5. A. M. Freeman. On the Incidence of Auto Pollution Control Costs. In Benefit-Cost and Policy Analysis 1974 (Richard Zeckhauser and others, eds.), Aldine, Chicago, 1975, pp. 269-282.
6. K. V. Green, W. B. Neenan, and C. D. Scott. Fiscal Interactions in a Metropolitan Area. Heath, Lexington, MA, 1974.
7. W. L. Hansen and B. A. Weisbrod. Distributional Effects of Public Expenditure Programs. Public Finance, Vol. 27, No. 4, 1972, pp. 414-420.
8. E. G. Hoachlander. Bay Area Rapid Transit: Who Pays and Who Benefits. Institute of Urban and Regional Development, Univ. of California, Berkeley, Working Paper 267, July 1976.
9. R. A. Musgrave and P. B. Musgrave. Public Finance in Theory and Practice. McGraw-Hill, New York, 2nd Ed., 1976.
10. N. M. Singer. Public Microeconomics. Little, Brown, Boston, 2nd Ed., 1976.
11. J. W. Zupnick. The Short-Run Incidence of a Tax Induced Rise in the Price of Gasoline. Journal of Economic Issues, Vol. 9, No. 2, June 1975, pp. 409-414.

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Who Favors Work-Schedule Changes and Why

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Factors that influence attitudes of white-collar employees toward alternative work-schedule changes are examined to determine whether the desire to avoid traffic congestion is a primary determinant of such attitudes. A random sample of 110 employees from the main office of the New York State Department of Transportation in Albany, New York, were given a short questionnaire on travel patterns, attitudes toward components of work schedules, and perceptions of impacts of work-schedule changes on family life, travel patterns, and working environment. An attitude scaling technique known as trade-off analysis was used to determine the most preferred programs and the characteristics of those in favor of and those opposed to schedule changes. Results showed the basic motivation behind favoring work-schedule changes is the employee's desire to introduce flexibility into family, leisure, and work activities; the desire to avoid traffic congestion is a contributing, but not a major, factor. The most preferred arrangements are 5-d variable hours, 4-d variable hours, and 5-d individual-specific hours, all with over 65 percent support. Support was strongest among younger employees who had children in school and weakest among single and older employees and car poolers. The policy implications for transportation planning are discussed.

Considerable research has been published on the application of staggered work hours as a device to relieve commuter congestion in public transit facilities (1, 2, 3, 4). The conclusion of these studies is that peak demands in transit facilities can be reduced by 10 to 30 percent through widespread use of such policies. Studies of the impacts of the 4-d workweek on highway congestion (5, 6, 7, and a paper elsewhere in this Record by Tannir and Hartgen) and other studies (8, 9) support variable work hours and 4-d workweek policies as a possible policy for low-cost shifting of travel to reduce traffic congestion. All of these studies, however, have concentrated on large metropolitan areas.

The impacts of staggered work hours and 4-d workweek schedules on firms and their employees have been studied and generally found to be positive (10, 11, 12, 13). General benefits include improvement in employee morale and productivity, reduction in absenteeism and overtime, better use of capital assets, extended hours of service to clients, improved driving conditions during the trip to work, and, under certain conditions, reductions in energy consumption.

DATA AND METHOD

The New York State government offices located at the State Campus in Albany, New York, were selected to be surveyed in this inquiry. The site is located approximately 6.4 km (4 miles) west of downtown Albany in a predominantly residential area, and there are approximately 10 042 employees. The campus is accessible by way of a highway network of local streets, major arterials, and expressways. New York State is the only employer on the campus, employment density is high, and public transportation does not play a major role in the daily movement of employees to and from their jobs. White-collar workers constitute the majority of these employees.

Employees on the State Campus were surveyed to determine employee characteristics, attitudes toward changes in work schedules, and perceived impacts. For several reasons, the main office of the New York State Department of Transportation (NYSDOT) was selected as the focal point for the employee survey. First, it is located on the State Campus. Second, the department population is generally representative of the entire campus population. Third, it was convenient because the researchers were familiar with the organizational structure and functional units of the department. And, finally, permission to conduct such a survey was obtainable from management and employee representatives of NYSDOT.

