Work Schedule Changes

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■ Introduction

The typical 8-hour work day, 5-day week contributes to peak period congestion on the transportation network corresponding to the beginning and the end of each work day. In order to shift commuters out of these peak periods, a variety of work schedule changes have been developed and applied throughout many areas in the U.S. Work schedule changes may affect either the location at which work is performed or the times when an individual must be at work. These strategies have a positive impact on peak period congestion by moving work trips out of the peak period and can reduce the duration or even eliminate an entire trip. In turn, air quality benefits are realized as speeds on congested routes are increased and the number of trips are reduced.

In this information document, the potential transportation and air quality impacts, costs and other impacts, and implementation requirements for telecommuting, flextime, and compressed work weeks are summarized. Work schedule changes are traditionally the province of personnel officers and human relations departments. It is essential to bring these professionals into the discussion when considering changes to existing work schedules. In addition, state laws often govern a variety of issues related to work hour schedules, and must be understood and addressed prior to program implementation. A bibliography of key resources for work schedule changes is also provided. This is not meant to be a comprehensive listing of references, rather, it is a select group of documents that could be helpful in implementing a work schedule change program.

■ Definition of Measures

One type of work schedule change that affects the location of where work is performed is **telecommuting**. Individuals who telecommute perform their work duties for part or all of the week at home or at a work center near the home. Through telecommuting, the work trip is eliminated or drastically reduced in length, leading to both congestion and air quality benefits. Two recent telecommuting pilot projects, one for the Southern California Association of Governments and one for the State of California, have indicated that telecommuting reduces the number and length of automobile trips taken, even after factoring in the effects of changes in the mode of travel and number of non-work trips. This, then, leads to reduced automobile emissions and improved air quality.

Work schedule changes that affect the times when an individual works are referred to as **variable work hour** programs. There are a variety of variable work hour programs that

have been developed, including flextime, compressed work weeks, and staggered work hours.

Flextime allows the employee to set his/her own start time, within given guidelines, while typically continuing to work an 8-hour work day. This flexible schedule allows the employee to commute outside of the peak periods and to more effectively coordinate home and work demands. San Francisco implemented a flextime demonstration project and examined the impact of flextime on the commute. If a sufficient percentage of commuters are on a flextime schedule, then congestion in the peak period would decrease, speeds would increase, and air quality would be improved.

Employees work more hours per day and fewer days per week under a **compressed work week** schedule. Unlike flextime, however, the employer sets the start times. Fewer work trips are made per week with a compressed work week schedule, and at least one end of the trip is made outside of the peak period. The reduced number of trips has a direct impact on emissions, due to reduced vehicle miles traveled and reduced cold starts. Similar to flextime, moving some of the trips outside the peak period could reduce congestion and increase speeds. Denver participated in a compressed work week experiment that indicated positive impacts on the transportation system.

An 8-hour work day and 5-day work week is the basis of **staggered work hours.** The employer, however, staggers the start times so that groups of employees arrive at work at different times. Staggered work hour programs result in a lessening of peak period congestion levels, and therefore can reduce vehicle emissions by increasing vehicle travel speeds and reducing the number of start/stop cycles. The overall number of vehicle trips, however, is not changed with staggered work hours, although the rigidity of such programs may make ridesharing arrangements and transit utilization more difficult than under a flexible hours arrangement.

■ Telecommuting

Telecommuting is working at a location other than one's usual office, and therefore avoiding the trip to the office, while performing the same duties as would otherwise be performed in the central office. The telecommuting location could be at home, at a satellite work center, or at a neighborhood work center. A satellite work center is used by the employees of only one company while a neighborhood work center is used by the employees of more than one company. Ideally, a neighborhood work center would be within convenient walking or bicycling distance of a large number of potential residents, and provide parking facilities for visitors and those unable to walk or bike. Individuals who telecommute may do so full-time, or may only telecommute a few days a week or even a few hours a day.

Telecommuting is made possible by the presence of technology as simple as a telephone or by more sophisticated telecommunications equipment that allows the employee

direct access to the central office. Telecommuting also can be facilitated through the use of mixed use developments that would aid in the development of neighborhood work centers. Computer programming is a good example of a task that easily can be performed while telecommuting. However, non-computer-related work that does not require frequent face-to-face interaction also can be performed by an employee who telecommutes. This may include tasks such as writing, reviewing and editing reports, making phone calls to clients, and preparing presentations. The telecommuter may schedule specific days that they will be in the office so that tasks that must be performed in person, such as staff meetings, can be accommodated. This is especially important so that a telecommuter is perceived as participating in important office requirements.

A number of occupations have utilized the concept of working outside the conventional office even before telecommuting was formalized as an alternative transportation measure. These include sales, consulting, accounting/auditing, journalism, academia, creative professions, and home-based businesses. A variety of criteria have been used by employers to select employees for telecommuting including type of work to be done, availability of work space within the home, and consideration of in-home distractions.

Examples

In the last few years, as traffic congestion and air pollution problems worsen, telecommuting increasingly has been viewed as a potentially viable option and has been examined in a number of localities throughout the United States. Some examples of telecommuting experiments are summarized below.

