecommuting on various factors of interest to the *stakeholders*.

This Appendix focuses on the summative evaluation component.

Rationale

There are many stakeholders in the telecommuting project. Stakeholders are individuals or groups who have an interest in, or are affected by, the outcomes of the project. Primary stakeholders¹ include the telecommuters themselves, their direct supervisors, their families and colleagues, the organizations *in* which they work, the organizations *with* which they work and State government in general. Secondary stakeholders² include the communities in which telecommuters live and/or work, various agencies of government at the local, state and national levels (in the U.S. as well as in other countries), manufacturers and the distribution channels for information technologies and office equipment, the business community, the research community, consumer advocacy and other special interest groups, etc. Each of these stakeholders or stakeholder groups has a set of specific interests and priorities for judging the outcomes of the project. Often the interests of different groups coincide; at least some of the time they conflict.

Telecommuting, if it becomes widespread, can affect almost every aspect of contemporary life, from fundamental job patterns, to the physical structure of communities, to broad scale environmental changes such as global warming, to international economic competitiveness. Thus, we have attempted in the evaluation to address as many as possible of the major issues affected by telecommuting.

This attempt was necessarily moderated by the constraints of budget and time — and the patience of the telecommuters and their supervisors. Budget and time constraints dictated investigation by questionnaire rather than the more expensive interview process. Respondents' patience limits constrained the length of the questionnaires (the final, 'abridged' questionnaire contained 466 items) and the frequency of their administration. Considering the time required to complete the questionnaires, the response rate of 100% in many of the agencies is quite gratifying. In addition to the annual round of questionnaires, the participants and their driving age family members were asked to complete logs of their automobile use for periods of three consecutive days, once before telecommuting began and at the end of the first year of telecommuting.

¹Those who are or can be immediately or directly affected by telecommuting.

²Those who have a broad or indirect interest in some of the impacts, such as air quality, energy use, land use planning, the economy, management techniques, etc.

Statistical and Measurement Issues

Strength of Inference

The results of the surveys, occurring as they did in the real world instead of a laboratory, are complicated by the time-varying composition of the group of telecommuters. Transfers, departures, switches to and from telecommuter/control status (some individuals did this more than once) all tend to obfuscate the results. Consequently, where important factors in the evaluation are discussed, I have included confidence estimates of the reliability of the conclusions. These are generally in the form of an estimate of Type I error: the likelihood that two sample populations (such as telecommuters and controls) are really identical even though the statistic says they aren't. This is expressed in the form of a probability, p , that the two populations are the same. The *lower* this probability is, the more likely it is that the populations are indeed different. Ordinarily I don't state that two groups are different in the characteristic in question unless the p -value is 0.1 or less, preferably less than 0.05. That is, the odds are 9 to 1 or 19 to 1 or more $[(1-p)/p]$, respectively *against* the two groups being the same.

Productivity/Effectiveness Measurement Issues

One of the key economic impact statements about telecommuting is its effect on productivity. There are some very important distinctions to be considered here since major economic commitments may be made on the basis of productivity estimates. The following describes my considerations in developing the various evaluation questionnaires.

Productivity

Productivity is a loaded term. In particular, manufacturing productivity is usually taken as the model. One has mental images of whiz-bangs being turned out like clockwork. Productivity in this situation is measured as the ratio of the price received for the whiz-bangs produced, divided by the cost of production. When one turns to information work the first problem is: what's the product? In the case of clerk typists the identifiable product may be typo-free letters and memos going into the mail. In the case of an administrative law judge or a policy analyst, as examples of the types of telecommuters in the project, the measure of productivity is significantly less well defined. In any case, productivity is a measure of *doing things right*.

Effectiveness

Effectiveness is the term I prefer to use. Our approach is that *productivity* is the wrong term to use in any case. This is specifically because of the tendency to count things (letters, typed, decisions made, briefs or specifications written, etc.) as the means of measure. This distracts one from the real purpose of information work: to generate or convey information and to affect decisions. This is a broader concept and, unfortunately, one that is even harder to measure. But the breadth is, I feel, in the right direction. Effectiveness is a measure of *doing the right things - and doing them right*. As such, it includes productivity as a component, but someone who is very efficient/productive at doing the wrong things is decidedly not effective.

Measuring changes rather than absolutes

It is not possible to measure absolute levels of information work effectiveness, if for no other reason than that there is no consensus on what it is. However, most individual information

workers, and their supervisors, have a feel for what has changed over some relatively short period, such as a year or two.³ In this way we do not have to be concerned with what the elements are of the effectiveness evaluation; we do not sink into the pit of endless qualifications of measures for each type of job. We simply ask what has changed, and proportionately how much, in whatever terms the subject is used to thinking of his/her own (or his/her own subordinate's) effectiveness.

Intergroup comparisons

In addition to focusing on changes rather than absolutes, I compare estimates of effectiveness. We compare the self estimates of the telecommuters with the self-estimates of the members of the control group. We compare both of these with the estimates made by the telecommuters'/controls' supervisors of their effectiveness changes. We compare the final self-estimates with the pre-telecommuting self-estimates.