A random sample of 140 employees from the NYSDOT main office staff of 1771 were selected and contacted. Of these, 110 completed returns were used in the analysis. The returned sample was representative of the main office population (Table 1). Respondents were administered a questionnaire that covered travel and demographic characteristics, general attitudes toward work-schedule changes, perceived impacts of these

Table 1. Comparison of sample population and population of NYSDOT main office.

Category	Sample Population		Main Office Population	
	Number	Percent	Number	Percent
Sex				
Male	86	78	1314	73.7
Female	24	22	469	26.3
Total	110	100	1783	100.0
State grade level				
1-9	29	28.7	615	34.7
10-19	42	41.6	676	38.2
20-29	22	21.8	387	21.9
30-38	7	6.9	68	3.8
Unclassified	1	1.0	24	1.4
Total	101	100	1770	100.0
Bargaining unit				
Administration	33	30.5	517	29.0
Operational	2	1.8	32	1.8
Professional, scientific, and technical	60	55.1	1031	57.8
Management and confidential	14	12.8	203	11.4
Total	109	100	1784	100.0

Figure 1. Partitioning of the sample.

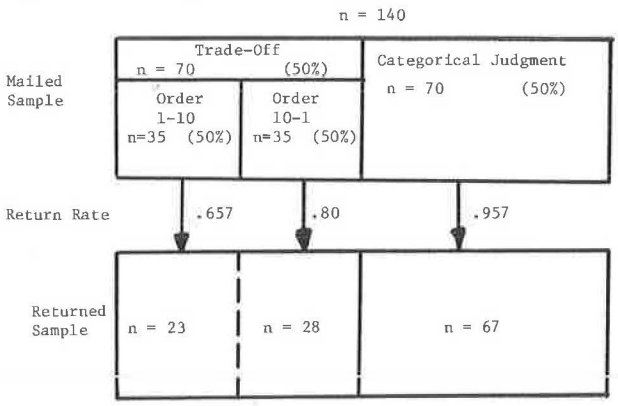
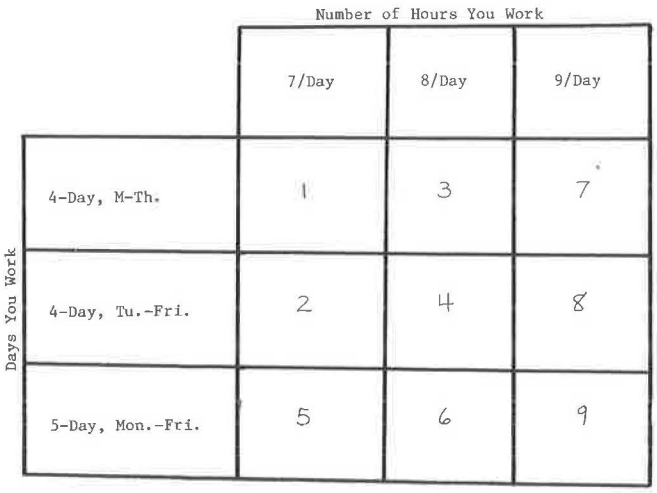


Figure 2. Example of trade-off matrix used in the survey.



changes, and attitudes toward various attributes of work schedules. In the case of the last item, 50 percent of the sample received a questionnaire in the categorical judgment format (short form), and 50 percent of the sample received a questionnaire that contained attitude questions in the trade-off analysis format (long form). To control bias resulting from respondent fatigue, this group was further divided into two equal subgroups (each 25 percent of the total sample), and the sequence of questions was reversed (Figure 1). The differences in these approaches are analyzed elsewhere (14, 15, 16).