Puget Sound Telecommuting Demonstration: The Washington State Energy Office has developed a telecommuting project, with between 200 to 300 employees expected to be involved from ten to fifteen public, private, and non-profit organizations around Puget Sound. In addition to encouraging telecommuting from the home, there are plans to develop telework centers for state employees and one for the private sector. An evaluation of the project is being performed that is examining how telecommuting affects job performance, job satisfaction, personal stress, family relationships, and travel behavior.

Hawaii Telework Center Demonstration Project: This was a one year demonstration project that is a public/private joint venture and involves seventeen employees from the Mililani area, eight of the employees work for the State of Hawaii and seven work in the private sector. The employees telecommute from a telework center that opened on July 14, 1989. A formal project evaluation has been performed and examined work productivity, employee satisfaction, job relationships, and commuting travel assessment. The evaluation included input from supervisors and managers of telecommuters. Average weekly work round trips were reduced from 5.14 to 1.25, a decease of 76 percent. Weekly transportation costs for commuting were reduced by 59 percent, and weekly fuel consumption decreased 29 percent.

South Coast Air Quality Management District (SCAQMD): The SCAQMD has had a program in place for two years where 30 employees telecommute at least one day per week.

Los Angeles County: The County has a very successful program which currently has over 1,700 participants from its 123 worksites throughout the County. Most participants telecommute 1 to 2 days per week.

Federal Flexible Workplace Project: The U.S. government is overseeing this one year pilot project and is expecting several thousand civilian employees to participate nationwide.

Of the telecommuting pilot projects that have evaluated the transportation impacts of telecommuting as well as its feasibility from an organizational point of view, two are summarized in more detail in the following subsections:

SCAG Telecommuting Pilot Project

The Southern California Association of Governments (SCAG) implemented a telecommuting pilot project in 1986 among its 128 employees. The primary objectives of the SCAG pilot project were:

1. To obtain firsthand experience with the benefits, disadvantages, and other issues associated with telecommuting.

2. To evaluate the potential for widespread adoption of telecommuting.

3. To assess the potential impacts of telecommuting on Central City and regional transportation and land use.

After a screening process to determine which employees were eligible and an orientation regarding how the telecommuting process would work, eighteen employees from a broad spectrum of occupations participated in the six-month pilot, beginning in June 1986. The cooperation of the telecommuting employee's supervisor was a prerequisite to being one of the participants. It was not required that the employee use a computer while telecommuting. Most of the staff did not use a computer on a daily basis at the time of the pilot program.

The costs of telecommuting were shared by SCAG and the employees. Sixty percent of the cost of all SCAG-related phone calls were reimbursed and partial reimbursement for selected other expenses was also authorized. In addition, SCAG paid for any software required to enable a home computer to emulate SCAG's DEC VT100 terminals.

The employees, with the agreement of their supervisors, were allowed to choose the frequency of their telecommuting, which ranged from three days per week to once every two weeks. It was rarely chosen to telecommute for only part of the day by the participants in this pilot program. Seventeen of the employees telecommuted from home and one telecommuted from a workspace in a City Hall near the employee's home.

The sources of information for the findings of this evaluation were:

- Surveys of the potential telecommuters and their managers used to select the participants;
- Before and after background and attitude surveys of all SCAG employees;
- Monthly logs completed by the telecommuters that included information on costs incurred, additional energy consumption due to telecommuting, and travel changes due to telecommuting;
- Timesheets and receptions log for the telecommuters;
- Telephone interviews of the telecommuters and their managers;
- Round-table discussion with the telecommuters and their managers;
- Personal conversations held with the project coordinator; and
- External data such as amount of sick leave taken and tardiness.

California Telecommuting Pilot Project

The California Telecommuting Pilot Project was first planned in 1985 and the implementation phase lasted for two years, including training of the telecommuters. Fourteen State agencies participated with a total of about 200 telecommuters, mostly located in Sacramento. Originally, the pilot program was to include home-based and satellite office telecommuting. However, due to budget constraints, satellite offices were not set up and all of the telecommuters were home-based workers.

The primary objectives of this pilot program were:

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.

9. To develop and test ways of equitably sharing office space and reducing total space requirements.

The selection of the participants occurred in three stages. First, familiarization briefings were given to prospective telecommuters and their managers. Second, background questionnaires were distributed to the potential telecommuters and their managers. Based on these questionnaires, the third stage, selection of the participants and the control group was performed. The selection was made by the managers.

Almost all of the participants only telecommute part-time. In December 1989, the average number of days spent telecommuting per week was 1.5 full days and 0.2 partial days. Approximately half of the telecommuters used their personal computers when they worked at home.

The participants were asked to complete annual questionnaires in order to assist in the evaluation of the pilot program. In addition, each participant and their driving age household members were asked to complete three-day travel logs of their automobile use prior to telecommuting and one year after telecommuting began.