Related measures

Finally, I also examine what has stayed the same. What hasn't changed? The work environment, the roles played by the individuals in their work, the work activities in which they engage, the technological tools they use, the factors that make up effectiveness measures are all part of our evaluation questionnaires. That is, I try to detect any changes in the work environment that might explain changes otherwise attributable to telecommuting. If these work-environmental factors are unchanged and/or common to both the telecommuter and control groups then any effectiveness differences between the groups are more likely to be attributable to telecommuting. Note that there were no significant differences detected in these factors in the pre-telecommuting and the first annual evaluations. In the interests of reducing the length of the questionnaires (and reducing the strain on the respondents), the information infrastructure and work roles questions were dropped from the final questionnaire.

³Even periods of one or two years' duration can be difficult to measure since one's memory of what one did as long as a few days ago can often be faulty.

APPENDIX B: TELECOMMUTING DEFINITIONS and GUIDELINE FACTORS

This Appendix provides some basic definitions and outlines what we believe to be the key factors that should be included in a formal guidelines document to be distributed to State agencies. A more detailed Policies and Guidelines document has been drafted by the Policy and Guidelines Task Group, chaired by Nancy Baldwin, of the California Youth Authority and including:

Noel Durham, Department of Justice

David M. Fleming, Department of General Services

Sue Gillette, Franchise Tax Board

Frank Marr, Personnel Administration

Judith Toledano, Public Utilities Commission

A. J. Watson, Department of Justice

Parts of the outline included here are extracted from that draft.

Introduction

Definitions

Telecommuting needs to be carefully defined to eliminate confusion about what is — and isn't — telecommuting. Here are Jack Nilles' definitions, expanded from the 1973 original version:

1. **Home-based Telecommuting.** In this version, the employee works at home, keeping in touch with the main office mostly by telephone or other telecommunications technologies. Most home-based telecommuters work at home only part time, say, one or two days per week, spending the rest of their work time in the `main' office or at other facilities. Home-based telecommuting is to be distinguished from home-based business in which the entirety of the individual's working time is devoted to his/her entrepreneurial activities; telecommuters are employees of other organizations. The transportation impact derives from their elimination of some trips that would otherwise be taken in a `traditional' information work setting.
2. **Regional Center Telecommuting.** There are three variants of this, known as satellite center, local center and neighborhood center telecommuting. There are the following distinctions among these versions.
 - ◆ **Satellite Centers** are facilities set up by relatively large organizations to house only their own telecommuting staff. Typically they house from twenty to more than one hundred workers, some of whom may still commute several miles to get to the center — as contrasted with tens of miles commute distances otherwise. Branch banks and fast food outlets are well established examples, provided that their employees are local residents. Note that, in the fast food outlet case, not all telecommuters are information workers.

- ◆ **Local Centers** are facilities that house a number of telecommuters from different organizations (companies and/or government agencies) in a single structure. Except for the multiple tenant and decreased organizational representation factors, with their accompanying management issues, they are otherwise similar to satellite centers. The State of Hawaii is currently experimenting with a local center, as did the Swedish government (Nordplan) in the mid-1980's.
- ◆ **Neighborhood Centers** are smaller facilities, such as store-front operations. They house just a few workers and can serve as mini-satellites or mini-local centers. The emphasis here is on neighborhood: each such center would be within a few blocks, walking distance, of the workers' residences. The author knows of no such centers currently in existence in the U.S.; there are at least 42 of them in Scandinavia.

For all of these the common criterion is that they are close to where the telecommuters live (with the neighborhood center being the closest) and the telecommuters work there instead of at home. Clearly, however, some telecommuters do and will share their work time among two or more of these options, including working at the distant central facility. The transportation impact is a function of the areal density of centers in the region.

3. **Information Workers** are individuals whose livelihood depends mostly upon their ability to create, manipulate, transform or disseminate information, or to operate information machines. The majority of workers in developed countries are information workers. In California, about 60% of the workforce comprises information workers; about 30% of those may not currently have jobs that are suitable for telecommuting, in principle about 20% could be home-based telecommuters.
4. **Telecommuters** are individuals who telecommute with some regularity, typically at least one day per week, on average.
5. **Telemanagers** are direct supervisors of telecommuters.
6. **Telecommutable** tasks are tasks that are *location independent*; the person performing them can perform them almost anywhere. Telecommutable jobs are jobs (such as secretary, lawyer, engineer, judge) that include enough telecommutable tasks so that the job holder might be able to telecommute in full-day increments.

Technological change, particularly advances in information technology, can be expected to increase both the number of information workers and the proportion of telecommutable jobs over the next 20 years.

STAA Responsibilities

The ultimate responsibility for establishing and running a telecommuting program rests with the operating agency. However, we recommend the establishment of a State Telecommuting Advisory Agency (STAA), with responsibilities derived from legislation and Governor's Executive Orders, to advise and consult with State agencies wishing to set up telecommuting programs. Specific responsibilities of the STAA might include:

1. *Communication and coordination*, acting as the primary point of contact for the public, private sector employers, state agencies and state employees for information regarding the State's telecommuting program. The STAA would also advocate and encourage joint efforts designed to increase the total amount of telecommuting in order to achieve the goals and benefits described in this report.

2. *Legislation review* and impact assessment for telecommuting programs operated by other employers. The STAA also could sponsor and/or work with other agencies to sponsor legislation to facilitate cost-effective and responsible telecommuting programs within California.
3. Development and updating *policies, procedures and guidelines* to assist agencies in the planning and implementation of telecommuting programs.
4. Needs identification, location setting and development facilitation for *Satellite Centers*.
5. *Pilot Program* design, implementation and evaluation assistance.
6. *Operational Program Evaluation*.