A technique known as trade-off analysis (14, 17, 18, 19) was used to develop alternative feasible policies on changes in work schedules. This technique requires the respondent to rank order the cells of a two-variable matrix from most preferred to least preferred, as shown in Figure 2. A set of (n) (n - 1)/2 such matrixes is administered for the n attributes. These attributes and their levels are given below (current schedules call for 7.5-h workdays):

Attribute Level	Mean Utility	Standard Deviation
Days worked		
Four, Monday-Thursday	0.38	0.08
Four, Tuesday-Friday	0.37	0.07
Five, Monday-Friday (current schedule)	0.25	0.11
Number of hours worked per day		
Seven (current schedule)	0.43	0.11
Eight	0.33	0.05
Nine	0.24	0.09
Times worked		
Fixed (current schedule)	0.29	0.08
Specific for individual	0.32	0.07
Variable	0.39	0.11
Parking location		
Wherever desired (current schedule)	0.39	0.09
Special place if car pool	0.27	0.08
Same space every day	0.34	0.01
Cost of parking		
Zero (current schedule)	0.58	0.09
$1/month	0.40	0.03
$1/week	0.12	0.08

The trade-off algorithm (17) uses these rank-order preferences to produce estimated utilities for each respondent by minimizing the differences between the observed rankings and the rankings of the cell-product utilities. Mean utilities are given in Table 2. This information is then inputted to a simulation routine that estimates preferences for alternative work-hour programs based on the preferences of all individuals. Shares are computed as follows: Let u_{ik} = the utility that respondent i places on attribute level k, U_{ip} = the utility that respondent i places on future p, and P_{ip} = the preference (percentage favorability) given future p by respondent i. A linear utility function is assumed:

$$U_{ip} = \sum_{k} u_{ik} \quad (1)$$

A Luce share model is assumed for preference calculation:

$$P_{ip} = U_{ip}/(U_{ip} + U_{iq} + \ldots.) \quad (2)$$

Aggregations of P_{ip} over all respondents reveal total market preference, and detailed breakdowns of support by demographic and other characteristics reveal which groups stand to gain or lose under different work-schedule policies.

Table 2. General attitudes toward alternative work schedules.

Attitude	Congestion Experienced on Work Trip	Response (%)				Percentage of Total (n = 110)
		Unfavorable	Neutral	Favorable	No Response	
Toward variable work hours	None (A)[a]	50	6	44	0	16.4
	Somewhat (B)[a]	21	15	64	0	48.2
	Considerable-severe (C, D, E)[a]	15	8	72	5	35.4
	Average	24	11	64	1	
Toward 4-d workweek	None (A)[a]	28	17	56	0	16.4
	Somewhat (B)[a]	30	8	62	0	48.2
	Considerable-severe (C, D, E)[a]	13	10	72	5	35.4
	Average	24	10	64	2	

[a]Letters in parentheses denote level of service as described in the Highway Capacity Manual (21).

Table 3. Summary of attitudes toward personal impacts of work-schedule changes.

Area of Impact	Response (%)						
	Very Unfavorable Impact	Somewhat Unfavorable Impact	Neutral	Somewhat Positive Impact	Very Positive Impact	Total (N_t)	Weighted Mean
Second job	25	5	52	14	5	107	2.70
Fatigue	9	17	52	8	14	107	3.03
Communication	7	13	56	14	10	106	3.08
Rush-hour congestion	11	9	40	20	20	107	3.27
Leave time	5	5	49	20	21	107	3.49
Gasoline savings	6	4	45	24	21	107	3.50
Productivity	0	7	47	24	22	107	3.60
Job satisfaction	1	5	42	27	25	107	3.71
Family time	3	4	21	20	52	108	4.16
Leisure time	2	2	17	29	50	108	4.25

RESULTS

General results of the survey are given in the table below:

Characteristic	Percent
Family size, number in household	
1	13.6
2	28.2
3-4	36.5
5-6	15.4
≥7	4.5
Other (blank)	1.8
Automobile ownership, number of automobiles	
0	3.6
1	45.5
≥2	49.1
Other	1.8
Mode to work	
Drive	80
Automobile passenger	18
Other	2
Car pooling	
None	70.6
Occasional	13.8
Car poolers	15.6

The key findings are that

1. The level of automobile ownership for the sample is very high,
2. The sample is average in relation to family size,
3. The automobile predominates in travel to work, and
4. Frequent and occasional car pooling is quite common.