Transportation and Air Quality Impacts

The transportation impacts of telecommuting depend upon the characteristics of the telecommute as well as the characteristics of the individual's work commute prior to telecommuting. For those who telecommute from home for an entire day, the work trip in each direction is eliminated. If one only telecommutes for a portion of the day, then the work trip may be shifted out of the peak period. For those who telecommute from a satellite or neighborhood work center, a work trip is still made, however, it is presumably of a shorter distance, does not take place along the more congested routes, and may occur outside the peak periods. In addition, if the new commute is reasonably short, the trip may be made by walking, bicycling, or transit rather than using a car at all, thereby not incurring cold start emissions. Over a period of time, families with one or more members who regularly telecommute may reduce the number of vehicles owned.

It is important to examine not only the number and length of trips that are reduced, but also the change in travel mode that occurs as a result of telecommuting. If the telecommuter previously drove alone, then telecommuting at a minimum reduces the length of the drive alone commute during the peak period, and may induce a mode shift or eliminate the trip entirely. If the telecommuter previously used transit as their commute mode, then the transit agency loses ridership without being able to reduce the number of buses, unless the overall effects of telecommuting are great enough that peak period bus service can be reduced. It is assumed that an individual who previously used transit to commute to work will not switch to a driving mode as a result of telecommuting to a satellite or neighborhood work center. If the telecommuter was in a two-person carpool, then the other carpooler would be driving alone unless they can form a new carpool, however, the number of vehicles would remain unchanged. If the telecommuter was in a three or more person carpool, where their absence caused the carpool to have less than the minimum required number of occupants to use facilities such as carpool-only lanes, than the carpool may dissolve and the number of vehicles on the road would increase. This impact could be offset by the formation of new carpools.

There is a concern that travel could not be reduced to its full potential or be increased due to telecommuting due to a number of factors:

- Time spent commuting is now available for other trips;
- Car normally used for the commute is available for other household members;
- Trips previously chained with the work trip still need to be made;
- Telecommuter may take trips to break up the day; and
- Telecommuter may move farther from the office, resulting in an overall increase in trip lengths.

The transportation impacts of telecommuting as a result of fewer and/or shorter work trips, shifts from the original transportation mode, and induced non-work-related travel were examined in the SCAG and State of California case studies. The results are summarized below.

SCAG Telecommuting Pilot Project

Ten percent of SCAG staff eliminated fifteen percent of their work trips, which averaged out to 26 miles and 1.3 gallons of gasoline saved per telecommuter per day. These values took into account the number of telecommuters that previously used transit or carpooled, and the induced travel that occurred. Of the travel generated on telecommute occasions, only five percent was created as a result of telecommuting, and eighty-two percent would have occurred with or without telecommuting, but at a different time. The remainder were not affected by the presence of telecommuting. Using worst case assumptions about the induced travel, the induced travel due to telecommuting was only fourteen percent of the total system miles saved.

A related evaluation has been conducted of 1,700 Los Angeles County employees that telecommute at least one day a week. Based on an analysis of trip logs, 35 percent of the telecommuters reported no trips during the first three to four months for the day worked at home. This increased to 45 percent during the sixth and seventh months, and to 51 percent in the ninth and tenth months. Average trip length of telecommuters decreased from 14 to 9 miles.

California Telecommuting Pilot Project

A detailed analysis of the daily travel diaries of the telecommuters and their family members as well as a control group and their family members has been performed by Professor Ryuichi Kitamura of the University of California, Davis under a grant from the Department of Transportation. Overall, the findings were that telecommuters reduce their work trips, telecommuting does not induce new non-work trips, and that family members may also reduce non-work trips. The average number of days per week that the participants telecommuted was 1.4, which resulted in a reduction in the home-to-work trip rate of thirty percent. There was no change in the home-to-work trip rate for the control group. The number of trips that occurred during the morning peak period decreased by thirty-one percent for the telecommuters and by four percent for the control group. Both the telecommuters and the control group reduced their non-work trips by fifteen percent. Non-work trips by family members decreased by thirty-five percent for the telecommuters and ten percent for the control group, creating a net decrease of twenty-five percent. The reduction in non-work trips by family members may be due to the increased ability to organize trips, however, the study was the least confident in the data that supported this finding. Emissions for organic compounds, carbon monoxide and NO_x were each reduced by approximately one-third for telecommuters.

Subsequent analyses were conducted using the data from the California Telecommuting Pilot Project to explore the possibility of a long term impact of telecommuting resulting from its ability to decrease constraints on household location, thereby enhancing the rate of spread of suburbia. Evidence from the California Telecommuting Project supports the contention that telecommuting does not, as yet, exacerbate urban sprawl and that telecommuting does produce net reductions in household travel in proportion to the intensity of telecommuting.

Only very limited assessments of the emission or air quality impacts of telecommuting have been conducted. Telecommuting, however, would be expected to have a positive impact on air quality for a number of reasons. The number of trips and VMT are reduced during the peak period. This would lead to emissions benefits during the peak period due to the reduced number of cold starts and hot soaks as a result of the reduced number of trips. There also would be a reduction in emissions directly due to the reduced VMT in the peak period, with a possible additional reduction due to increased speeds at certain locations. The results from the examples also indicate that the trips that occur in the peak period do not simply shift to off-peak times, they are reduced in number over the entire day. Therefore, there is an improvement in air quality overall, not just during the peak periods.