Participating Agency Responsibilities

Each agency participating in the State's telecommuting program should be responsible for establishing its own specific program, tailored to its own needs. The agency should develop its own formal policies and guidelines, consistent with the overall State guidelines, and should appoint an agency 'champion'/coordinator to serve as the focal person for the program. The coordinator should be at a high enough level within the organization to have access to, and the confidence of, top management of the agency. An agency that is large or widely dispersed may wish to assign additional coordinators. A motivated, enthusiastic coordinator is highly desirable.

Specific Guidelines for Implementing a Telecommuting Program

Planning

While telecommuting has many benefits, there are also potential problems that can be mitigated by careful planning and design of an agency's telecommuting program. Successful telecommuting requires thorough orientation, support of top management, a controlled pilot, careful selection of managers/supervisors and telecommuters, focused training for participants and their peers, and ongoing monitoring and evaluation. The following are the elements that we believe must be considered and/or included in any plan.

1. *Telecommuting Options*. The various forms of telecommuting should be considered in terms of selecting the ones — or the combinations — that are most suitable to the needs of the agency. Remember that our survey of State information worker employees indicates that about half would be best suited for telecommuting from a satellite office.
2. *Management and Labor Involvement*. Top-down support is vital. Any innovative program requires the support of senior management. In addition, an active champion is usually essential to getting a program off the ground. Although telecommuting always must be considered a management option, bargaining groups should have early involvement and opportunity to contribute to the plan.
3. *Emphasis on Management by Objectives/Results*. Managing the work of information workers is very different from managing production units. The products are often intangible, production standards are difficult to develop, and assessment of quality is often subjective in the short term. Yet, process-oriented management is difficult or impossible when the workers are often not physically present. Therefore it is particularly important that managers develop skill that emphasize the work product, rather than the process. This viewpoint must be included in training and evaluation components of the plan.

4. *Assessing Costs and Benefits.* Since the ultimate test of the success of telecommuting is the increased vigor of the agency, the plan should include a relatively detailed cost and benefit measurement component. This should include the more obscure, less easily measured costs and benefits, such as quality of work life, energy consumption/conservation, changes in turnover rates and medical costs, as well as the more obvious factors such as telephone bill increases, computer equipment costs, worker effectiveness changes, facilities and office space savings. Over the long term (say, two or three years or more) an attempt should be made to measure the more subtle variations of these, such as work unit and higher level effectiveness changes, broad scale impacts on transportation, etc. It is very important to distinguish between costs/benefits that are specifically related to telecommuting and those that may be attributable to other sources.
5. *Establishing Selection Criteria.* Since not all information workers can be expected to telecommute effectively, specific selection criteria should be established at the outset. These should combine considerations of job content, telecommuter and supervisor motivation, attitude and personality factors and general policy related issues such as preference for distant employees, single parents, mobility handicapped, etc. Job content, that is, the *telecommutability* of the job should be determined before the other characteristics are evaluated. Clearly, home-based telecommuters must have suitable space at home for useful telecommuting.
6. *Unit, Supervisor and Employee Selection.* Once the factors have been established, the agency should plan for a formal selection process for the pilot project involving interviews and/or a questionnaire process. For the pilot phase — in a relatively large agency — specific organizational units may be selected first, after which supervisors and subordinates in those units constitute the complement from which the final eligible participants are selected.
7. *Technology Needs.* While some telecommuters may do their required work at home or in the office with pen and paper, others will require a computer, computer with modem, or dedicated terminal to communicate with people and access the information needed to do their jobs. Other equipment and additional telecommunications capability may be needed for some jobs. A central policy issue for each agency is: who pays for the equipment and its maintenance if additional equipment is needed; who pays for additional telephone line installation and/or use charges? At the planning level there is some uncertainty, since it is not known who will be involved in the project — and therefore not known what the specific equipment and telecommunication needs will be. Nevertheless, provisional policy guidelines should be established at the outset.
9. *Information Security Requirements.* Use of external telephone lines or transport of files from agency facilities to employee homes may involve issues of protection of confidential information. In some cases there is no way to adequately guarantee the safety of the material other than not allowing telecommuting for those jobs — or those occasions — that require access to it. In other cases, the security considerations may require restriction to satellite office telecommuting. In still other cases, available computer security techniques may be adequate. In any case, these requirements should be reviewed as part of the plan.
10. *Administrative Issues.* A number of administrative issues must be considered as well. These include telephone and travel expense reimbursement procedures, liability exposure for home offices, maintenance of supplies and equipment, establishment of core work hours, maintaining a “who's where today” file, relevant secretary/receptionist training, etc.

The Telecommuting Pilot

The immediate outcome of the plan is the implementation of the telecommuting pilot project. The purpose of the pilot is to identify what does and doesn't work for that agency prior to a larger scale start-up of the telecommuting work option. The pilot should encompass a broad cross section of job classifications. The pilot should include units where there are multiple telecommuters to assess the impact on the unit. The pilot should be large enough to be generalizable for the agency as a whole — and small enough so that the evaluators are not overwhelmed by details.