The survey also revealed that, for car poolers and non-car-pool users, average work-trip length was 24 and 18 km (15 and 11 miles) respectively.

Data given in Table 2 show that the sample is generally very much in favor of variable work hours or 4-d weeks (64 percent overall). Favorability appears to be sensitive to the perceived level of traffic congestion: The higher the congestion is, the greater is the inclination to favor variable work hours. The impact of congestion level on attitudes toward a 4-d workweek is less pronounced. These findings suggest that the desire to avoid traffic congestion has at least a moderately important influence on favorability toward work-schedule changes.

Table 3, however, suggests that other factors may be more important. The respondents felt that work-schedule changes would have a very positive impact on family and leisure time but only a marginally positive impact on ability to avoid rush-hour congestion. These results suggest that the desire for flexibility in personal activities and the desire for more leisure time are the primary determinants of attitudes toward work-schedule changes.

Attitudes Toward Work-Schedule Arrangements

As described earlier, the trade-off procedure allows the analyst to compare alternative work-schedule arrangements with the current fixed-hours schedule. The attributes and levels given previously are the basis for formulating various work-schedule programs.

Theoretically, it is possible to structure 243 possible programs or five attributes of three levels each. However, based on a literature search and previous surveys, it became apparent that most of the programs that can be structured are either unrealistic or not implementable from management, employee, or legal viewpoints. Therefore, only selected programs, called "futures," were structured for testing. Figure 3 shows eight such tests along with demographic breakdowns of support. It is apparent that only futures 5, 6, and 1 are preferred to the current policy.

Figure 3. Support for proposed policies (or futures).

