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THE IMPACT OF FLEXTIME ON CARPOOLING AND TRANSIT USE: A CASE STUDY OF THREE GOVERNMENT AGENCIES IN NASHVILLE, TENNESSEE

A Thesis

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ABSTRACT

Planners and policy-makers are under increasing pressure to improve urban transportation and to do so within the constraints of tighter budgets and increasing costs. In addition, efforts at improving urban travel must coincide with current programs to improve air quality and reduce energy consumption. One suggested means of improving urban transportation, especially during peak travel periods, and concurrently pursuing the goals of improved air quality and reduced energy consumption is through the use of a relatively new method of work scheduling—flextime. However, the impact of flextime on two other widely advocated means of improving urban travel, carpooling and transit use, is unclear. This study examines the relationship between flextime and carpooling; and between flextime and transit use.

Following a description of flextime and its impact on the work environment and a review of literature concerning its potential as a travel congestion reduction measure, this study attempts to determine the impact of flextime on carpooling and transit use through a case study of three government agencies in Nashville-Davidson County, Tennessee. The following research questions provide the focus of the study:

1. Is there any change in the number of persons carpooling before and after flextime was implemented?
2. Is there any change in the number of persons riding transit before and after flextime was implemented?
3. Does flextime influence whether or not persons carpool with persons who work in a different location?

4. Does flextime influence whether or not persons carpool with persons who have different working hours?
5. What factors related to flextime influence a person's choice of travel mode?

The study employees a literature review, a survey in the form of a questionnaire and interviews with pertinent individuals to answer the research questions.

The principle findings of the study are:

1. Flextime does not discourage persons from carpooling to and from work and in some instances increases the propensity for them to carpool.
2. Flextime does not discourage persons from using mass transit for home-to-work travel and, in some instances, increases transit use through improved convenience and accessibility.
3. Flextime does not encourage persons to drive to and from work alone.

The conclusions of the study are based upon these findings and the findings of past studies. They serve to dispell the popular assumption that flextime would, by encouraging persons to drive alone, impact negatively on existing patterns of carpooling and transit use.

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CHAPTER I

INTRODUCTION

A primary function of urban transportation systems is to accommodate travel from home to work. It is generally agreed that the route structure of both highways and transit lines reflects the spatial organization of work trip origins and destinations. But the temporal organization of work also influences the transportation system in terms of both capacity requirements and system performance. As a result of rigid and most often coterminous work schedules, many freeways and transit coaches are "jammed to capacity" during the rush hour and "underutilized" during the rest of the day. The clustering of scheduled work arrival times in a narrow band — typically from 7:30 to 8:30 a.m. — has, in many instances, resulted in the construction of "excess" capacity to service the "peak"; coterminous work shecules are also responsible for "excess" fuel consumption, "excess" air pollution, and "excess" transit operating costs. In this sense, urban congestion and system efficiency can be viewed as a "peaking problem" that is potentially susceptible to temporal management.[1]

Decisions about the necessary capacity of the transportation system typically have taken the scheduling of work as given. Where transportation planners have sought to influence the spread of work-arrival times, their discussions have typically focused on the four-day work week and the

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[1]David W. Jones, Takuya Nakamoto, and Matthys P. Cilliers, *Flexible Work Hours: Implications for Travel Behavior and Transport Investment Policy* (Berkeley, California: Institute of Transportation Studies, University of California, December 1977), p. 1.

staggering of work hours. Some of these discussions have led to work staggering — in Manhattan, Newark, Philadelphia, Washington, D.C., Madison, Wisconsin, and Riverside, California. Where implementation has occurred, it has typically been pursued as a joint endeavor between transportation planners and business councils. Areawide implementation of a publicly planned work staggering program is the exception rather than the rule. The four-day work week has never been implemented on an areawide scale. After some experimentation, interest in the four-day work week seems to have flagged among both unions and management.[2] In addition, both staggering and the four-day work week, in order to be successful in reducing peaking, must be well coordinated and centrally managed on a massive scale. Such large scale planning and management efforts would be costly and their possibility of continued success somewhat questionable.

An alternative means of spreading work arrival and departure times concerns the variation of daily work hours — a concept commonly referred to as flextime, flexitime, flexible-hours or gliding-time. The flextime concept is simple. Fixed times of arrival and departure are replaced by a working day which is composed of two types of time: core time and flexible time. Core time is a set number of hours in the day during which all employees must be present. Flexible time is all of the time designated as part of the schedule of work hours within which the

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[2] Ibid., pp. 1-2.

employee may choose his or her time of arrival and departure from the office.[3]

The following chapter consists of three parts. The first part explores the concept of flextime — what it is, how it works, what its benefits and drawbacks are and briefly summarizes how it affects urban transportation systems. The second part states the purpose of this thesis — to study the impact of flextime on how people travel to and from work. The third part consists of a description of how this thesis is developed. Included in this section are research questions, research methodology and a general description of the organization of this thesis.

The Flextime Concept

Definition

Flextime, as the name implies, can be very flexible, and as a result, there are many variations in its use. One variation concerns the use of flexible hours within the span of the work week. A set number of weekly hours must be worked, but they can be spread out on a daily basis as necessitated by work load and preference of the employer and/or employee. A similar type of flextime can be established on a monthly or even longer basis.

The most commonly used variation of the flexible hours concept, and that with which this paper is concerned, is flextime by day. As described in the Introduction, this type of alternative work schedule consists of

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[3]Barbara L. Fiss, *Flexitime — A Guide* (Washington, D.C.: Government Printing Office, 15 May 1975), p. 4.

core time; a set of number of hours in the day during which all employees must be present, such as 9:00 a.m. to 3:30 p.m., and flexible time; the time designated as that part of the workday within which the employee may choose his or her times of arrival and departure, such as 7:00 to 9:00 a.m. and 3:30 to 5:30 p.m. The two basic requirements of flextime are: (1) the employee must be present during core time, and (2) he must account for the total number of required hours each day. Beyond this, the precise working hours can be selected in accordance with the wishes and individual circumstances of each organization and its employees.[4]

Within a system of flextime, lunch breaks can be either fixed or converted into flexible hours. Which system is preferable depends upon the amount and timing of core time needed, based upon the individual circumstances of each place of work. If the lunch break is a fixed period, then the employee's arrival determines his departure time. If the lunch break is a flexible period, then within this period the employee may choose his time of lunch. It follows that the time he leaves work is not merely determined by his arrival time, but also the length of his lunch break.

Time keeping under flextime is most frequently based on the honor system.[5] However, manual records and time clocks are sometimes used, especially where management is particularly concerned with abuse of

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[4]Ibid., p. 5.

[5]Stanley D. Nollen and Virginia H. Martin, *Alternative Work Schedules, Part 1: Flexitime* (New York: American Management Association, 1978), p. 5.

working hours or where the number of employees precludes close personal supervision. Flextime, in its pure form, allows an employee to vary his hours of arrival and departure from day to day provided that he is present during core time and puts in the required number of hours each day. Some organizations, however, require that an employee, once he chooses a particular set of work start and stop times, adhere to that schedule. Such alternative work scheduling is still considered flextime since each individual employee had the choice of which hours he wanted to work. Individual choice of work hours, even if this choice is limited to a predetermined range of work schedules, separates flextime from another form of work scheduling — staggered hours. In a staggered hours program, work start and stop times are assigned to groups of workers without regard to individual preferences.

The ways in which flextime can be implemented and monitored within an organization are highly variable. This capacity for individual organizational variation makes the concept of flextime adaptable to a great variety of work environments and causes minimal disruption of existing work routines within most places of business.[6]

Background

Flextime is a relatively new idea in the employment policies of organizations. Beginning in West Germany in 1967, at the Messerschmitt-Boelkow-Blohm aerospace firm near Munich, the concept soon spread throughout Western Europe. According to Bernhard Keppler of Interflex,

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[6]Ibid., pp. 5-8.

a New York firm, some 20,000 European organizations use flextime. This number accounts for about one-quarter of the West German labor force and 40 percent of the Swiss labor force.[7]

Flextime has been adopted more slowly in the United States. According to Keppler, this is primarily because U.S. management tends to be more cautious than its European counterpart.[8] Still, according to AMACOM, a Division of American Management Associations, which concluded a survey of flextime for the U.S. in December, 1977:

- 12.8 percent of all nongovernment organizations with 50 or more employees use flextime.
- 5.5 percent of all employees were on flextime.
- Between 2.5 and 3.5 million employees were on flextime, not counting self-employed people and many professionals, managers, and salespeople who have long set their own hours without calling their schedules flextime.[9]

Flextime use has increased rapidly, perhaps doubling from 1974 to 1977.[10] Stanley Nollen reports that in early 1980 an estimated 17 percent of all U.S. companies and 237 government agencies are trying flextime. He estimates that by 1990, 30 percent of all American workers will be flexing their own schedules.[11]

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[7]Sylvia Lewis, "'We Love It!' Say People Who Work Under Flextime," *Planning*, January 1978, pp. 15-16.

[8]Ibid., p. 15.

[9]Nollen and Martin, *Alternative Work Schedules*, pp. 5-6.

[10]Ibid.

[11]Eric Gelman et al., "The Superwoman Squeeze," *Newsweek*, 19 May 1980, p. 78.