Costs and Other Important Impacts

The potential costs of implementing a telecommuting program include the cost of providing computer terminals and telecommunications capabilities, setting up a satellite or neighborhood work center, and training telecommuters and their supervisors. There are also daily expenses such as telephone usage and work-related travel. These costs may be incurred by either the employer or the employee, depending upon the particular program developed.

SCAG incurred very low costs in the implementation of its pilot program. No computer or telecommunications equipment was purchased for telecommuting employees. SCAG only reimbursed sixty percent of work-related telephone expenses, which discouraged heavy telephone users from participating in the pilot and kept to a minimum the number of telephone calls made by the telecommuters. On average, SCAG only paid $0.19 in direct costs per telecommute occasion. There were indirect costs to SCAG as a result of staff time spent on training and orientation, and on completing the evaluation surveys. These costs were not quantified. Costs to the telecommuter were also very low, only $1.00 per telecommute occasion, compared to their estimated travel and food savings of $6.42.

The State of California performed a much more detailed benefit-cost analysis of its pilot program. Listed below are the cost and benefit categories identified by the State as being relevant to home-based telecommuting. There would be additional costs if a satellite work center was established.

Costs

- Additional Training
- Telecommunications
- Computers
- Computer Maintenance
- Moving Costs (i.e., moving furniture from office to home)
- Furniture Purchase/Lease
- Insurance
- Rental Costs
- Administration
- Additional Travel
- Building Energy Consumption (by the employee)
- Increased Local Traffic Congestion (at the satellite work center)
- Diversion From Ridesharing

Benefits

- Increased Employee Effectiveness
- Decreased Sick Leave
- Decreased Medical Costs
- Increased Organization Effectiveness
- Decreased Turnover
- Decreased Move Rates
- Reduced Parking Requirements
- Office Space Savings
- Decreased Energy Consumption (by the employer)

It should be noted that benefits associated with reduced traffic congestion and improved air quality were not quantified and included in this benefit-cost analysis, and therefore, the overall benefits are understated. The results of the benefit-cost analysis are provided below by program year.

	1987	1988	1989	1990	1991	1992
Total Annual Costs ($000)	$93	$265	$141	$116	$59	$59
Total Annual Benefits($000)	$0	$231	$1,128	$1,190	$1,254	$1,327
Cumulative Costs($000)	$135	$399	$540	$656	$715	$775
Cumulative Benefits($000)	$0	$231	$1,359	$2,549	$3,803	$5,129
Annual Benefit/Cost	0.00	0.87	8.00	10.27	21.10	22.32
Cumulative Benefit/Cost	0.00	0.58	2.52	3.89	5.32	6.62

A summary of the potential benefits and disadvantages of implementing a telecommuting program to the employer and employee are summarized below:

Potential benefits to the employer

- Increased productivity
- Decreased turnover (higher morale)
- Decreased absenteeism and sick time
- Decreased tardiness
- A competitive hiring advantage
- Decreased overhead (less office space needed)

Potential benefits to the employee

- Better concentration on the job
- Increased flexibility and autonomy
- Reduce travel expenses and commute time
- Decreased stress (due to traffic)
- Increased job and residential location opportunities
- Family/work schedules can be better coordinated

Potential disadvantages to the employer

- Potential change in management style
- Decreased productivity due to lack of direct supervision if employee selection is not done properly
- Liability of personnel and computer equipment
- File and access security

Potential disadvantages to the employee

- Professional isolation
- Possible distractions at the remote worksite
- Lack of clerical support services
- Increased home utility and phone costs

Implementation Requirements

Some of the potential benefits and disadvantages listed above appear to be in conflict, such as whether telecommuting increases or decreases worker productivity. The way in which the telecommuting project is implemented determines the extent to which the potential benefits are realized. One of the first steps that should be taken is the development of an implementation plan. This plan should outline the goals of the project, all of the steps to be taken, who will be involved in each step, and what method of evaluation will be used to determine whether or not the stated goals have been reached. Also, a legally binding telecommuter's agreement should be written that outlines the responsibility of the employee, their immediate supervisor, and the participating company. In particular, any procedural issues that are affected as a result of telecommuting, such as filling out timesheets or the coverage of Worker's Compensation, should be detailed and the reimbursement levels for equipment, phone use, or other telecommuting-related expenses should be specified.

The types of companies and employees that should be targeted need to be identified. It is important that any company participating have a stable company environment, and that the program has the support of all levels of management, in particular, the support of senior management. In terms of types of employees, those that work primarily with information, such as computer programmers, clerical workers, or sales personnel, are prime candidates. In addition, specific requirements of the job and work-social considerations should be taken into account.

Once a target group of employees has been identified, they and their supervisors should be invited to attend an informational seminar on telecommuting. Both the telecommuters and their supervisors should be volunteers to make the program successful. If it is felt that telecommuting is being forced upon an individual, then their performance may suffer. At the informational seminar, the telecommuting program can be described, as well as what will be expected from those participating in it. It is important at this seminar to stress the benefits to both the employee and the supervisor of telecommuting.