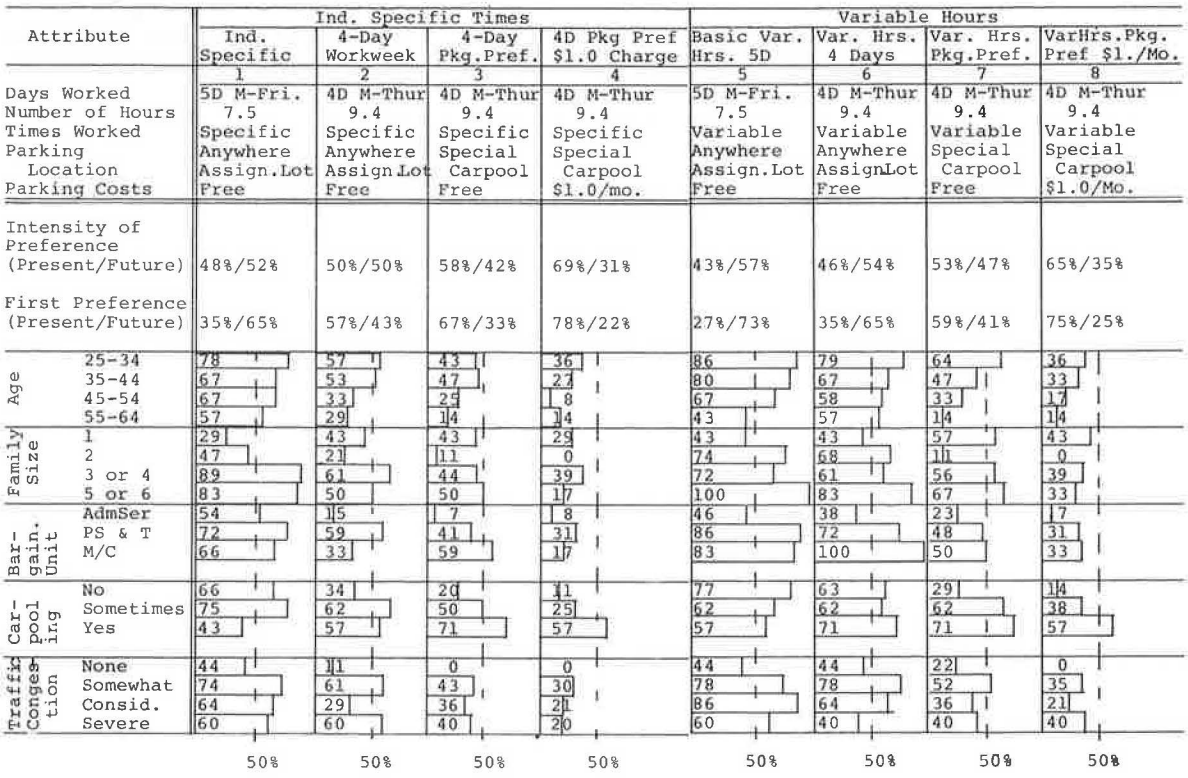


Table 4. Profiles of groups that most strongly support or oppose the three preferred programs.

Program	Overall Preference (%)	Strongest Support		Strongest Opposition	
		Group	Percent	Group	Percent
Future 5 (5-d workweek, variable work hours)	75	Age 25 to 44	80-86	Age 55 and over	43
		Professional, scientific, and technical	86	Administrative services	46
		Non-car-pool users	77		
		Family size ≥2	72-100	One-person family	43
		Travel time ≥30 min	75-100		
		Some and considerable congestion	78-86	No congestion	44
Future 6 (4-d workweek, variable work hours)	65	Ages 25 to 44	67-79	Age 19 to 24	50
		Professional, scientific, and technical; management and confidential	72-100	Administrative services	38
		Car poolers	71		
		Family size ≥2	61-83	One-person family	43
		Travel time 20 min	74	Travel time 10 min	44
		Some congestion	78	Severe congestion	40
Future 1 (5-d workweek, individual-specific work hours)	65	Age 25 to 34	78		
		Professional, scientific, and technical; management and confidential	66-72		
		Occasional car poolers	75	Car poolers	43
		Family size ≥3	83-89	One-person family	29
		Travel time ≥30 min	75		
		Some congestion	74	No congestion	44

Future 5

Future 5—the 5-d workweek with variable hours—received the broadest support: 73 percent versus 27 percent support for the current schedule. This preference is especially strong among the 25 to 34 age group (85 percent) and 35 to 44 age group (80 percent). This strong preference can be explained by the fact that employees in these age groups tend to be in the child-raising stage, and variability in work start times provides the flexibility needed to reconcile job and child-care activities. Employees from families of three to four members also favor such arrangements (72 percent support); those who have more than two children tend to favor it even more, which further supports the hypothesis.

The only group that does not show enthusiasm is the 55 to 64 age group (only 43 percent support). This can be explained by observing that employees in that age bracket are very much used to the current schedule,

and any change from it may cause hardships. As expected, car poolers only moderately support this program (57 percent) since car pools might be dissolved. Those who occasionally car pool are more enthusiastic about it (62 percent) since they most likely drive an automobile to work. Traffic congestion also plays a part in making this program the most preferred: Persons who experience more traffic congestion tend to support this program more. When the traffic problem is nonexistent, the support is 44 percent; when there is some congestion, the support becomes 78 percent; when congestion is considerable, the support for variable work hours is 86 percent.

Future 6

Future 6—the 4-d workweek with variable hours—also generates strong overall support (65 percent). A close analysis of the support estimates shows that the preference trend among the various groups follows lines similar to those for future 5. Preferences by age groups indicate that the 25 to 34 group favor this schedule the most (79 percent) compared with 86 percent favorability for future 5. The 35 to 44 group gives 67 percent support to future 6 compared with 80 percent to future 5. The 45 to 54 age group gives 58 percent support to future 6 as compared with 67 percent to future 5. This degree of favorability underlines the inference that the attitudes of employees in these age groups are influenced by their desire to reconcile their work schedules with their family obligations. This point is further emphasized by the percentage preference based on family size. It is evident that households with three or four persons and those with five or six persons are strongly in favor of future 6—by 61 and 83 percent respectively. The 19 to 24 age group is evenly split in its support for future 6. Members of this group are most likely members of one- or two-person households. The support from this group is only 43 percent.