Pilots typically last one year. During this time, regular assessments and evaluations should be conducted, both by surveys and informal meetings of telecommuters, managers and non-telecommuting co-workers. At the end of the pilot, the agency will have a strong sense of how appropriate telecommuting is for that agency and its staff.

Before launching a telecommuting pilot, temporary operational procedures and pilot policies should be adopted. At the end of the pilot the plan for expansion of telecommuting should be completed.

Implementation

Before active telecommuting begins, the following milestones should be completed:

- There should be top management endorsement and support and identification of an agency “champion” responsible directly to top management.
- There should be a clear statement of the goals and measurable objectives for the pilot. (e.g. reductions in personnel and operating costs, improved employee effectiveness, improved supervisor/worker communications, reduced commute trips). The evaluation criteria and methods should be included.
- Contacts should have been made with the STAA and the Telecommuting Advisory Group for guidance and support.
- The detailed plan and schedule for the start up of the pilot should have been completed. The plan should identify both the necessary activities and the staff responsible for completing them.
- All prospective telemanagers, telecommuters and bargaining group representatives should have been given orientation briefings. These briefings should address the nature of telecommuting and its impacts on employees and their organizations. They also serve as part of the volunteer selection process.
- “Before telecommuting” equipment, facilities and telecommunications costs should be determined.
- A method should be in place for monitoring and reporting progress during the pilot period for the purpose of making corrections and adjustments to the pilot.
- An outline of the final report should be prepared, describing the results and recommendation for full-scale implementation.
- Responsible staff should be assigned and given adequate resources to conduct the pilot.

At which point the actual pilot implementation can proceed. The key steps in this are:

- Select telecommuters and supervisors using criteria developed by the STAA in cooperation with participating agencies.

- Conduct formal training and provide reference material for selected managers, telecommuters, and clerical staff. This training is the single best prevention strategy for avoiding pitfalls. Subject matter should include the following:
 - ◆ Health and safety
 - ◆ Equipment ownership, maintenance and use
 - ◆ Communications and other technology needs
 - ◆ Identification of telecommutable work tasks
 - ◆ Work hours and attendance reporting
 - ◆ Security issues

The training should culminate in each telecommuter signing a Telecommuter's Agreement or similar document that clearly specifies the rules and requirements of the pilot project.

- Acquire equipment and install technology as required.
- Begin telecommuting.
- Monitor and conduct on-going evaluations of the pilot using telecommuters' and telemanager's forums. It is important to also assess the satisfaction and effectiveness of staff who do not telecommute.
- Conclude pilot with a report and recommendations regarding expansion of the program.

After completion of the pilot a full-scale program can be implemented. This step basically involves repetition of the steps of the pilot project, *including a review of the plan*. The latter is necessary because other organizational elements may not have the same needs and requirements as those that participated in the original pilot.

Program Operation

1. Periodic Performance Review

Supervisors should meet regularly with their telecommuters (weekly or monthly). On an ongoing basis, just as a supervisor would do with a non-telecommuting employee, work plans should be reviewed and compared to actual work completed.

2. Problem Resolution

Telecommuting problems can be separated into two broad categories of job-related and general problems. Job-related problems arise from impediments to doing assigned work away from the central office and may include resources that are needed but were not identified earlier, lack of co-worker cooperation, or equipment needs. These problems should be handled just as they would be if the employee were not a telecommuter — through the supervisor.

General problems include everything but job-related items. There may be transition adjustment problems in the office or at home with family and neighbors. An agency telecommuter's forum provides one way to deal with these challenges. Sharing of experiences and solutions is facilitated by regular forum meetings and direct contact with other telecommuters on an individual basis.

3. Renewal of Telecommuting Agreement

Each telecommuter agreement must be discussed and renewed annually, whenever there is a major job change (such as a promotion), or whenever the telecommuter or manager changes positions. Because telecommuting was selected as a feasible work option based on the combination of job characteristics, employee characteristics, and supervisor characteristics, a change in any one of these requires a review of the telecommuting arrangement.

Because this is a management work option, there is no automatic right of the telecommuter to continue telecommuting in the event of a change of supervisor.

4. New Telecommuters and New Managers

To facilitate the smooth transition for new telecommuters and new managers of telecommuters, an ongoing training program should be established within each participating agency which takes advantage of training offered by the STAA. Training should include the topics discussed earlier under Program Implementation.

Evaluation

A specific evaluation plan should be established prior to undertaking the evaluation, tailored to the agency's specific telecommuting program. Special attention should be given to the need to collect baseline data before telecommuting is implemented. If feasible, a "control" group should be selected, consisting of employees with work experience and qualifications very similar to that of the telecommuters. Their progress should be followed along with that of the telecommuters.

1. Program Effectiveness

Program effectiveness can be difficult to measure quantitatively. What should be assessed in evaluating the success or failure of a telecommuting situation is the change in performance. Does telecommuting affect expected performance? The supervisor and employee must assess performance changes to determine telecommuting's effectiveness.

Are there other benefits resulting from telecommuting? Some areas for agencies to look at include:

- Leave usage - has annual use of sick leave or overtime changed from pre-telecommuting years?
- Office space savings - has the demand for more office space been reduced?
- In-office resources - are computers or other equipment more available as a result of people telecommuting?
- Peak commute trips - has there been a reduction? (Coordinate with agency transportation coordinator and also document in the agency's Transportation Reduction Plan.)
- Reduced demand for parking - has reducing the number of employees in the office reduced the demand for parking spaces?
- Coordination - are telecommuters generally available when needed or do co-workers waste time because of lack of access to telecommuters?