Institutional Benefits and Drawbacks of Flextime

Flextime, although characterized as being minimally disruptive of existing work situations, has some quite substantial impacts upon organizations and their personnel.[12] Such impacts can generally be categorized as either benefits or drawbacks from the standpoints of the organization, its employees and managers, and from the impacts upon the area-wide transportation system and its related urban environs. The organization-management-employee impacts of flextime are discussed in the following paragraphs. The transportation system impacts are summarized under the heading *Flextime and Transportation*, and are described in detail in Chapter II.

Benefits

Flextime has several important effects upon the organizations that use it. Benefits related to the implementation of a flextime program are typically divided into those benefitting management and those benefitting employees.

Organizations utilizing flextime report the following advantages:

For Management —

- Reduction in short term absences as employees handle many personal affairs before or after their selected work hours.
- Quicker starts as employees arrive at different times they quickly and quietly settle down to work without the usual morning conversations.

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[12] Alvar O. Elbing et al., "Flexible Working Hours: It's About Time," *Harvard Business Review*, January-February 1974, pp. 18-28.

- Service may be increased to the public if Flextime allows the organization to be open longer hours.

- A quiet time is possible for thought and concentration as not all employees are present for the same hours. Many people have for years recognized this advantage by arriving early or staying late, reporting that their best accomplishments occur during this time.

- Tardiness is virtually eliminated as an employee's day begins when he arrives.

- Workers become job oriented rather than time oriented as time now becomes an element the worker can control.

- Cross training and cooperation among employees improves as they share skills and know-how in order to "fill-in" during another worker's absence.

- Supervisory skills improve as the supervisor's absence during part of the work day requires him to more effectively communicate and plan daily work assignments and projects. Such enforced planning leads to greater efficiency.

- The recruiting of new employees may be made easier since the existence of flextime may be construed by some as a type of "fringe-benefit."

- Employee turnover is decreased because of the improved working atmosphere and employee morale. The ability to control one's time of work to some extent is considered a prime factor in determining job satisfaction.[13]

For Employees —

- Personal pace setting allows the individual to adjust his work hours according to his own rhythm. As a result, "night people" and "morning people" work with greater enthusiasm, concentration and enjoyment.

- Reduces "rush hour rage" as workers utilize the highways, buses, subways and trains at other than peak load periods. Travel time and travel costs are thereby reduced.

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[13]Fiss, *Flexitime — A Guide*, pp. 6-7.

- Family, community and social activities increase as employees are better able to schedule participation.
- Education may be continued as schedules result in access to classes previously unavailable during employees' off-duty hours.
- Recreation facilities can now be utilized during less crowded hours. More daylight hours are available for swimming, tennis, golf, etc.
- Shopping can be done when stores are less crowded.
- Working parents may adjust their schedules so as to facilitate the transport of their children to day care centers, schools or other such activities.
- Greater ease in forming car pools may result. Individuals who might otherwise pool, but have been prevented from doing so because working hours could not be coordinated, may now find this problem eliminated.
- Transit riders may be able to reduce their wait and travel time as they may vary their work schedule so as to match existing transit schedules.
- Generally improved morale usually results when flextime is initiated. Employees react positively to the increased control over their work environment, a privilege which professionals, managers, and sales-people have always had.[14]

Do the benefits of flextime last? Do they endure after flextime has been used several years and becomes routine? Nollen and Martin say yes, without exception. They state that just as many long-term flextime users report improved employee relations and job performance as do short-term users.[15]

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[14] Ibid.

[15] Nollen and Martin, *Alternative Work Schedules*, p. 7.

Drawbacks

Flextime, while providing numerous benefits to both management and employees, also has some drawbacks. Such negative aspects primarily affect management rather than employees. Organizations using flextime report the following drawbacks:

- Additional record keeping to maintain accurate account of varied working hours is often required.
- Supervisors may not be available to subordinates during part of an extended work day. This means that management must do a thorough job of planning and scheduling work, i.e., managers must really manage.
- Overhead costs may increase for lights, heat, etc., because of the need to keep the work place open for an extended day. It should be noted, however, that from an overall energy consumption standpoint this may well be neutralized by the decline in fuel consumption realized through reduced travel time on less congested highways.
- Flextime may not be appropriate in some work situations within an organization, while it may be feasible in other situations. These schedule differences in some organizations may produce employee-management problems.[16]
- Some abuse of working hours may occur as some employees may not work the required number of hours per day. On the average, about 5% of employees do abuse working hours under flextime when only the "honor system" is used.[17]

The occasional problems raised by flextime require immediate attention and continue to do so in the long run. Coverage, scheduling and communication problems continue to occur a quarter to a third of time among long-term users of flextime. This situation may result from

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[16]Fiss, *"Flextime — A Guide,* pp. 6-7.

[17]Lewis, *"Flextime, 'We Love It,'"* p. 16.

a tendency of long-term users to reintroduce change by increasing the flexibility of their flextime systems.[18]

Overall, the benefits of flextime outweigh its drawbacks. Although the magnitude of flextime's benefits may vary from one work situation to another, it generally has a positive effect on both the employee and the organization for which he or she works.[19] Stanley Nollen and Virginia Martin, in their study of flextime conducted for the American Management Association, summarized the benefits of flextime to employees and their employers as follows:

> For workers, the fundamental feature of flexible working hours is a new freedom of choice and autonomy. This flexibility enhances the quality and dignity of working life by offering them more control over their working time and the ability to accommodate personal and family life needs as well as work needs. Flexitime treats workers as responsible adults and may increase job satisfaction. As a respondent in a large governmental agency in the Northeast said, "Employees are provided with the opportunity to mesh their personal schedules with their work schedules and thereby function in a more mature and responsible manner." It removes the emphasis from hours worked to work performed. And, though this is yet largely unrealized, it may also facilitate lifelong learning since the new time-management possibilities involved permit adult workers to take advantage of educational opportunities.
>
> Flexitime also offers benefits to employers. There is both the potentially higher productivity to be gained from more satisfied and more highly motivated workers and the prospect of using the flexible hours feature of jobs to attract people with high-level capabilities. In addition, it poses new flexibility for employers as well as workers. It expands the range of options for solving scheduling problems and meeting customer service needs. The fact that flexitime implementation costs very little in visible dollars and cents also appeals to employers. However, it does present a

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[18] Nollen and Martin, *Alternative Work Schedules*, p. 7.

[19] Ibid.

management challenge and, at least initially, requires new management thinking and additional management inputs.

Two major sets of social benefits may flow from the use of flexitime among organizations. First, a variety of public services and facilities can be provided more efficiently — with fewer, and less steep, peaks and valleys. Chief among these are more evenly distributed commuting traffic flows, demands for public transportation (with potentially reduced energy consumption), and use of recreational facilities. Second, employment opportunities for several groups of people are improved — particularly women, men who wish a more balanced work and home life, the handicapped and the aging.[20]

Flextime and Transportation

Existing System Characteristics

Every day, during the morning and evening peak periods, most urban transportation systems are jammed to capacity with persons traveling to and from work. Frequently, elevators are packed beyond their load limits, transit coaches are crowded, parking garages are suddenly transformed into miniraceways, and the roads and highways cease to function with any degree of efficiency. With each of these urban transport systems bogged down, the worker's travel time from home to work or work to home is lengthened considerably. Figure I-1 shows the daily profile of trip making in St. Louis, a typical case of peaked demand. The St. Louis tripmaking profile shows that between the 6:30 to 7:30 a.m. time period, over 1,100 hours of vehicle delay occur each weekday morning.[21]

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[20] Ibid., p. 5.

[21] Jones et al., *Flexible Work Hours*, p. 4.