Future 6 does not appeal to drivers who do not experience any traffic congestion during their morning trip to work. Only 44 percent support this schedule. However, those who occasionally encounter traffic delays would greatly support this policy (78 percent). This may be caused by their desire to improve driving conditions through earlier work start times. On the other hand, those who experience considerable traffic delays support this policy by 64 percent. Their support may be based on the assumption that a 4-d workweek would spread the peak-hour demand, which would result in improved traffic conditions.

A third feasible schedule is a 5-d workweek with individual-specific hours (future 1 in Figure 3). The pattern of support follows similar general lines as those for futures 5 and 6. This underlines the desire of employees to reconcile their work and personal schedules. The remaining policies are not analyzed here; they are left to the reader to contemplate.

Support and opposition profiles are summarized in Table 4.

CONCLUSION

In this study, broad support was found among white-collar state-government employees for changes in work-schedule arrangements. The most preferred programs are those that feature variable work hours. A program of this kind with five 7.5-h days is most favored and is followed by a variable-hour program with four 9.4-h days.

The desire for flexibility in work and family schedules is the basic motivating factor behind attitudes toward work-schedule changes. This is reflected through age and family size, which are the prime demographic factors in favoring a given program over the current schedule. An analysis of perceived impacts shows that leisure time and family activities would be the primary aspects of personal life that would benefit from such changes. A desire to avoid traffic congestion does not seem to be a dominant factor in attitudes toward alternative work schedules. However, those who experience some or considerable traffic congestion tend to be in favor of variable work hours.

These findings have broad policy implications for transportation planners and decision-makers who are concerned with ways to reduce traffic congestion. Since traffic congestion is not the primary factor influencing attitudes toward work-schedule changes, attempts to sell such programs on the basis of potential travel benefits are likely to be ineffective. A better approach would be to emphasize positive, achievable impacts on family life and leisure time and treat avoidance of traffic as an ancillary benefit. Even so, planners should recognize that all employees will not be equally affected: Flexible work hours will primarily benefit young households that have children at home to the detriment of single-person households, older employees, and car poolers. Thus, actions taken to relieve rush-hour congestion by introducing flexible work hours may be partially offset by the dissolution of current car pools and greater difficulty in car-pool formation. To deal with such trade-offs, the transportation planner must increasingly understand structural relations in family and work environments so that actions in one sphere will not be offset by unexpected detrimental effects in another.

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REFERENCES

1. L. B. Cohen. Work Staggering for Traffic Relief: An Analysis of Manhattan CBD. Praeger, New York, 1968.
2. B. O'Malley. Staggered Work Hours Project in Lower Manhattan. TRB, Transportation Research Record 348, 1971, pp. 152-165.
3. J. C. Plewes and M. H. Yeates. The Urban Rush Hour: An Analysis of the Yonge Street, Toronto Subway System. Traffic Quarterly, Vol. 26, 1972, pp. 209-229.
4. C. Selinger. Managing Transportation Demand by Alternative Work Schedule Techniques. TRB, Special Rept. 172, 1977, pp. 67-74.
5. V. R. Desimone. Four-Day Work Week and Transportation. Transportation Engineering Journal, ASCE, Vol. 98, 1972, pp. 705-714.
6. S. E. Rowe and S. S. Taylor. The Effect of the Four Day Work-Week on Transportation in the Civic Center Area. Los Angeles Department of Traffic, 1972.
7. J. Guttman. Predicting the Effect of Variable Work Hours on Peak Period Congestion. Transportation, in preparation.