2. Training Adequacy

In evaluating if the training given was adequate, look back at the training objectives. In training telecommuters, the main objectives were to learn how to establish good working relationships with the manager and how to set up a home office safely and effectively. Did the training program accomplish these goals? Was there a good working relationship with the manager? Was the home office environment as good or better for the telecommuter to work in? Were there any accidents or injuries in home offices?

One objective of training supervisors is to learn techniques of managing remote workers. Was the supervisor able to manage the telecommuter remotely, maintain good communication, monitor results and assist where needed? Have the worker/supervisor/peer relationships improved, worsened or remained the same?

One goal of joint training sessions for telecommuters and their supervisors is to begin the process of establishing specific job objectives, schedules and the details of working together in telecommuting. Were all necessary topics covered in that workshop so that everyone had clear expectations? Was the transition into telecommuting fairly smooth? If not, were things missing or unclear in training that should have been included or emphasized?

3. Terms of Standard Telecommuter Agreements

Telecommuter agreements exist to clarify expectations. Is the telecommuter agreement doing that? Did major problems or misunderstandings arise? Were these problem areas addressed in the agreement? If not, should they have been? Revision of the agreements may be desirable if the problems are significant enough.

4. Effectiveness of Work Schedules and Time Reporting

It is essential that both the employee and the supervisor keep in mind that while telecommuting is a management work option, it is also a two-sided voluntary arrangement. This perspective will reinforce the continuing adjustments to each situation that need to occur so that telecommuting remains a positive option to management. Periodic review of the telecommuter's work schedule is necessary. Priorities constantly change and assurance that the telecommuter's efforts are spent on the highest priority tasks needs to be confirmed.

5. Evaluation Reporting

Reports describing the nature of an agency's telecommuting program may be required periodically by the STAA. These reports will be used to monitor the extent to which telecommuting is used, the number of telecommuters, types of jobs, average number of days spent telecommuting, benefits and costs of the program.

APPENDIX C: COMMENTS BY SUPERVISORS

The following is a selection of comments by supervisors of telecommuters. We did not ask for written comments from telecommuters, since they tend to be misleadingly enthusiastic. Supervisors are expected to be, and generally are, more moderate in their assessments. The comments are grouped by category of pertinence. The effectiveness ratings in parentheses are the supervisors' evaluations. First the bad news:

Problems

"Although . . . did not telecommute due to [lack of] upper management approval, I feel he could have benefited from it." (2% less effective.)

"Very difficult to schedule necessary meetings with telecommuter. Electronic access is NOT an adequate replacement for face to face contact." (5% less effective.)

"Work has turned out to be time sensitive and she is unable to acquire enough work for a day of telecommuting. Otherwise her work is outstanding." (20% less effective.)

"I do not believe that this is a valid project for engineers." (This supervisor only supervises members of the control group.)

NOTE: In the following case the supervisor did not go through the screening process. JALA's recommendation was that the telecommuter telecommute only from a satellite office, if at all. The supervisor did not receive pre-telecommuting training, although the telecommuter did — more than one year before beginning telecommuting. All of the problems mentioned below are covered in great detail in the training sessions. Had the agency adhered to the project guidelines this situation probably would not have occurred.

"I think telecommuting has serious drawbacks:

- 1) The employee is not present when someone needs to personally interact with the employee. Instead the task just gets postponed. The next day someone else is telecommuting. Result: MISSED DEADLINES OR SLOPPY WORK.
- 2) I have been unable to see any specific output that I could attribute to the telecommuting day. On the other hand, I have not asked to see some either because the employee would feel that I don't have trust in him/her.
- 3) Telecommuting should be approved on a day-to-day basis by the supervisor — rather than every Thursday, etc." (No change in effectiveness.)

Next the good news:

Output Quality Changes

". . . however [telecommuter's] written output was greater this year because of the uninterrupted working time she gained by telecommuting." (25% more effective.)

". . . has definitely had more quality time to produce this year by telecommuting." (10% more effective.)

"Although the quantity of work hasn't increased quality has."

"Quality and accuracy are as important as productivity." (10-15% more effective.)

“I note an increase in effectiveness in terms of written work product. [The telecommuter's] output increased when she began telecommuting and this increase was especially evident when her workload was more diverse and she was responsible for drafting a number of different decisions. Overall productivity during the period she has been telecommuting is excellent. Also excellent weekly reports to me of her telecommute projects.” (5-10% more effective.)

“[Telecommuter] telecommutes 3 days a week and is very effective. . . [she] is able to accomplish many of our special projects off site and perform her normal tasks.” (25% more effective.)

“. . . an excellent employee who can be depended on to get the job done, on time and with outstanding results.” (20% more effective)

“When she did telecommute the result was very high quality given the dedicated time that telecommuting provided.” (40% more effective.)

Quality of Work Life and Employee Morale

“Telecommuting has proved to be beneficial in reducing job burnout. This was very important this year due to an unusual level of high stress situations.”

“By being able to telecommute, [the telecommuter's] work product and attitude has improved by at least the above listed percentage.” (30% more effective)

“Telecommuting is [a] definite boost in employee morale and enthusiasm.” (Several employees, 15% to 20% more effective.)