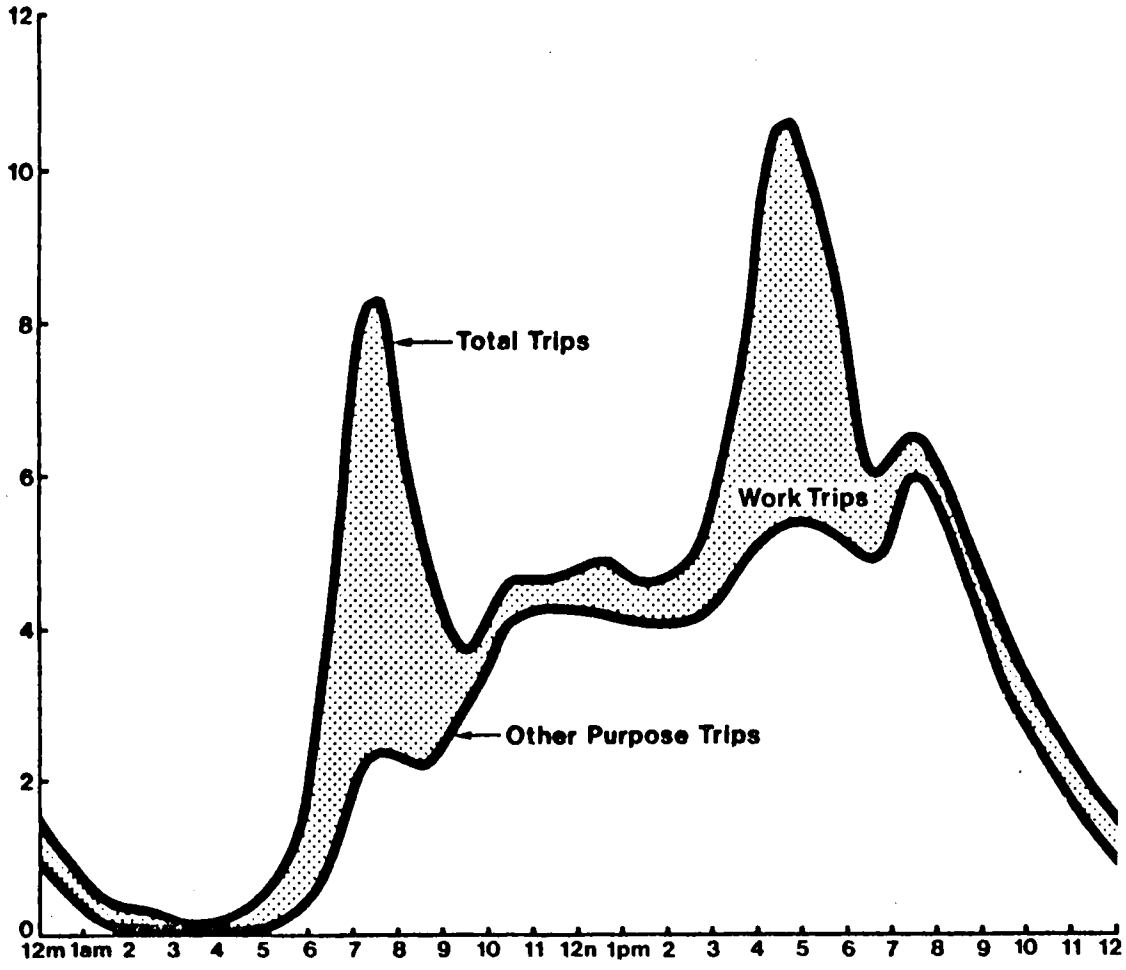

Figure I-1. Volume of Trips by Time of Day, St. Louis, Missouri, 1966.

Source: David W. Jones, Takuya Nakamoto, and Matthys P. Cilliers, *Flexible Work Hours: Implications for Travel Behavior and Transport Investment Policy* (Berkeley, California: Institute of Transportation Studies, University of California, 1977), p. 5.

The twice-a-day peaking which creates travel delays is not only an inconvenience to those who must use urban streets and highways, but it is costly as well. The costs of peaking are:

Delay imposed on drivers and passengers;

Delay imposed on goods-in-transit and delivery schedule constraints imposed on the customers of freight carriers;

Excess investment requirements imposed on highway builders and transit operators;

Salary premiums imposed on overtime and split-shift differentials paid to transit operating personnel, and;

Excess pollution and energy use associated with stop and start driving regimes.[22]

The actual magnitude of these costs varies from situation to situation. However, they are generally not insignificant as illustrated by a study done in California. A study of Route 80 between the San Francisco-Oakland Bay Bridge and Route 17 showed that by spreading out periodic peaks of traffic congestion during the evening hours, 3:30 to 6:00 p.m., while holding volume and mode shares constant, a 16 percent reduction in total passenger travel time, a reduction in vehicle emissions and a minor reduction in fuel consumption could be obtained.[23] While this is an isolated case, it does begin to suggest the magnitude of the user and social costs associated with rigidly scheduled, coterminous work hours — the "five o'clock bulge" in trip-making. Other cases are described in Chapter II.

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[22] Ibid., pp. 7-8.

[23] Ibid., pp. 8-10.

Flextime as a Travel Alternative

Several means of reducing the daily peak periods of congestion on city streets and highways have been suggested. The U.S. Department of Transportation, in *TSM: State of the Art*, categorizes such suggestions as follows:

> Work Rescheduling — Rescheduling work hours to distribute work trip making over a longer period of time,
>
> Congestion Pricing — Charging peak period users of transportation more than off-peak users through toll and transit fare increases, and
>
> Peak Period Truck Restrictions — Restricting the movement and loading of trucks to off-peak periods.[24]

Of these three, work rescheduling in the form of flextime has the most promise for quick and low cost implementation. Its cost is minimal and it does not require major legal and institutional changes.[25] If flextime could be implemented on an area-wide basis, it is possible that peak period congestion on roadways and transit facilities would be reduced and the need to construct new transportation facilities or increase transit capacity would be delayed or even eliminated. In addition, it is probable that flextime would reduce congestion in other public places, e.g., in restaurants, lobbies, elevators and stores. The reduced congestion could shorten travel times for commuters and make their trips safer and more pleasant.

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[24]U.S. Department of Transportation, *TSM: State of the Art* (Washington, D.C.: Government Printing Office, February 1977), p. 43.

[25]Nollen and Martin, *Alternative Work Schedules*, pp. 48-51.

Air Quality and Energy Conservation

To the extent that work rescheduling causes improved traffic flow, increased speeds and reduced idling, some fairly substantial, yet indirect impacts on energy consumption and air quality would result. Tobin estimates that implementation of an areawide flextime program would, by increasing speeds and smoothing traffic flow, result in a 0.72 percent reduction in fuel consumption.[26] This figure could theoretically be increased if the expected mode shift resulting from flextime occurred. Air pollution is directly related to fuel consumption, therefore it stands to reason that if flextime reduced fuel use, a corresponding reduction in auto emissions would occur. Moreover, because the intensity of air pollution is directly related to the temporal concentration of pollutants, it may be diminished simply by changing the temporal distribution of pollutants, even though the total amount of pollutants emitted may be reduced only marginally.[27]

Mode Choice

Since changes in work schedule imply changes in existing travel patterns, it is assumed that some impact on carpooling and transit ridership would occur if a flexible hours program was implemented. In the past, transportation planners automatically assumed that flexible hours would adversely affect carpooling and that transit riders would

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[26] Roger L. Tobin, *Calculation of Fuel Consumption Due to Traffic Congestion in a Case Study Metropolitan Area* (Warren, Michigan: General Motors Research Laboratory, 12 July 1979), p. 12.

[27] U.S. Dept. of Transportation, *TSM: State of the Art*, pp. 46-47.

be encouraged to drive alone. However, recent experiences in Sacramento, Toronto and Ottawa have indicated that this assumption is invalid, and that in most instances, carpooling and transit use actually increase.[28] Chapter II explores these experiences in depth.

Statement of Problem

Flextime has been implemented by numerous firms and agencies since its inception some ten years ago, and the results have been overwhelmingly positive from the standpoints of labor, management and impacts upon the transportation system. The Federal Highway Administration, the Urban Mass Transportation Administration, the U.S. Department of Energy and other government agencies have identified the concept of flextime as a realistic and low cost alternative for lessening traffic congestion, improving air quality and conserving energy.[29] Flextime is a valid concept, and is advocated, to some degree, by virtually all transportation related agencies.

There does, however, appear to be some question as to how flextime would affect other programs to lessen urban traffic congestion which are advocated by the agencies mentioned in the preceding paragraph. Since changes in work schedule imply changes in existing living patterns, it has been assumed that some impact on carpooling and transit use would

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[28] Ibid.

[29] Tennessee Department of Transportation, *Summary Report — Tennessee's Statewide Transportation Plan* (Nashville, Tennessee: Tennessee Department of Transportation, 1977), pp. viii-1—viii-12.

occur if flextime were implemented. In the past, planners and policy-makers have automatically assumed that such impact would be negative, and that persons would be encouraged to drive alone. The fear of disrupting established carpooling incentive schemes and transit marketing programs, within which a great amount of money has been invested in recent years, has discouraged many decision-makers and planners from actively supporting flextime in environments where it could conceivably be implemented.

Despite several studies to the contrary, the assumption that flextime has a negative impact upon carpool formation and maintenance and upon transit use persists. There may be several reasons why this assumption is so deeply rooted, but the lack of a sizeable body of research, wherein the impact of flextime upon transportation mode choice has been definitively studied, appears to be a major one. Most past studies of flextime program impacts have concentrated on the managerial and labor oriented impacts of its implementation. The transportation mode choice data which evolved from such studies was, for the most part, of a secondary nature, and was seldom examined with any real scrutiny.

Purpose of Thesis

The purpose of this thesis is to study, as a primary objective, the impact of flextime on how people travel to and from work. More specifically, it attempts to determine if flextime has any impact on carpooling and transit use patterns of persons who formerly worked on a rigid 8:00 a.m. to 4:30 p.m. schedule. Secondary objectives of the thesis are: to

describe the characteristics of urban peak period travel; to examine flextime as a means of reducing peak period travel congestion; and to predict possible impacts of a large scale flextime program on urban travel congestion, air quality and energy consumption.

Research Questions and Organization

Chapter I defined flextime, described how it works, addressed its institutional benefits and drawbacks and described its general transportation system impacts. The remainder of this thesis focuses on the primary research question: Does the implementation of flextime affect persons' choice of transportation mode used for home-to-work travel?

The first part of Chapter II, through an assessment of urban travel characteristics and various means of dealing with persistent peak period congestion problems, provides a foundation from which flextime, as a congestion reducing technique, is examined. Past experiences with flextime are reviewed, and the relationship of flextime to carpooling and transit use is described. The latter part of Chapter II introduces the case study of three governmental agencies located in Nashville, Tennessee, which have worked on a flextime schedule.

Chapter III analyzes the results of the survey utilized in the case study and addresses the following research questions:

1. Is there any change in the number of persons carpooling before and after flextime was implemented?
2. Is there any change in the number of persons riding mass transit before and after flextime was implemented?