Once the participating telecommuters have been identified, a training session should be held with both the telecommuters and their immediate supervisors. Especially important issues at this point will be how to keep track of productivity and what is the basis for employee-supervisor interaction.

Once the program has been implemented, there should be a continuing evaluation of the program so that any problems or complications that do arise can be addressed quickly.

■ FLEXTIME

Flextime refers to a wide range of flexible scheduling procedures that allows the employees to set their own start times. The specific way in which flextime is implemented is subject to company policy. The employees may or may not be allowed to vary their start times from day to day, the length of the lunch period may or may not be allowed to vary, and the number of hours worked may be set by day or by week. Flextime allows the employee to coordinate their work, commute, and home activities and thus minimize any conflicts. In addition to a number of personnel-related benefits, from a transportation and air quality point of view, flextime allows employees to avoid the peak commute periods and to better coordinate with transit schedules and rideshare arrangements. Employers should be careful, however, when establishing a flextime program to ensure that the program is not counter-productive to facilitating rideshare arrangements.

In order to accommodate staff meetings and times when one can expect an employee to be available, core times in the midday are usually set when all employees are expected to be at work. Their schedules then "flex" around these core times. Flextime has been the most successful in those areas dominated by office-related employment that can accommodate this level of flexibility. For manufacturing or production oriented sectors, flextime is not a feasible option because the employees need to be at work at the same time for the processes to run efficiently. In these cases, compressed work weeks or staggered work hours would be more appropriate.

Examples

The first documented flexible work hours program was in 1967 at the Messerschmidt Headquarters in Ottobrunn, West Germany. Since then, a number of individual companies have allowed their employees some flexibility in their work hours, however, there are far fewer projects that have been documented and evaluated. A few of these projects are summarized below.

Seattle Central Business District: An evaluation of eight companies in downtown Seattle that offered flexible work hours was performed in 1980. Over six hundred employees responded to a survey questionnaire. It was found that with flextime, most employees chose to arrive at work earlier than they previously had. In addition, more employees chose to carpool and use transit.

Tennessee Valley Authority (TVA): A flextime program was offered to employees with the TVA in Knoxville, where an extensive employer-based ridesharing program involving ninety-two vanpools and twenty-seven express buses was already in place. All employees were required to be at work during a core time, and to work an eight hour day with a forty-five minute lunch break. Each employee was also required to announce their schedule on a biweekly basis. Overall, transit and ridesharing use declined because of the very strict schedules that had to be met.

The **San Francisco Flex-Time Demonstration Project** was implemented in 1979 to determine whether employers would be willing to participate in a city-wide flextime project and whether sufficient participation would occur to affect the performance of the transportation system. The demonstration project was sponsored by the California Department of Transportation (Caltrans) and was a cooperative effort of public agencies and private employers.

In San Francisco, travel to the CBD was heavily concentrated between 7:30 A.M. and 8:00 A.M. and this led to crowded conditions on the roadways and on the public transportation system. With this type of commute scheduling, flextime should be very effective. In addition, the businesses in the San Francisco CBD are predominantly banks, insurance companies, and corporate headquarters that perform primarily office functions, which are the prime candidates for a flextime program. As a part of the demonstration project, advice was provided to the employers about how to design and implement flexible scheduling procedures.

Approximately 6,000 employees participated in the demonstration program, or 2.3 percent of the workforce in downtown San Francisco. Most of the employees chose to arrive at work earlier than had been the previous norm. They were able to avoid the peak congestion or meet the transit schedules more conveniently and therefore realize a significant savings in travel time. On average, transit users saved six minutes per trip and commuters traveling by car saved nine minutes per trip.

Transportation and Air Quality Impacts

The primary transportation-related impacts as a result of implementing a flextime program are reduced peak period congestion and modal shifts. There are a number of factors that affect whether the shifting of trips out of the peak period has an impact on overall travel conditions. They include the amount of peak period congestion, how sharp the peak is during this peak period, the proportion of total peak period trips affected, and the specific shifts in starting times. The extent to which these factors occur

will determine what improvement in speeds and travel flow will occur and, therefore, what improvement in emissions can be obtained.

In the San Francisco demonstration project, the participants were able to adjust their schedules and experience a travel time savings, whether they used transit or drove. An analysis was also performed of whether this demonstration project had a noticeable impact on the peak period traffic entering the CBD. There are two primary corridors that were analyzed, the East Bay corridor and the Northbay corridor. In the East Bay corridor, specifically, crossing the Bay Bridge into San Francisco, there was not a significant impact on the number of vehicles during the peak period.

There was an improvement over a two year period in the transit system serving the Northbay corridor, Golden Gate Transit, with an eleven percent reduction in peak hour bus operations while total bus patronage increased 4.7 percent. Golden Gate Transit rescheduled its service, which had previously been oriented to the 8:00 A.M. start time, to accommodate flextime schedules. In addition to allowing the transit service to operate more efficiently, it was discovered that there was latent demand for transit service in the earlier hours that had previously not been met.