8. J. H. Dupree and R. H. Pratt. Low-Cost Urban Transportation Alternatives: A Study of Ways to Increase the Effectiveness of Existing Transportation Facilities. U.S. Department of Transportation, 1973.
9. R. Remak and S. Rosenbloom. Peak Period Traffic Congestion. NCHRP, Rept. 169, 1976.
10. H. L. Krieger. Statement Before the Subcommittee of the Senate Labor and Public Welfare Committee on Employment, Poverty, and Migratory Labor. U.S. General Accounting Office, April 7, 1976.
11. R. Poor, ed. Four Days, Forty Hours. Mentor Books, New York, 1973.
12. K. E. Wheeler, R. Gurman, and D. Tarnowieski. The Four-Day Work Week. American Management Association, New York, 1972.
13. A. Tannir. The Impacts of Feasible Staggered Work Hours and Compressed Workweek Policies on Highway Networks, Transportation Economics, Organizations and Employees. Planning Research Unit, New York State Department of Transportation, Albany, Preliminary Research Rept. 129, 1977.
14. P. M. Eberts. Trade-Off Versus Categorical Judgment: A Comparative Analysis of Two Attitude Scaling Methods for Transportation Planning. Planning Research Unit, New York State Department of Transportation, Albany, Preliminary Research Rept. 114, 1977.
15. P. M. Eberts and P. Koeppel. Trade-Off Analysis: Recent Empirical and Structural Findings. TRB, Transportation Research Record 673, in preparation.
16. P. Koeppel and P. M. Eberts. The Trade-Off Model: Empirical and Structural Findings. Planning Research Unit, New York State Department of Transportation, Albany, Preliminary Research Rept. 123, 1977.
17. S. M. Howe, E. P. Donnelly, and J. A. DesChamps. Trade-Off Analysis: Theory and Applications to Transportation Policy Planning. High Speed Ground Transportation Journal, Vol. 11, 1977, pp. 93-110.
18. Carpooling Impact Study: Trade-Off Model and Policy Simulation. Peat, Marwick, Mitchell and Company and U.S. Department of Transportation, 1976.
19. Statewide Public Opinion Poll on Transit Operating Assistance. Market Facts, Inc., and New York State Department of Transportation, Albany, 1975.
20. Highway Capacity Manual. HRB, Special Rept. 87, 1965.

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Traffic Impacts of Work-Schedule Changes in Medium-Sized Urban Areas

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A test is made of the hypothesis that changes in work schedules can significantly reduce traffic congestion in medium-sized automobile-oriented cities. By using an extreme case—a single high-density employer in a residential area—estimates are made of the change in peak trips that would result from three alternative work-schedule changes. The impact on the surrounding street system is then evaluated by using traffic-assignment techniques. Results show that even a maximum-impact policy (4-d workweek) would have only a marginal effect on local traffic, reducing regional travel costs by 0.4 percent and costs in the immediate surrounding area by 2.2 percent. Of all the traffic benefits accrued, over 90 percent flow to actual participants, primarily through the reduced number of required work trips. Because of the institutional problems associated with implementing such policies on a large scale, it is concluded that efforts to reduce highway congestion in medium-sized automobile-oriented cities by use of alternative work schedules may not be cost-effective.

The congestion-reducing approach of shifting travel in time and space so as to fit it within existing system capacity is receiving increasing attention. Numerous recent studies (1, 2, 3) describe the potential savings in traffic congestion achievable through such methods, and recent federal guidelines on transportation systems management require the analysis of such methods on a continuing basis. Some of the most attractive demand-shifting approaches involve the shifting of work schedules to permit greater use of limited facility capacity over a longer peak period. Work-shift policies have been given considerable attention in relation to transit service, and it has been concluded that such policies are capable of reducing peak-period congestion in transit facilities (particularly terminals and stations) by as much as 10 to 30 percent. However, considerably less is known about the effect of such policies on highway operations, particularly in small or medium-sized urban areas. Although several studies (2, 4, 5) have identified potential reductions in congestion as one of the primary benefits of such proposals, it is clear that cities in which a large portion of peak-hour trips do not currently use transit services will find the implementation of work-schedule changes a less feasible method of reducing congestion than larger urban areas might find it to be.