3. Does flextime influence whether or not persons carpool with persons who work at a different location?
4. Does flextime influence whether or not persons carpool with persons who have different working hours?
5. What factors related to flextime influence a person's choice of travel mode?

With this data at hand, generalized implications of a projected flextime program for government employees in downtown Nashville, Tennessee, are examined. Impacts on peak-hour travel, air pollution and energy consumption are projected and generalized conclusions are drawn.

Chapter IV assesses the results of the literature review and case study presented in Chapters II and III and identifies areas for future research.

CHAPTER II

FLEXTIME AND URBAN TRAVEL

Characteristics of Peak-Hour Travel

A study of the impact of flextime on urban travel must begin by first examining the basic characteristics of urban travel, particularly the capability of urban transportation systems to meet the concentrated spatial and temporal travel demands caused by home-to-work trip making, a phenomenon popularily known as "rush-hour." The peaking of daily travel characteristic of urban areas is best studied within the framework of human activity patterns. The most common daily activities (except sleeping) are working or attending school. Next come activities needed for keeping a household, such as shopping and banking. Finally there is a need for socializing, recreation and attending cultural events. The combined effect of the scheduling of each individual activity is what determines the hourly traffic pattern within a given day.[1] Some of the activities which necessitate travel may be undertaken on a more time-flexible basis than others, but the most rigid, generally, is work. It is widely accepted that the principle determinate of the magnitude of peak-hour travel is the scheduling of the work day.

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[1] National Capital Region Transportation Planning Board, *Altering Work Hours to Reduce Congestion* (Washington, D.C.: National Capital Region Transportation Planning Board, November 1971), pp. 1-2.

Rush-hour traffic is not confined solely to work commuting trips. Shoppers, students and tourists are among those who may be traveling during the same hours as persons on their way to and from work. Nonetheless, journeys between home and work make up almost one-third of all vehicle miles of travel and comprise a far greater proportion during the peak commuting hours.[2] Data gathered for the Bureau of Labor Statistics by the Bureau of the Census, as part of the Current Population Survey (CPS) in May, 1973 and 1974, provides some insight into national patterns of work start and stop times. The CPS found that nationwide, there was a sharp peak in the starting times for workers around 8:00 a.m., and an even sharper peak in stopping times around 4:00 p.m. Figure II-1 shows that some 26,000,000 wage and salary workers, almost two-fifths of the total, usually started work at, or about, 8:00 a.m., and that some 37,000,000 workers, more than half the total, usually stopped work at, or about, 4:00 p.m. These two daily peaks predominated in both goods-producing and service industries and in government. It was concluded that the prominence of the morning and afternoon traffic peaks was attributable, in part, to the fact that far more full time wage and salary employees usually worked from 8:00 a.m. to 4:00 p.m. than any other schedule. In addition, almost 1,000,000 part-time workers worked from 8:00 a.m. to 4:00 p.m., one to four days per week. Traffic around the 4:00 p.m. peak was further exacerbated by the 4,000,000 full and

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[2]Janice Neipert Hedges, "Work Schedules and the Rush Hour," *Monthly Labor Review*, July 1975, p. 43.

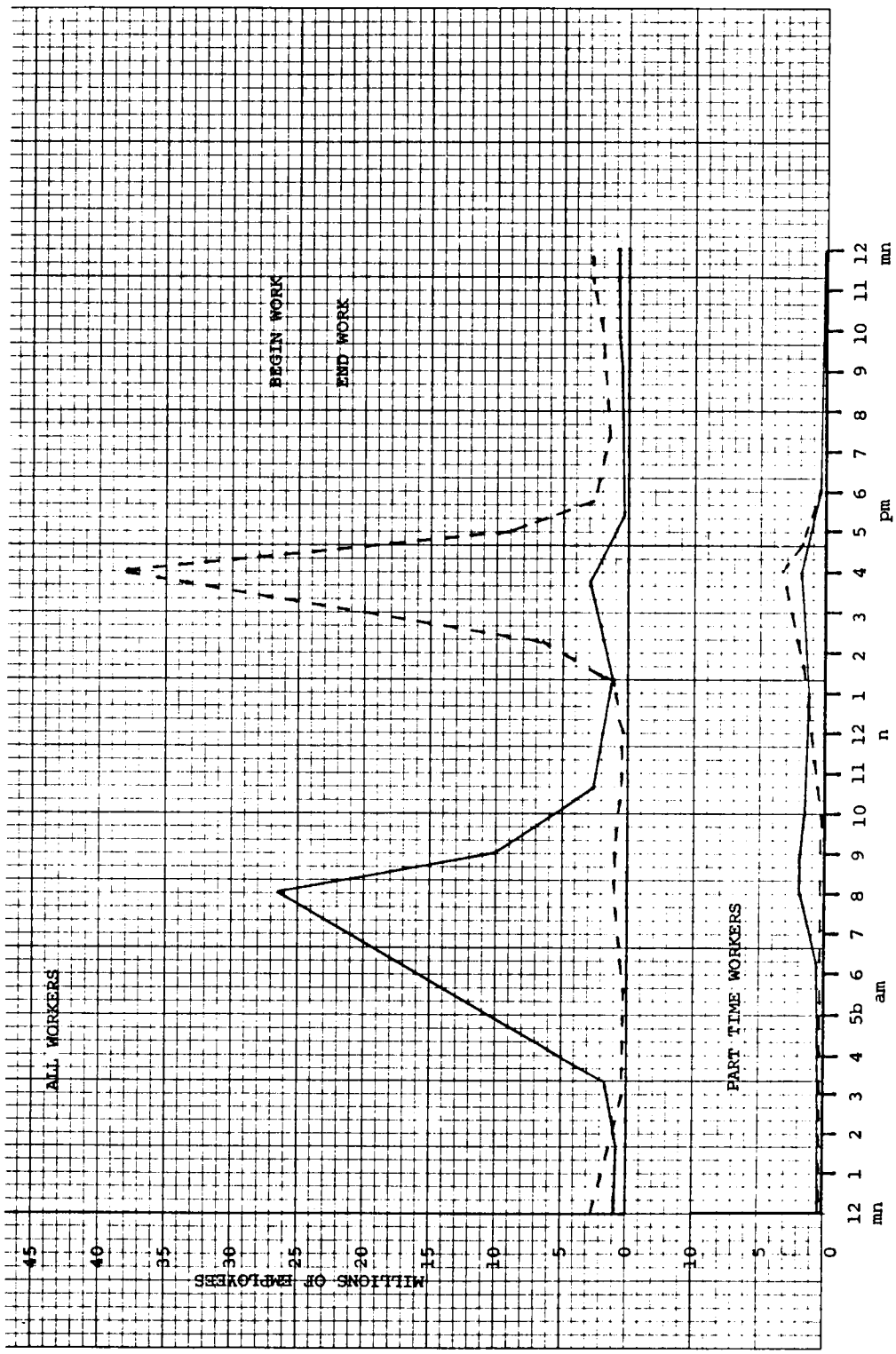

Figure II-1. Work Start and Stop Times of All Wage and Salary Workers, May, 1974.

Source: Janice Neipert Hedges, "Work Schedules and the Rush Hour," *Monthly Labor Review*, July 1975, p. 45.

part-time employees, in roughly equal numbers, who started work at that hour.[3]

The aggregate effect of individual travel decisions on regional and urban roadway and transit systems, is that approximately 9 to 10 percent of daily travel can be expected to occur in each of the day's two peak periods. In most cities, traffic entering the core area has an even higher peak.[4] Figure II-2 shows a profile of daily trip making in the Metropolitan Nashville-Davidson County, Tennessee, urban area — a typical case of peaked travel demand. The figure shows that approximately 20 percent of all daily travel occurs during two periods of the day — 7:30 to 8:30 a.m. and 4:30 to 5:30 p.m.[5] This pattern of peaked travel demand was further documented in a survey of major employers performed by the Metropolitan Planning Commission of Nashville-Davidson County in 1978. This survey found that approximately 67 percent of the workers surveyed started their jobs between the hours of 7:30 and 8:30 a.m., thereby creating a corresponding peak in vehicular traffic and transit patronage. Since most worked a 7-1/2 to 8-1/2 hour day (including 1/2 to 1 hour for lunch) a similar, though less pronounced, peak occurred

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[3]Paul B. Svercl and Ruth H. Asin, *National Personal Transportation Study, Home-to-Work Trips and Travel* (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1973), Report 8, p. 10.

[4]National Capital Region Transportation Planning Board, *Altering Work Hours*, pp. 2-3.

[5]Tennessee Department of Transportation, Office of Research and Planning, *Nashville Urban Area Transportation Study, Update Methodology and Technical Memorandum — 1959 and 1970* (Nashville, Tennessee: Tennessee Department of Transportation, 1975).