There are two schools of thought about the interaction of flextime and ridesharing. The first is that flextime allows more people to carpool, because they can arrange their schedules more easily. The second is that flextime will discourage ridesharing due to the uncertainty of what each carpooler's schedule is day to day. Many of the early studies of flextime (late 1970's and early 1980's) found that there was a negligible or positive relationship between flextime and ridesharing. However, the increase in transit and ridesharing identified may have been due to outside factors, such as the increase in gasoline prices. There was no attempt to differentiate influences of these outside factors from flextime. Some more recent studies, especially those that have been conducted in suburban employment centers, indicate that flextime may have a negative impact on ridesharing. One possible way to counteract this impact would be for employers to restrict the flex-time privilege to ridesharers or transit users.

Whether flextime has a significant positive impact on air quality depends upon the number of commuters that participate in a flextime program. A large percentage of the commuters who previously arrived at work during the peak period must choose to arrive outside of the peak period in order to improve traffic flow and speeds and thus reduce emissions. Any negative impact on ridesharing or transit as a result may offset these emissions gains. If there is not a strong ridesharing or transit mode split, then this is not a concern. If transit services are provided at fixed intervals, or are oriented to the peak period, then flextime may cause some transit users to switch to driving alone.

Costs and Other Important Impacts

The costs of implementing a flextime program are primarily those associated with developing and administering the program. Once flextime has been in place for awhile, the administration costs should decrease as everyone becomes accustomed to the new

work schedule system. There also may be an increase in utility costs for the business if flextime leads to overall longer hours of operation.

Some of the employer benefits associated with variable work hours programs include reduced absenteeism, reduced turnover, reduced tardiness, easier employee recruiting, and lower overtime costs. In addition, a flextime schedule may allow longer customer service hours in a service organization as some employees choose to arrive earlier in the morning and some choose to stay later in the evening.

Any work schedule that is different from traditional work hours may be perceived as posing significant management difficulties in areas such as timekeeping and providing adequate supervision. It has been found that there are managerial problems when employees have variable work hours imposed on them. If the employees have a choice, however, there does not appear to be abuses of the new system.

For the employees, flextime is seen as a benefit by those who desire greater autonomy and responsibility in their jobs. There is also the opportunity to better integrate their home life and their work life, which leads to taking fewer sick days and reduced tardiness.

Implementation Requirements

There are a number of institutional issues that need to be considered in the development of a variable work hours program, whether it is flextime or compressed work weeks. The questions to be addressed include: what types of workplaces should be targeted; what agencies, organizations, and individuals should be involved; and what types of institutional considerations are relevant. In this section, those aspects that apply to variable work hours programs in general and flextime in particular are discussed. It should be noted, however, that these issues are discussed based on the assumption that compressed work weeks is an alternative work schedule option.

A flextime schedule can be most readily accommodated in an office environment for firms that are involved in service-related organizations, transportation/communications/utilities, and financial/insurance/real estate. In addition, smaller firms may be best able to implement a flextime schedule because they do not require as complex or structured set of rules as does a large organization. Also, both the employer and the employee may be more receptive to variable work hours programs if the congestion problems in the targeted area are perceived to be severe.

Support for a variable work hours program must be provided by both the business community and local government in order to encourage individual employers to participate. The development of this support can also be used to better design the program so that it best meets the needs of the community. In Seattle, a variable work hours' advisory board of business community members and transportation officials was a successful mechanism for providing support and guidance. In San Francisco, executives from firms that had already adopted flextime were enlisted to "sell" the concept to other firms.

It was found that employers are more receptive to listening to ideas from their peers. Promotion of the program through the media also assures the employers that their employees are aware of the benefits of a variable work hours program and would therefore be more likely to be supportive. When the initial contact is made with the employer, it is important that it be made with someone high in the organization.

In order to maximize the transportation and air quality benefits achieved, the involvement of transit operators, highway agencies, and rideshare agencies should begin at the early stages of the program. They may be able to supply data that better allow the design and evaluation of the program. In addition, there may be actions that can be taken by these agencies that would counter possible negative impacts on transit use or carpooling. An example would be to increase transit service in the hours just before and after the peak period.

Institutional considerations are important. The variable work hours program must be accepted by the employers and the employees, and must be able to overcome any barrier imposed by unions or work hours legislation. The potential benefits and impacts listed in the previous section will affect the acceptability to employers and employees.

Unions tend to be wary of variable work hours programs and they should therefore be involved in the initial design and development of the program. Some of the issues that unions may be concerned about include schedule setting, overtime pay, night differentials and weekend premiums, distribution of productivity gains, paid time off, time of union meetings, timekeeping, job classification, and excluded employees. Flextime in particular poses a concern to unions as a possible way to coerce employees to work overtime without adequate compensation, especially if it is posed as a competitive situation. Some of the compromises that have been reached as a result of including unions are summarized below.

- **Timekeeping:** Use sign in and sign out sheets at all exits rather than a timeclock.

- **Time Off:** Employees are allowed to charge time taken for medical and other "necessary" errands, all others are done on personal time.

- **Overtime Pay:** Overtime pay not required if it is the employee's choice rather than the management's request that they work overtime.

- **Productivity Gains:** Real gains resulting from the shift in work schedules should be returned directly to the workers in the form of bonuses.