“This was a good experience and is a good program. The telecommuter's work increased without a decrease in quality. Also, his morale went from good to high. His interest in his job increased. I believe that he felt his employer was giving him something special, requiring trust and confidence.” (20% more effective.)

“I see telecommuting as a tool to be able to reward valued employees. There are so few ways to do that in the State government environment.”

“. . . duties fit very well with telecommuting and she has demonstrated a new enthusiasm towards work.” (20% more effective.)

“I feel that I get more work out of [the telecommuter] under this program because he will do the work at his own pace but also making sure it gets done, no matter what the time or the day. He works his schedule well.” (No change.)

Coping with Disabilities

“Because of telecommuting he was able to accomplish much work at home, including periods during which he was suffering from his disability and would otherwise have been totally on sick leave.” (25% more effective.)

“During and subsequent to [telecommuter's] pregnancy she telecommuted. Thus we were not shorthanded, which prevents an additional workload on an already overburdened staff.”

“Telecommuting was especially helpful to [a handicapped telecommuter] in terms of work productivity because of his physical disabilities and how hard it is on him (and his energy level) to get to work.” (20% more effective.)

“While I have indicated no major change in job performance effectiveness, if [the telecommuter] had not telecommuted she would have been on a leave of absence. . . [T]he bureau would have felt an impact in job performance from me and from a replacement for [her].”

“Decline in use of sick leave.” (5% more effective.)

Management Impacts

“The telecommute project helped this unit perform a task that was impossible without telecommuting. [This telecommuter] was able to completely produce and present a training course in I wish to express my thanks to you for the support and assistance given [telecommuter and his unit] during his involvement with the project. The experience gained has helped from a management perspective, watching the increased level of independence of action that [the telecommuter] has attained during this project. Employee growth and development has been an important ‘side benefit’ of the telecommuting project.” (60% more effective.)

“The freedom and independence afforded by the program was sufficient incentive for my employees to assure its success. Although work goals and objectives are difficult to establish in appraisals, I believe the appraisees worked harder and placed pressure on themselves to achieve our goals because of their satisfaction with the program. I am personally pleased with the program and its results and although I was recently transferred, propose to continue the program.” (25% more effective.)

“Employee was promoted while telecommuting.” (20% more effective.) [As it turned out, the promotion meant that the employee would move out of the program. The employee decided to accept the promotion after much hesitation, even though the new job had been a long term goal of this employee.]

“I appreciate [the telecommuter’s] willingness to be present at the office even when it conflicts with his telecommuting schedule.”

“Note that flextime was introduced concurrently with telecommuting giving rise to [a] wide range of experience and difficulty in recognizing telecommuting as compared to flextimers. In general I am favorably disposed to telecommuting.”

“Telecommuting has fostered greater independence in this individual’s staff.” (40% more effective.)

“I believe telecommuting has played a significant role in this individual’s confidence and independence as well as supervisory skills.” (35% more effective.)

“Excellent program — I hope it continues after the pilot and change of administration.” (35% more effective)

“This has been a very positive experience to focus on the desired product rather than whether the employee is present. Only negative thing is to remember [when the telecommuter] is available, also to notify him of changes.”

“. . . has been an essential employee; without telecommuting capabilities his input would have been lost, very important.” (10 % more effective.)

General

“Telecommuting is working out excellently for our unit. If possible, we should look to expansion to additional staff as well as supervisors and managers.” (20% more effective.)

“Uses the telecommute time to complete project work from on-site reviews. . . . purchased a compatible computer system and prepares correspondence at home. . . . was a control for one year.” (10% more effective.)

“. . . was a control and recently started telecommuting regularly. Some of the tasks . . . require total peace and quiet . . . not possible here. [Telecommuter] is able to accomplish `back burner` tasks and improve on meeting objectives.”

“. . . telecommutes regularly. She does a lot of budget type work, cost projections analysis and the environment of working at home is a plus. . . . an excellent employee and has great self starter skills.” (20% more effective.)

“He was able to handle a significant amount of work when he was telecommuting.” (50% more effective.)

“A great program.”

“The only negative aspect of this telecommuting program has been filling out these questionnaires. Otherwise, I’ve found that it’s been quite successful.” (No change.)

“Telecommuting works - continue the program.” (15% more effective.)

“He has found it to be a productive way to perform his responsibilities.” (30% more effective.)

“The `home office` is a very quiet place to accomplish work with a minimum of distractions.” (20% more effective.)

“Excellent program! I hope the State will continue to influence managers to promote telecommuting.” (30% more effective)

“Besides increase in productivity [telecommuting] provides him more flexibility in managing his time and reduces commuting 1 day a week.” (15% more effective.)

“This has been a productive experiment.” (25% more effective.)

APPENDIX D: TELECOMMUTING — A PERSONAL VIEW

by
Al Jacobus

Al Jacobus is a Telecommunications Engineer working for the State of California, Department of General Services, Telecommunications Division. He has been in the State's telecommuting pilot program since its beginning and has been instrumental in making it a success. He telecommutes four days a week from his home office, uses his own computer, and makes maximum use of the telecommunications technology available to him. He sees telecommuting as one of the most effective ways of reducing freeway traffic and the ensuing air pollution. He also recognizes the human problems that result when a paradigm shift of this nature is made.