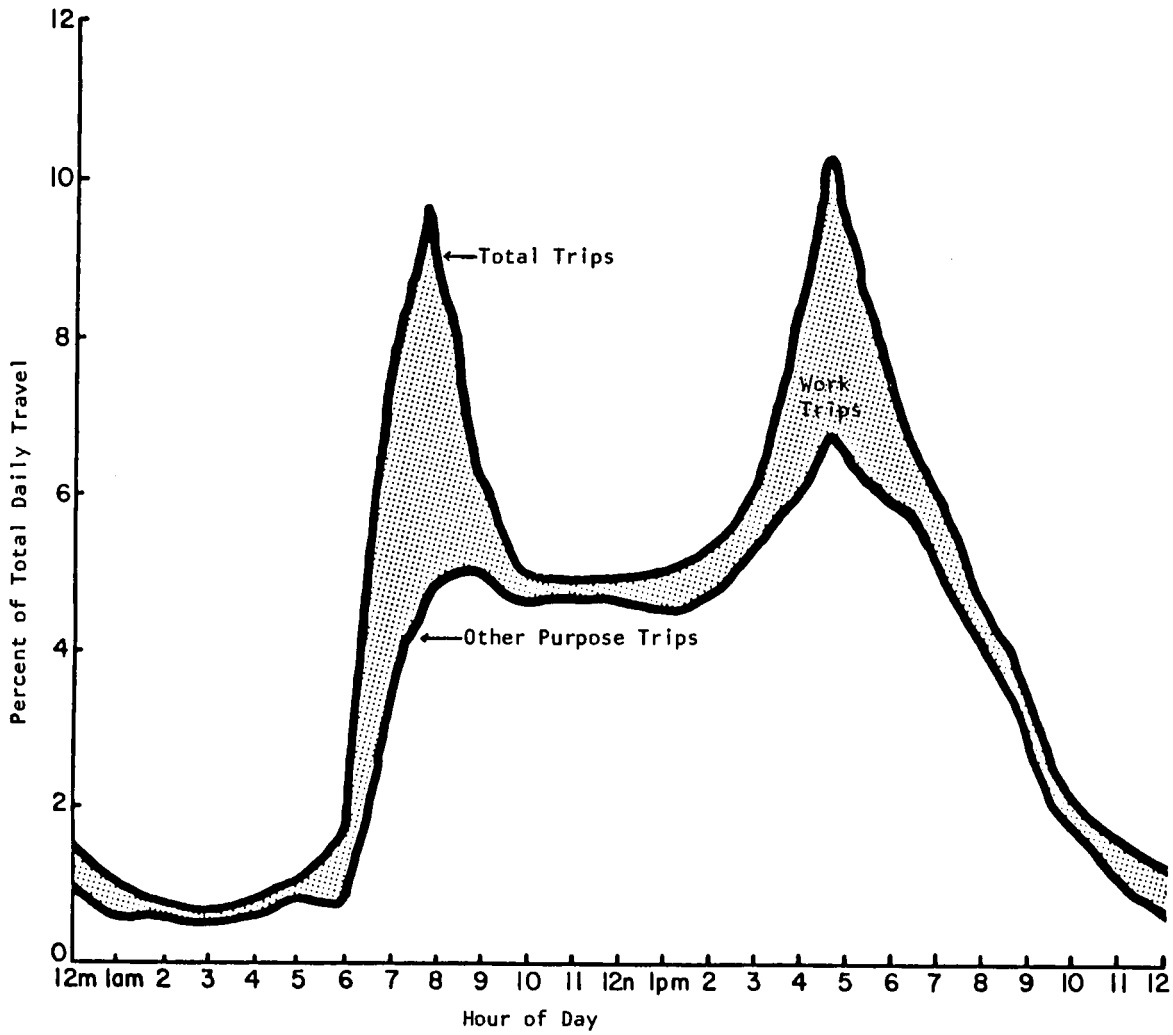

Figure II-2. Volume of Trips by Time of Day, Nashville, Tennessee, 1970.

Source: Tennessee Department of Transportation, Office of Research and Planning, *Nashville Urban Area Transportation Study, Update Methodology and Technical Memorandum - 1959 & 1970* (Nashville, Tennessee: Tennessee Department of Transportation, 1975).

between 4:30 and 5:30 p.m. Hourly traffic counts taken at selected locations along major transportation arteries further substantiated the existence of this condition.[6] Such a peaking pattern, as is exhibited in Nashville, is repeated, with possible minor shifts in the precise times of the peak periods, in cities throughout the world.[7]

The problems created by the clustering of work start and stop times, and the generation of travel which results from such clustering, are described in Chapter I. However, one needs only to observe, first hand, the congested streets and highways or a typically crowded transit coach during the morning or evening rush-hours in virtually any American city, to realize the magnitude of the peak-hour congestion problem. Remak and Rosenbloom, in a study conducted for the Transportation Research Board, concluded that:

> Traffic congestion is basically a supply and demand problem. Because congestion conditions exist when demand for roadway is greater than can be efficiently accommodated by the existing road system, the problem must be treated by increasing the capacity of the system to meet the demand or by reducing demand so that it can be handled effectively within the existing capacity.[8]

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[6]Metropolitan Planning Commission of Nashville and Davidson County, *Staggered Working Hours Study* (Nashville, Tennessee: Metropolitan Planning Commission of Nashville and Davidson County, October 1979).

[7]Norman Morton, *Staggered Hours in Industry and Their Effect on Transport* (Great Britain: University of Newcastle upon the Tyne, 1972), p. 44.

[8]Roberta Remak and Sandra Rosenbloom, "Peak Period Traffic Congestion — Options for Current programs," *National Cooperative Highway Research Report 169* (Washington, D.C.: National Research Council, 1976), p. 62.

A similar conclusion may be applied where transit systems are concerned. If the demand for space on a bus or rail car exceeds the number of seats available, either additional seats must be provided or the demand reduced so that it can be handled by the existing seats.

Highway and transit agencies have traditionally approached the peak-hour congestion problem by attempting to increase the capacity of their systems to meet the demand.[9] The 1950's and 1960's urban freeway programs, in particular, were massive attempts to accommodate an ever increasing number of automobiles, many of which were traveling to and from increasingly distant work locations. However, it gradually became clear, that despite the existence of the travel-elastic funding provided by the Highway Trust Fund, the demand for travel within urban areas continued to exceed the capacity of virtually every roadway system constructed. In addition, the continued buildup of capital-intensive highway systems has become increasingly controversial in light of mounting concern with economic, social, energy and environmental impacts. The increasing realization that more and more miles of new roadway are not the ultimate solution to urban peak-hour travel congestion is rather strongly stated by Norman Morton:

> It is the necessity to meet the maximum demand for traffic at peak periods which results in the destruction of the urban environment — the wilderness of roads, the flyovers, the

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[9]Although for many years the level of transit ridership in the U.S. declined, recent trends indicate a steady increase in riders. Much of this increase has resulted from attempts by transit agencies to extend additional service to peak-hour commuters in suburban areas, thus requiring larger fleets of vehicles and more employees.

> underpasses, the viaducts, the noise, the smell, the universal slabs of concrete and glass which replace the historic buildings and picturesque cobbles and alleys, and the steady abandonment of public transport in the main cities. And perhaps, worst of all, is the enormous and continuing cost in terms of sheer money money to accomplish this destruction.[10]

Of special concern in the decade of the 1980's are the problems of energy and air quality. Transportation and energy are two complex and interwoven systems which play vital roles in the American economy and style of life. With the increasing costs and uncertainty of supply of energy, especially for petroleum products, energy conservation has become an increasingly important goal of public policy. Conservation of energy in the transportation sector is especially important because petroleum products are the dominant transportation energy source. It is generally concluded that the largest single use of oil in the United States is for gasoline, and that the biggest single use of gasoline is in auto commuting.[11] Energy conservation is also advantageous because it offers one means of alleviating the "energy-environment" dilemma. Those actions which tend to reduce energy consumption often also lead to reductions in air pollution.[12]

The increasing economic and social impacts related to the construction of expensive and frequently environmentally disruptive street and highway systems, along with the combined national concerns with energy and air

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[10]Morton, *Staggered Hours in Industry*, p. 43.

[11]C. Carroll Carter, "Editorial," *Mass Transit*, March 1980, p. 5.

[12]Dilip R. Limaye and Jeffrey P. Price, *Energy and Environmental Implications of Alternative Work Patterns* (Princeton, N.J.: MATHTECH, Inc., March 1977), p. 1.

quality, have encouraged planners and policy-makers to begin to approach the congestion problem by attempting to reduce or spread travel demand so that it may be accommodated, to the maximum extent possible, within the existing system capacity. Remak and Rosenbloom, in a study of peak hour congestion, concluded that:

> 1. In general, solutions aimed at reducing demand are preferable to those aimed at the supply side of the equation. Techniques that work toward decreasing the numbers of vehicles attempting to use overcrowded roads during peak commuting hours tend to provide more lasting solutions to congestion than those that attempt to increase the capacity of the system to meet continually growing needs for more commuter room.
>
> 2. Congestion is to a certain extent a self-regulating phenomenon. Congestion in itself acts as a deterrent to drivers choosing to add their vehicles to an already overcrowded roadway. When road capacity is increased, this deterrent is weakened, and although, for a time, traffic flows more smoothly, new users are soon attracted to the improved route until congestion conditions reappear.
>
> 3. The self-regulating phenomenon is more pronounced in large urban areas than in smaller ones. The smaller economic base in less populated urban areas places limits on needs to commute to work, and techniques directed toward increasing road capacity may be relatively long-lasting, especially if supported by other techniques aimed at reducing travel demands in critical locations. However, the larger, more volatile economy of major urban areas produces an almost endless supply of commuters, who quickly adjust their travel-to-work patterns to take advantage of improved traffic conditions.[13]

Several means of reducing the daily peak periods of congestion on city streets, highways and transit vehicles have been suggested. Although these techniques vary considerably in their direct effectiveness in reducing congestion, their cost of implementation, their indirect benefits and disbenefits, the time lapse between implementation and

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[13] Remak and Rosenbloom, "Peak Period Congestion," pp. 62-63.

realization of benefits, and the duration of these benefits, they may, for research purposes, be categorized into four major types of approaches:

1. Social Approaches — Techniques that attempt to alter travel behavior and ultimately traffic congestion, by first altering interpersonal behavior and habit through social incentives. These techniques include variations in work scheduling such as flexible work hours, staggered work hours and variable work weeks.