- **Union Meetings:** On days when union meetings are scheduled, workers return to their old fixed schedules with a block of time held open for the meeting.

Finally, there may exist legislation that hinders the implementation of a variable work hours program. At the federal level, the legislation primarily affects work performed directly or indirectly for the Federal Government. A summary of Federal Legislation is provided below.

- **The Walsh-Healy Public Contracts Act** (41 U.S.C. 35) – for employees working on U.S. Government contracts to manufacture or furnish more than $10,000 worth of goods. Overtime pay at time-and-a-half is required for hours worked in excess of eight per day or forty per week.

- **The Contract Work Hours and Safety Standards Act** (40 U.S.C. 328) – for employees working on U.S. Government contracts exceeding $2,000 for construction or $2,500 for service, and less than $10,000. Overtime pay at time-and-a-half after eight hours per day.

- **The Fair Labor Standards Act of 1938** (as amended by P.L. 93-259, April 18, 1974) – for all employees in interstate commerce and public administration (with some exemption) Overtime pay at time-and-a-half after forty hours per week.

- **The Federal Pay Act** (U.S.C. title 5) – establishes a forty hour work week for full-time U.S. Government employees. Work should be Monday through Friday with days of equal duration and a break should be allowed of not more than one hour. Overtime pay at time-and-a-half after eight hours per day.

The above legislation affects flextime only if the program is designed such that an employee is allowed to carry over hours from one day to the next or from week to week. There also may be state or local legislation regarding work hours that should be reviewed before any variable work hours program is implemented.

■ Compressed Work Weeks

With a compressed work week, an employee works more hours per day and fewer days per week as compared to a normal work schedule. The most common forms of compressed work week schedules are a four-day, ten-hour day work week and the 5/4-9 plan. In the 5/4-9 plan, employees work 80 hours in nine days, and have an extra day off every other week. The hours are set by the employer and all of the employees work the same hours. In some cases, employers remain open five days with 20% of the employees off each day while in others, the employer is actually closed one day per week or one day every other week. The number of work trips per week are reduced under this type of work schedule, and the schedule can be designed so that at least one end of the work trip will occur outside the peak period.

Compressed work weeks can be particularly successful for areas characterized primarily by manufacturing employment. In the manufacturing sector, it is important that all of the employees arrive at work at the same time and leave at the same time, irregardless of the number of hours or number of days worked. Compressed work weeks may also be applied in an office setting, as is described in the following example.

Example

Compressed work weeks have not been implemented as widely as have telecommuting and flextime. There is only one example in the literature where the transportation impacts have been systematically documented.

Denver participated in a federal employee compressed work week experiment that lasted for three years, beginning in 1978. The purpose of the experiment was to "determine whether and in what situations such varied work schedules can be successfully used by Federal agencies on a permanent basis." (Public Law 95-390 (H.R. 7814), "Federal Employees Flexible and Compressed Work Schedules Act of 1978," Section 2.) The experiment was viewed as a way to demonstrate that compressed work weeks can be successfully used as a method to improve air quality.

Within the participating agencies, eligible employees were given the choice of whether to work a compressed work week schedule. As of December 1979, thirty-five agencies and over 7,000 employees were participating, with the form of compressed work week about evenly split between a four-day work week and the 5/4-9 plan. The thirty-five agencies represent a wide range of office-related work environments in terms of both function and size of organization. To collect data for the evaluation, surveys were distributed to approximately 2,150 federal employees in twenty-nine agencies in June 1979 and in June 1980.

The following were identified as potential impacts of the compressed work week schedule prior to performing the evaluation:

Changes in Employee Work Travel

- Day of week
- Time of day
- Travel time
- Mode of travel
- VMT
- Fuel consumption
- Vehicle emissions

Changes in Household Total Vehicular Travel

- Total weekly VMT
- Household travel characteristics
  - Day of week
  - Trip purpose
- VMT by vehicle type
- Fuel consumption
- Vehicle emissions

Changes in Highway Traffic

- Traffic volume by day of week
- Traffic volume by time of day
- Fuel consumption
- Vehicle emissions

Changes in Transit Ridership

- Transit volume by time of day

Participants Rates By:

- Household composition
- Socioeconomic characteristics
- Employment and locations factors

Transportation and Air Quality Impacts

As a result of a compressed work week program, the impacts on the transportation system include decreasing the total number of weekly work trips, reducing peak period congestion, and, possibly, changing the mode of travel for the work trip. The new schedule may make it difficult for commuters to rideshare and use transit, and they may therefore switch to driving alone. In the literature, it has been hypothesized that there may be an increase in the number of non-work trips, especially on the day off. Each of these effects must be combined to determine what the overall impact on the transportation system is.

The air quality impact of compressed work weeks greatly depends upon the magnitude of the transportation impacts. If the number of work-related trips that are eliminated, taking into account changes in mode share, are greater than the number of non-work trips that are generated, then there will be an air quality benefit due to the reduced number of cold starts. In addition, the non-work trips are probably shorter in length than the work trips, therefore, there will be an emissions benefit due to the reduced VMT. It should be noted that these air quality benefits are not evenly distributed throughout the week, but are concentrated on the days off, most likely Monday and Friday. On the days when the work trip is made, at least one end of the trip is made outside of the peak period. If a sufficiently large number of commuters are shifted out of the peak period, then speeds will be increased and emissions will be decreased.