He organized the Telecommuting Forum in the department, which meets quarterly to discuss successes and find solutions to problems people are having with telecommuting. The Forum participants include prospective telecommuters, existing telecommuters, supervisors, and management. It has been a useful platform to air concerns and reduce the likelihood that misunderstandings will escalate into obstacles.

My alarm goes off at 5 o'clock each morning. Most of the time I'm one of those people who can't wait to start a new day. This was a most-of-the-time day. I pulled the bed covers aside, slid out onto the floor, turned off the clock radio, and I was up. I grabbed a pair of exercise shorts, went into the living room, and snapped on the VCR. "Morning Stretch" is an exercise program that is broadcast at four-thirty in the morning; just a little too early for me, so I use the VCR to shift it in time. Stretching, warm-up, low impact aerobics, and cool down all helped the morning coalesce into a great day.

This was not an egg day, so I had some cereal, discussed the day with my wife, sent our daughter off to school, and began to plan my business day.

Oh, by the way, I work for the State of California. I'm a Telecommunications Engineer with the Telecommunications Division of General Services. We do all of the communications for most of the State Agencies. It's a big job. My client agency is Caltrans, the California Department of Transportation.

The State has a telecommuting program and I'm a part of it. I get to work at my home, and I love it.

I had to check on a job in Ukiah and make sure the technicians had all the parts they needed. The schedule for the big job in District Eight needed to be finished. I wanted to open my E-Mail, check my voice mail, and give the boss a call at the main office to get the late-breaking news about bureaucracies and politics.

I took a shower and put on a pair of slacks and a wool sweater. If I were going to the main office today I might have worn a tie, but not at home. Just enough dressing-up to convince myself that this was a work day. I took the ten second commute to my home office—a converted bedroom of our three bedroom home. This engineer was going to work in style today!

I clicked on the computer and the hard drive began its whine as it reached for 3600 rpm, ready to belch data at the stoke of a key. The screen lit up and presented me with a menu. I pressed the key for "COMMUNICATIONS" and then the one that said, "CONNECT TO THE MAIN OFFICE". I like to call it the MO. The main office has a local area network. I like MO Grid, the MOG, or sometimes simply, "the grid". It gives the illusion of something other-worldly; like a phrase from a science fiction story.

The modem that is connected to my computer dialed the MOG, the MOG called me back, and I was on, "the grid". I got a feeling of power. I could now access the local area network at the MO. My day was getting better with each keystroke. I checked my E-Mail. Someone was reminding me about a change in health benefits. It didn't apply to me so I deleted it. Never let those maybe-I-will-need-it-some-day files accumulate. They're like rust that builds up in water pipes. One day it closes off the flow and the water stops.

Another piece of E-Mail announced a meeting at which a vendor was giving a presentation on a new antenna I wanted to learn about. I'll have to see if Marty is going. He always takes good notes and can get a copy of the literature. I sent him an E-Mail note to that effect and asked him to call me after the meeting. That was all the mail for today, so I originated a note to the computer section guru asking about an upgrade to my spreadsheet and exited the E-Mail system.

I called my boss on the telephone and he inquired about the status of a job at Telegraph Hill. I turned to my computer, which was still on the grid, and attached a copy of the project management file for that site to an E-Mail message.

"OK, Dick check your E-Mail for the TELEHILL.T#0 file. It will give you the info you need," I said.

"Thanks, Al. Let me see how you're progressing on the schedule for the District Eight job. I'd like to see the partial schedule by tomorrow morning." Dick likes to know about my progress. He should, it's part of his job to know what his people are doing.

"No problem. Check your E-Mail after eight tomorrow."

"We need to talk to Motorola today about the new controller for Santiago."

"I'll set up a conference call for one-thirty this afternoon, if that's a good time for you."

"Sounds OK to me. I'll be sitting on the phone."

"Maybe you should just sit next to the phone."

"OK. OK, I'll sit next to the phone."

"There goes my call-waiting tone, Dick. Hang on just a sec."

I put my boss on hold and answered the other call. It was Ukiah. They needed some more wire. I agreed to send it today.

"OK, I'm back," I said, "Ukiah wants some more wire."

"Better get to it. Talk to you later," Dick hung up.

I signed off, "Later." I went to the computer, checked stock on the wire, made out an electronic parts request, and marked it for delivery to Ukiah. I indicated that it was urgent and should be shipped today. That was easy.

Since I was already at the computer, I pulled-up Time Line and started to work on the District Eight schedule. Project management schedules take time to set up, but they sure can help you stay on track.

After a couple of hours working with project management schedules, I decided to take a walk around the yard to stretch my legs and clear my head. I grabbed the cordless phone, switched it to the Centrex line, clipped it to my belt, and went outside. Oh, yeah, I have a State Centrex line at my home office. That's how I can stay on line with the computer and use the other line to talk to my boss. No magic. Just technology.

As I walked around, I thought about how great it is to be able to work in an environment that is of my own making. It's quiet, I can set the temperature where I want, there are fewer interruptions, fewer phone calls, and I can be alone for a few minutes to relieve stress and renew myself when necessary.