2. Socioeconomic Approaches — Techniques that attempt to alter human social and economic behavior primarily through incentives considered to be broadly economic. Altered behavior in turn leads to travel patterns that reduce demands on transportation systems in peak periods. Such techniques include pricing and regulatory mechanisms, restriction of access, land-use planning, marketing, and carpooling or other ride-sharing.

3. Sociotechnical Approaches — Techniques that use technological devices to modify social behavior at or near the immediate source of traffic congestion. Such techniques include different means of using communications in lieu of travel.

4. Technical Approaches — Measures that use technology directly to modify travel behavior at or near the immediate source of traffic congestion. These approaches include practical traffic engineering, transit operations, and vehicle design factors.[14]

The basic subject of this thesis, flextime, is included in the social approaches category.

Flextime and Peak Period Congestion

Flextime, in theory, affects peak period travel congestion by redistributing the times at which the largest number of daily trips are made. In flexible working hours programs, the lack of congestion in off-peak periods tends to induce workers, given the choice, to reorient their work trips to off-peak periods. Other factors such as nonwork

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[14] Ibid., p. 6.

activity scheduling or prearranged ride-sharing may contribute to the determination of work start and stop times for workers on flextime. Nevertheless, the avoidance of peak period congestion is a primary motivating factor for choosing a particular work schedule.[15]

Many experts disagree as to the actual impact of flextime on urban travel congestion. Such disagreement is largely the result of the lack of a significant body of definitive research concerning the travel related effects of flexible working hours. A substantial number of studies concerning the impact of flextime on employee morale, attitude, productivity and managerial control were conducted in Europe during the 1960's. Almost none of these studies, however, analyzed the transportation implications of flextime in any depth.[16] Studies conducted in the United States have also tended to place most of their emphasis on the nontransportation impacts of flextime. Because flextime is such a new phenomenon, and definitive research concerning its impacts on transportation systems is lacking, it is necessary to attempt to predict its transportation system impacts by paralleling it with a similar variable working hours technique, staggered hours.

A staggered hours work schedule consists of the assignment of different work arrival and departure times to different groups of workers. For example, one group may work from 7:30 a.m. to 4:00 p.m., another from

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[15] David W. Jones, Takuya Nakamato, and Matthys P. Cilliers, *Flexible Work Hours: Implications for Travel Behavior and Transport Investment Policy* (Berkeley, California: Institute of Transportation Studies, December 1977), pp. 20-22.

[16] Ibid., p. 5.

8:00 a.m. to 4:30 p.m., and another from 8:30 a.m. to 5:00 p.m. The major difference between staggered hours and flextime is that, under a staggered hours program, work start and stop times are designated for groups of employees, where, under a flextime program, an employee may choose, within an established range, when he or she, individually, wishes to start and stop work.[17] Although flextime and staggered hours work schedules differ with respect to an individual employee's choice of work start and stop times, their impacts on peak-hour traffic flow are theoretically similar.[18] Both techniques attempt to spread work arrival and departure times over a longer time period, thereby causing a flattening of the traditional rush-hour peak in traffic flow and transit patronage.

The most ambitious staggered work hours program to date was implemented in New York City, during the early 1970's, to relieve peak period congestion on subways and buses, and in elevators. According to surveys taken before and after initiation of the Manhattan Staggered Work Hours Program, the program successfully achieved its objectives. On the Lower Manhattan Subway Line, 6 percent fewer passengers were carried during the busiest 10 minute period. At the Port Authority Trans-Hudson (PATH) Terminal, the passenger volume during the busiest 15 minute evening period dropped from 7,500 to 6,500, while passenger

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[17] For a detailed discussion of the definitions of flextime and staggered hours see pages 3 and 4 above.

[18] Remak and Rosenbloom, "Peak Period Congestion," p. 7.

volume during the lightest 15 minute period rose from 3,100 to 4,600.[19] The study did not mention any tendency to change mode of travel as a result of the staggered work hours.

Another study of the impact of a combination of staggered hours and flextime on peak period congestion was conducted in Toronto, Ontario, Canada, in 1973 and 1974. In this study entitled "Staggered Hours Demonstration," approximately 11,000 Ontario public servants working at the Queen's Park Complex in Toronto were surveyed after the implementation of a staggered hours and flextime program. It was found that there was a shift in the travel peak of government employees using the public transit system serving the Queen's Park area. Before the demonstration, the peak distribution of commuters occurred between 8:00 and 8:30 a.m. After six months of the program, the distribution of morning commuters appeared to peak between 7:45 and 8:00 a.m., with more people traveling prior to, and fewer traveling during, the former peak. The peak distribution in the afternoon also spread over a longer time, because more people were leaving before the former peak. Figures II-3 and II-4 illustrate the peaking characteristics of passenger loading on the Yonge Subway Line, and show government employees' use of the line in the morning and evening peak periods as observed in 1973 and 1974 travel surveys.[20] The Toronto study made no mention of congestion

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[19] U.S. Department of Transportation, *TSM: State of the Art* (Washington, D.C.: Government Printing Office, February 1977), p. 44.

[20] A. M. Greenburg and D. M. Wright, *Staggered Hours Final Evaluation — Queen's Park Demonstration, Research Report 198* (Ontario, Canada: Ministry of Transportation and Communications, May 1975), pp. 1-20.

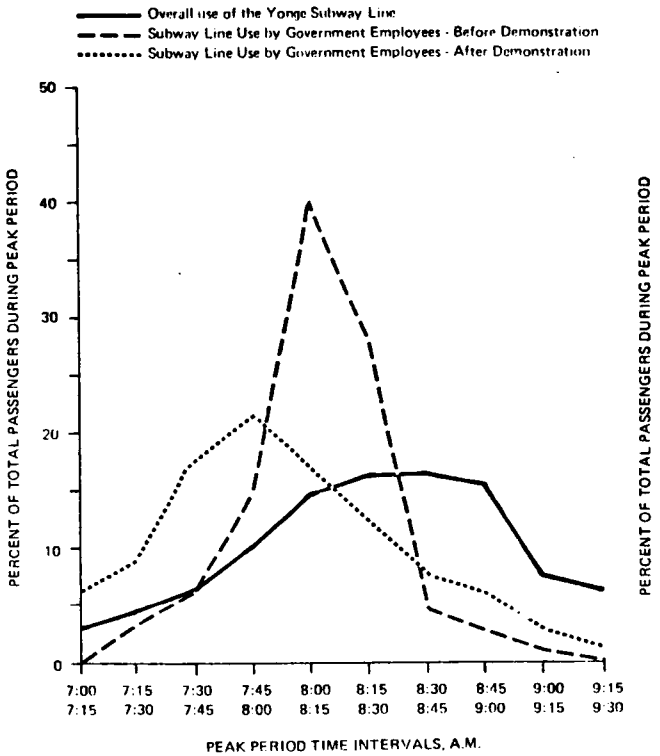

Figure II-3. Fifteen Minute Variations in the Use of the Yonge Subway Line, a.m.

Source: A.M. Greenburg and D.M. Wright, *Staggered Hours Final Evaluation - Queen's Park Demonstration, Research Report 198* (Ontario, Canada: Ministry of Transportation and Communications, May 1975), p. 2.

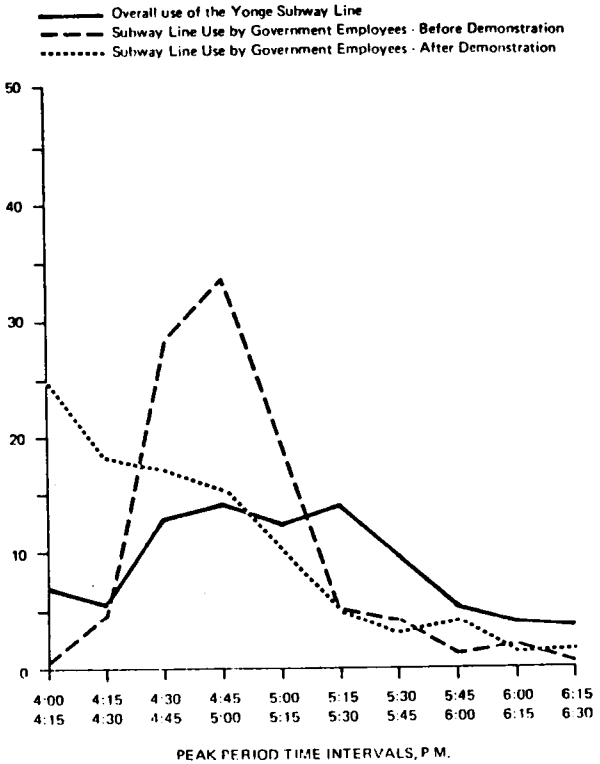

Figure II-4. Fifteen Minute Variations in the Use of the Yonge Subway Line, p.m.