The findings from the Denver experiment were very favorable in terms of both the travel-related impacts and the emissions impacts. Those who chose the four-day work week reduced their number of work-related trips by twenty percent, and those who chose the 5/4-9 plan by ten percent. Almost sixty percent of the employees chose Friday as their day off and thirty-six percent chose Monday. A reduction in total VMT of almost 15.3 percent was realized by the employees participating in the experiment. The

peak in arrival times has been flattened and shifted earlier by one hour in the mornings and one hour later in the evenings. Because only a small percentage of all employees in the Denver area were included in this experiment, there was not a significant reduction in overall work-related VMT, however, there may have been significant effects that were more localized in nature.

In terms of mode shares, overall there was little change in the mode selected by the participants once they began the compressed work week schedule. For those whose offices were located outside of the CBD, there was actually an increase in the percent who rideshare and take transit. This may have been due to the fact that, on average, sixty-five percent of the employees in participating agencies were on compressed work week schedules, and therefore were able to either continue carpooling or easily form new carpools.

The compressed work week schedule resulted in an overall decrease in household weekly VMT by almost sixteen percent. Not all of this decrease, however, was due to the decrease in work-related VMT. Approximately thirty-five percent of the reduction was due to non-work-related travel that had either been performed more efficiently or reduced somewhat. On a daily basis however, this result is somewhat misleading. There was a large reduction in non-work-related VMT that occurs on the weekend, the assumption is that some trips previously taken on the weekend were switched to the weekday off, which offsets an increase in weekday non-work-related VMT. Overall, weekday VMT was reduced and was fairly evenly distributed throughout the week.

The evaluation of the air quality impacts of the Denver experiment did not examine the effect of cold starts, because non-work-related VMT was tracked and number of trips was not. It can be assumed, however, that there was a reduction in the number of cold starts due to the reduced number of work-related trips and, because the non-work-related VMT did decrease, there was probably also a reduction in cold starts for non-work-related trips. It was estimated that average CO and HC emissions for employees were reduced by 16.4 percent. The changes of time and location that the emissions occurred could also serve to reduce peak CO concentration levels. In addition, about twenty-eight percent of the total emission reductions occurred on the weekends.

Costs and Other Important Impacts

As with flextime, the majority of the costs for a compressed work week program are those associated with implementing and administering the program. Because the hours of each employee are fixed once the program is begun, there is less of an administrative burden in terms of keeping track of time schedules. If the compressed work week schedule is designed so that overall there are longer hours of operation, there may be increased utility costs. These utility costs may be significant if energy-intensive machinery is used.

A benefit of compressed work weeks is increased productivity through a reduced number of start-ups and shut-downs. If the employees are scheduled so that there are days that the business is not in operation, there may also be a savings in utility costs despite the longer operating hours. With the longer working hours, however, there is a possibility that productivity will suffer as a result of worker fatigue and poorer work scheduling. This was not found to happen, however, in the Denver experiment.

To the employee who chooses to participate in a compressed work week program, an extra day off is an obvious benefit and worth working the longer hours. In addition, being able to have fewer days to commute to work and to have the commute occur outside of the peak periods can reduce the commute-related stress.

Implementation Requirements

As mentioned in the description of compressed work weeks, there are a number of types of schedules that can be implemented. It needs to be first decided which schedules best fit the needs of the employer and the employees. The employees must then be assigned a day off to ensure that operations can continue efficiently and that there is adequate coverage of business operations. Another issue is whether the employees are able to choose their own schedules. For measurable transportation and air quality benefits to be achieved, there needs to be high participation rates and the schedules need to be arranged such that the peak demand on transportation facilities near the employment sites are adequately avoided.

As discussed in the section on implementation issues for flextime, there are a number of institutional issues that need to be considered in the development of a variable work hours program. In this section, those aspects that particularly apply to compressed work weeks are discussed. It should be noted, however, that these issues are discussed based on the assumption that flexible work hours is an alternative work schedule option, not that the choice is simply between a compressed work week and a traditional schedule.

Manufacturing-oriented functions are probably the most compatible with compressed work week schedules, because of the need to have employees arrive at set times and work the same number of hours. The experience in Denver, however, does indicate that there are also situations where it can be applied for office-related employment.

Most of the institutional issues associated with implementing a compressed work week program are the same as for any variable work hours program, as described in the section on flextime. Unions do have slightly different concerns about compressed work weeks. Specifically, that the lengthened work day may lead to an increase in the number and magnitude of workplace-related safety and health problems. The unions are also concerned that the lengthened work day will interfere with those activities that are traditionally taken care of immediately before or after work (e.g., child care, personal errands). In addition, the Denver experiment involved federal employees, which would not have been allowed under the legislation previously described. The Flexible and Compressed Work Schedules Act of 1978 was passed to permit experiments with alternative work schedules for federal employees.

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