I was thinking about when I started telecommuting. I started out two days a week. At first the problems were making sure I had all of the materials I needed at the home office to do the job. I had to duplicate some materials, order additional vendor catalogs, and rediscover all of those things that I took for granted at the MO that were not at my home office. I never realized how much I used the copy machine until one was not available. Telecommuting helps you become more organized and gets you thinking a few more days out into the future. If you don't get organized, you can't do the work. Bottom line.

Then there was the culture shock when I started telecommuting four days a week. Two days a week was nothing. I did that standing on my head. The biggest problem telecommuting two days a week was all that stuff I had to carry back and forth. But, at four days a week, I lost contact with the society of the main work place.

Now, I've always been a self-starter. Nobody has had to come around and tell me what to do next. So, to some extent, I guess I was used to doing things on my own. That really didn't prepare me for the isolation that results when you telecommute eighty-percent of the time¹.

People are reluctant to call me when I'm working at home. Somehow it must seem to them that my privacy is being invaded. Of course, nobody comes around to my desk to chit-chat, and I don't hear, or overhear, all of that incessant chatter that goes on around the main office. I dropped out of the grapevine.

I gave up my desk, my computer, everything but a part-time cubicle for telecommuters at the MO. There was a personal sense of loss. I knew some readjustment was necessary. I bought some new furniture for my home office, moved things around, made everything as efficient as possible. It felt good. It was mine. My sanctuary. It was easier to work, and nobody was reminding me about how awful things were in the bureaucracy. Balance at last.

I began to find out more about myself; more about the people I worked with. My communication with them narrowed its bandwidth and its duration. The conversations became more efficient, shorter. Only occasionally did I get to talk about all of that juicy rumor stuff that goes on at the MO. I get it all at once, not in linear-time sequence. It feels good to plug into the grapevine now and then. But it's not like being there.

I sensed when people must have felt resentment about me working at home. Their voice shifted. I would hear things like, "Oh, you're working at home.", and "Gee, it must be nice." I didn't respond except to gently correct any mistaken thought that this was play and not work. I'm becoming more understanding.

I have become more aware of my work habits such as how I react when I come to a stumbling block. When I was at the MO five days a week it was easy to discuss a problem with a co-worker. Perhaps it was too easy. I tended not to figure it out for myself. While at the home office, I could have picked up the telephone and called someone, but I tended not to do that. Now I use some of those creativity techniques I learned in the classes I have attended over the years. I put the problem away and work on another project for awhile. Usually, the answer comes in a while. Maybe it's

¹JALA ordinarily recommends against telecommuting 4 or more days per week, largely for the reasons illuminated here. Note that Mr. Jacobus does not feel that the loss of informal contact is sufficiently intense to prompt him to return to his original two days per week telecommuting. - JMN

because of the quiet. I really prefer quiet to work. Whatever the reason, working through problems is easier. And there's always the telephone if I really get stuck.

Then I found I had to work with guilt. At first, I felt a little guilty because I was telecommuting and others who wanted to could not. I resolved that one. It was out of my control and I couldn't do much about it. All I could do was try my best to give telecommuting a good name, support the concept, and plant seeds of success where I could.

There was another problem. It dealt with those times when, for no apparent reason, I just didn't feel like doing anything. You know those times. You find an excuse to go talk to someone, or take an extended lunch, or find something to do that's equally nonproductive. You get through it. But, when you're working "at home", it's another story. Then the quandary comes. You can't even make believe you're being productive. And no one is watching you. No one is checking up on you. You're on your own with your conscience. Let me pass a little secret on to you. If you start anything, chances are you will get back on task. I love computers, so I tend to start one of those programming jobs classified under "I'll get to it when I have a few free hours". Usually that does it. Once the creative juices get flowing I can ease myself back to the day's real work. There are those times, however, when nothing seems to work. It helps knowing I'm not alone experiencing this but, most importantly, I don't let guilt build.

Sometimes I don't feel as though I have done all I could have done that day. At the MO, if I didn't perform up to my expectations-or my boss's-I might not feel successful that day, but I wouldn't let it get to me. At home there's only me and my expectations; and they are more demanding than my boss's or mine at the MO.

The result is I have become more efficient and the state is getting more for its buck. My only problem now is how to explain all of this subjective stuff to my boss and others who are watching the telecommuting program?

Here I am in a position where it's really difficult to measure productivity. We don't make widgets that can be counted; our project time lines tend to be in months or years; all manner of things can happen in the field that destroy the best laid plans; and our client agency's priorities keep changing. At least when the frustrations start to accumulate, I can look out the window and be thankful I'm at home and nobody can hear the screams.

The cordless phone on my belt started to ring and brought me back to earth and my backyard.

"Telecommunications, Al Jacobus," I said into the mouthpiece.

"Hi, Al this is Dick. Caltrans just called and they have a legitimate emergency in Stockton. I need you to get another base station installed down there by the end of the week. Can you handle it?" Dick asked.

Did you think I would say no, I can't handle it because I'm working at home? No way!

I replied, "Sure, I can handle it. But I'll need a little help."

"You name it."

"Please have John FAX the drawings I'll need to Franchise Tax Board. I'll run over there and pick them up. You remember that arrangement we made with them? Here's where it pays off," I said.

"Just let John know what you need," Dick said.

"Thanks," I said, "I'll get on it right away. Send me the job authorization on E-Mail and any notes you have." "Good as done. Thanks," that was Dick. He was pleased. So was I.