Source: A.M. Greenburg and D.M. Wright, *Staggered Hours Final Evaluation - Queen's Park Demonstration, Research Report 198* (Ontario, Canada: Ministry of Transportation and Communications, May 1975), p. 3.

relief on highways and surface streets. A shift toward carpools was reported, but much of this shift was attributed to the energy shortage which existed during much of the program period.[21]

Staggered hours programs have most frequently been implemented in an attempt to reduce congestion around entrances and streets associated with a large employment center.[22] The 3-M Company in St. Paul, Minnesota, developed a staggered hours program for this purpose. The 3-M industrial complex, which contains both laboratory and administrative facilities, consisted of 15 buildings on some 200 acres, and employed approximately 8,000 persons. In 1970, the 3-M Company began to become concerned about possible congestion, as their projected employment figure for 1980 reached 16,000. The access to this sprawling complex from nearby arterials and interstate highways was somewhat limited, and congestion near the center had increased over a period of years. In the years prior to 1970, various traffic engineering improvements had been made in an attempt to handle the increase in traffic congestion. Multiple turn lanes, ramp widening, channelization, one-way roads and other physical changes were made. However, despite all these efforts, delays at several entrances and exits existed during each peak hour. Although the delays to individual vehicles were generally less than 5 minutes, analyses indicated that the roads were near capacity, and small increases volumes could significantly increase delays.

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[21]Paul P. Jovanis and Adolf D. May, *Flextime Travel Choice: A Literature Review and Framework for Analysis* (Berkeley, California: Institute for Transportation Studies, January 1979), p. 16.

[22]U.S. Department of Transportation, *TSM: State of the Art*, p. 44.

The congestion problem at the 3-M complex was studied, and different means of solving it were tested. As a result of such tests, the Company, in May of 1972, implemented a variable work hours program consisting of a combination of staggered hours and flextime. To check the magnitude of the effect of variable hours on traffic congestion, traffic counts using 15 minute recorders were made in May, 1972 in many of the same locations counted in an earlier study conducted in 1970. It should be noted that, between the two counting periods, area population grew 12.2 percent and center employment grew 10.7 percent. The results, shown in Table II-1, indicate that a.m. traffic at all stations grew by 35.5 percent, close to the 33.6 percent expected due to population and employment growth. However, a.m. rush-hour volumes grew only 16.9 percent and peak 15 minute volumes grew 12.7 percent. Considering only the center entrances, a.m. volumes grew 66.6 percent, peak-hour volumes only 36.6 percent and peak 15 minute volumes only 15.7 percent. At external counting stations, reductions in peak-hour percentages were observed, indicating that the variable work hours program affected peripheral routes as well.

The results during the p.m. period, shown in Table II-2, were more dramatic in that daily p.m. volumes grew 12 percent, but peak-hour volumes decreased 2.4 percent, and peak 15 minute volumes decreased 12 percent. The variable work hours actually decreased peak-hour volumes despite an overall increase in traffic.

The significance of the 3-M variable work hours program as a valid congestion reducing measure can best be illustrated by the peak-hour

Table II-1

Rush Hour Traffic Count Results (a.m.), 3-M Company

	1970			1972		
	A.D.T.	Peak Hour	Peak 15 Min.	A.D.T.	Peak Hour	Peak 15 Min.
All Stations	32705	8884	3065	44330	10387	3455
1970-72 Diff.				+11625	+ 1503	+ 390
% Change				+ 35.5%	+ 16.9%	+ 12.7%
3M Ent.Only	4747	2698	1104	7969	3418	1192
1970-72 Diff.				+ 3222	+ 720	+ 88
% Change				+ 67.9%	+ 26.7%	+ 8.0%
External Loc. Only	27688	4578	1437	36361	5577	1845
1970-72 Diff.				+ 8693	+ 999	+ 408
% Change				+ 31.3%	+ 21.8%	+ 28.3%

Source: Robert D. Owens and Glen H. Vanwormer, "The Effect of Staggered Working Hours on Traffic Volumes at a Large Industrial Complex," *Traffic Engineering*, March 1975, p. 64.

Table II-2

Rush Hour Traffic Count Results (p.m.), 3-M Company

	1970			1972		
	A.D.T	Peak Hour	Peak 15 Min.	A.D.T.	Peak Hour	Peak 15 Min.
All Stations	52525	9445	3455	73008	11249	3632
1970-72 Diff.				+20483	+ 1804	+ 177
% Change				+ 39.0%	+ 19.1%	+ 5.1%
3M Exit Only	4576	2528	1161	5127	2467	1022
1970-72 Diff.				+ 551	— 61	— 139
% Change				+ 12.0%	— 2.4%	— 12.0%
External Loc. Only	26038	4099	1366	38374	5387	1597
1970-72 Diff.				+12336	+ 1288	+ 231
% Change				+ 47.4%	+ 31.4%	+ 16.9%

Source: Robert C. Owens and Glen H. Vanwormer, "The Effect of Staggered Working Hours on Traffic Volumes at a Large Industrial Complex," *Traffic Engineering*, March 1975, p. 64.

percentages of daily traffic shown in Table II-3. The table shows that there was a general percentage decrease at both in-bound and out-bound counting stations during peak-hours after staggered and flexible hours were implemented. Overall, it was concluded that the variable working hours program implemented by 3-M was highly successful in reducing peak period traffic congestion at the company's complex.[23]

Staggered and flexible work hours programs were also investigated in Chicago and Atlanta, but conflicts prevented the programs from advancing beyond the planning stages. In Chicago, difficulties were encountered with expanding rail services beyond the existing peak periods, because of conflicts with freight trains. In Atlanta, a significant proportion of workers were scheduled to be shifted to later than the traditional 9:00 a.m. work start time. This resulted in so much resistance from employers and employees that the program was discontinued soon after it began.[24]

The results of previously implemented staggered work hours and flextime programs indicate that such work scheduling techniques do have some impact on transportation congestion. Most large-scale staggered hours and flextime programs which have been implemented were primarily concerned with the peaking problems of transit operations. The major recipients of most positive impacts of such work schedule changes,

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[23]Robert D. Owens and Glen H. Vanwormer, "The Effect of Staggered Working Hours on Traffic Volumes at a Large Industrial Complex," *Traffic Engineering*, March 1975, pp. 61-64.

[24]Jovanis, *Flextime Travel Choice*, p. 16.

Table II-3

Peak Hour Percentages of A.D.T., 3-M Company

YEAR	INBOUND STATION							
	#1	#2	#4	#5	#7	#9 SB	#11	#12
1970	11.2%	17.1%	70.1%	53.7%	58.9%	22.4%	31.1%	21.4%
1972	8.8%	17.4%	55.5%	32.3%	55.7%	17.8%	28.3%	22.3%
YEAR	**OUTBOUND STATION**							
	#1	#3	#6	#8	#9 NB	#10	#12	
1970	13.5%	15.4%	54.2%	45.3%	18.3%	35.8%	21.3%	
1972	13.3%	13.8%	48.8%	43.2%	15.6%	31.9%	13.4%	

Source: Robert D. Owens and Glen H. Vanwormer, "The Effect of Staggered Working Hours on Traffic Volumes at a Large Industrial Complex," *Traffic Engineering*, March 1975, p. 64.

therefore, were transit systems. In addition, such studies were facilitated by the fact that the number of passengers carried during specific time periods, by transit vehicles, was easily and accurately measured. The impact of work rescheduling on street and highway traffic congestion, for the most part, was ignored or inadequately measured in past study efforts. Also, because past programs of work rescheduling have been either small employer-based operations or area-wide programs characterized by very limited participation, the measurement of the impact of such programs on peak-hour automobile congestion throughout an area-wide transportation system has been difficult.

The lack of accurate systemwide measurement of the impact of flextime or staggered work hours programs on street and highway traffic congestion has led some researchers to determine that such impact would be small. Tannir concludes that the congestion reducing impact of all alternative schedule policies, inlcuding flextime, in medium sized, automobile-oriented cities is small, and that individual high employment area impacts are quickly dissipated into the surrounding traffic. His findings, however, do not imply that there is no congestion reducing impact associated with alternative work scheduling, but only that such programs, by themselves, should not be viewed by planners as a panacea for traffic congestion.[25] Remak and Rosenbloom, in a study conducted for the Transportation Research Board, likewise acknowledge that the potential for congestion reduction through implementation of daily work

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[25]Annis A. Tannir and David T. Hartgen, *Impacts of Work Schedule Changes on Traffic Congestion in Medium Sized Urban Areas* (Albany, N.Y.: New York State Department of Transportation, June 1977), pp. 26-27.

schedule alterations is small. However, they also report that the joint implementation of a variety of compatible congestion reducing techniques can be significantly more effective in reducing peak period congestion than implementation of an individual technique.[26] Jones, Nakamoto and Cilliers, in their study of flextime in Sacramento, also acknowledge that the implementation of flexible working hours alone is insufficient to significantly improve freeway performance. They do state, however, that a program utilizing flextime and other congestion reducing measures could suffice as an alternative to other proposed capital-intensive measures to handle peak-hour traffic.[27]

Although a large body of research concerning the specific magnitude of the impacts of flextime on urban travel is lacking, the available data does support the following conclusions:

1. The theoretical basis supporting the potential for flextime to spread or "flatten" daily travel peaks, thereby reducing rush-hour congestion, is sound.
2. Flextime is frequently advocated as a valid technique for reducing peak period travel congestion.
3. The implementation of flextime, by itself, is not considered to be a total solution to peak period travel congestion.
4. If combined with other compatible congestion reducing techniques, flextime would contribute to an overall reduction in peak period travel congestion.

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[26] Remak and Rosenbloom, "Peak Period Congestion," pp. 7, 63.

[27] Jones, *Flexible Work Hours*, p. 36.

The first three of the above conclusions establish flextime as a feasible means of lessening peak-hour travel congestion. The fourth conclusion serves as an introduction to the basic issue which this thesis will address: The impact of flextime on two other widely advocated congestion reduction techniques, carpooling and transit use. The following sections of Chapter II explore the relationships between flextime and two travel modes (carpools and mass transit), and describes the case study developed for the purpose of addressing the research questions described in Chapter I.

Carpooling and Transit Use as Congestion Reducing Measures

One of the most widely advocated, and potentially most effective, techniques for reducing peak-hour travel congestion is ridesharing. Ridesharing approaches aim at reducing peak period congestion by increasing the number of occupants in each vehicle on the road. Carpools are the most familiar and widespread form of ridesharing, but subscription buses, vanpools, and group use of taxis also exist. The common characteristics of all forms of ridesharing are: (a) the ride is shared with other travelers; (b) there is some route deviation to pick up and drop off individual travelers; and (c) access to the service is determined by prior arrangement with other passengers.[28]

Among the various forms of commuter ridesharing, carpooling offers the strongest and most feasible tool available to cut the vehicle miles

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[28] Remak and Rosenbloom, "Peak Period Congestion," p. 9.

of travel (VMT) resulting from work trips. Already, more passengers are carried in carpools than in all other forms of mass transportation combined.[29] By raising auto occupancy 30 percent above the current level of 1.6 passenger miles per vehicle mile to 2.1, the commuter VMT could be reduced 22 percent. The 30 percent increase is believed to be a realistic goal, considering that all successful carpool programs to date have exceeded this goal.[30]

Carpooling is advocated as a primary means of reducing peak-hour congestion by virtually every transportation related agency in government. In addition, the United States Department of Energy and the Environmental Protection Agency advocate the use of carpooling as a means of accomplishing their goals of reduced energy consumption and improved air quality.[31] It may be concluded, therefore, that carpooling has been established as a recognized means of lessening peak period travel congestion.

Another widely advocated method of reducing peak period travel congestion is to increase the number of passengers using mass transit for commuting to and from work. The Current Population Survey found that, in 1974, 8.4 percent of all home to work trips were made via public transportation.[32] If this percentage could be increased

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[29]Lew Pratsch, "Carpools: The Underutilized Resource," *Civil Engineering*, January 1974.

[30]Ibid.

[31]Limaye and Price, *Energy and Environmental Implications of Alternative Work Patterns*, p. 1.

[32]Svercl and Asin, *Nationwide Personal Transportation Study*, p. 23.

within the existing capacity of public transportation systems, a dramatic reduction in peak-hour traffic congestion would result. Additionally, since transit vehicles are up to 15 times more efficient than automobiles, a significant energy savings would result if more commuters used public mass transportation.[33] The potential for reduced peak-hour traffic through increased use of mass transit is, however, limited to those areas served by mass transit systems. It may be concluded, therefore, that where it is available, increased use of mass transit is an established means of reducing peak period traffic congestion.

However, carpooling and increased use of mass transit, like all other congestion reducing techniques, by themselves do not present a total solution to the urban travel congestion problem. Remak and Rosenbloom, in a study conducted for the Transportation Research Board, state that joint implementation of compatible congestion reducing techniques can be significantly more effective in reducing peak period traffic congestion than the implementation of an individual technique.[34] The following paragraphs explore the relationship between carpooling and transit use, and flextime as jointly implementable methods of reducing peak period travel congestion.

Impact of Flextime on Carpooling and Transit Use

Carpooling and transit use are widely recognized and strongly advocated methods of reducing peak-hour traffic congestion. Carpooling

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[33] American Public Transit Association, *Transit Fact Book, 1978-1979 Edition* (Washington, D.C.: American Public Transit Association, 1979), p. 50.

[34] Remak and Rosenbloom, "Peak Period Congestion," p. 63.

reduces congestion by increasing vehicle occupancy and consequently reduces the number of vehicles used for commuting. Transit does likewise, to a greater degree. Flextime, on the other hand, is a relatively new phenomena and has had little support as a potential traffic congestion reducing measure. Flextime has been fairly thoroughly assessed from the viewpoint of organizational productivity and employee satisfaction. However, flextime has not yet been systematically assessed as to its impact on travel behavior and transportation system performance. To date, flextime has been resisted by many in the transportation community because of the assumption that it will promote auto use and discourage carpooling and transit patronage. Jones, Nakamoto and Cilliers state that this view seems to be fairly widely shared in the transportation planning community. They state that the assumption that flextime and carpooling or transit use are incompatible is based on the hypotheses that:

> Congestion and the wear and tear of driving in heavy traffic are incentives for bus use and other forms of ride-sharing.
>
> The ability to avoid the peak of the peak would encourage more riders to take to the road as drivers seeking the superior speed and flexibility of auto mobility.
>
> Concurrent work hours are the "glue" that holds carpools together.[35]

Such conventional wisdom, however, is not supported by fact.

Jovanis states that as of January, 1979, only three major studies of the tendency of persons working under flextime to change travel mode

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[35]Jones, *Flexible Work Hours*, p. 16.

had been undertaken. All three of these studies reported an increase in carpoolers and transit users of approximately 10 percent each.[36] In addition, the results of a survey of employees of the U.S. Geological Survey Center in Reston, Virginia, indicated that there was a slight increase in the number of employees using carpools during the one year period of their experimental flextime program. Bus use during the same period was virtually unaffected. These mode choice decisions took place despite the results of a feasibility study done prior to the implementation of the flextime program which indicated that there would be slight decreases in both carpooling and public transportation use.[37]

The only one of the above mentioned studies which made any significant attempt to address flextime's impact on a number of social, transportation and work related topics which may have some effect on a person's travel mode choice, was a survey of the California Department of Water Resources, a state agency located in downtown Sacramento, California. Flextime was introduced to the employees of the Division of Water Resources (DWR) in 1974 for its Sacramento based work force of 1300. Three years after the introduction of flextime, the agency evaluated the program preparatory to making the innovation permanent. In 1977, all of the DWR employees were surveyed by means of a questionnaire. The questionnaire, which was returned in usable form by 576

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[36] Jovanis, *Flextime Travel Choice*, pp. 19-21.

[37] U.S. Geological Survey, Branch of Management Analysis, *Comprehensive Report of a One-Year Experiment with Flexitime at the U.S. Geological Survey* (Reston, Virginia: U.S. Geological Survey, August 1977), p. 43.

employees, sought information on a number of issues related to flextime and its impacts upon the organization and work habits of its employees.[38] In addition, several questions related to travel behavior were asked. The major findings of the survey, relative to travel behavior were:

> 11 percent of the respondents reported a change in travel mode in the three years since flextime was introduced.
>
> 12 percent of the respondents reported that they carpooled more frequently since flextime was introduced.
>
> 14 percent of the respondents reported that they rode the bus more frequently since flextime was introduced.
>
> 11 percent of the respondents reported that they drove their car alone less since flextime was introduced.[39]

The scheduling autonomy and variability permitted by flextime seems to have allowed some "regular drivers" to use carpools or ride buses on an irregular, but more frequent basis. This accounts for the discrepancy in the number of persons who reported a change in travel mode, and the number who reported an increase in their use of carpools and transit.[40]

In addition, the Sacramento study found that flextime is most often used to improve the match between personal schedules, travel schedules, and work schedules, rather than solely as an opportunity to change travel mode. The authors of the study acknowledged that any mode changes indicated in the study could be explained by a large number of factors: changes in home location; transit service improvements; waiting list preference for carpool parking and increases in the out-of-pocket costs

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[38] Jones, *Flexible Work Hours*, p. 18.

[39] Ibid., pp. 22-24.

[40] Ibid., p. 24.

of driving. However, open-ended responses solicited by the questionnaire indicated that flextime was an instrumental factor in many of the mode change decisions. Survey results indicated that flextime seemed to "open-up" employee time budgets in a fashion that permitted employees to experimentally "test-ride" buses and carpools. The survey responses also suggested that flextime served to alter the relative travel times of the competing modes and, therefore, their comparative utility to the user. This was particularly true where mass transit was concerned. The study also suggested that flextime encouraged carpooling in tow special circumstances: it permitted the formation of multiple work place carpools which were previously discouraged by incompatible work start times; and it permitted working mothers to pool their children to school or day care with greater ease and reduced schedule friction. The effect of flextime on carpooling seemed to net positive due, in part, to an increase in husband-wife carpools, a subset of the class of multiple work place carpools.[41] Open-ended question responses suggested that many of these pools would not have been feasible in the absence of flextime.[42]

The survey findings suggested that flextime was a marginal factor in carpool formation. However, flextime did seem to relax scheduling constraints that allowed other factors such as cost and parking availability to play themselves out more forcefully than they might have in the absence of flextime. The truly significant finding of the study

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[41] Ibid., pp. 24-26.

[42] Ibid., pp. 28-31.

was, that while flextime did not appear to be a powerful incentive for carpooling, its marginal effect did seem to be positive, and not negative as predicted by the conventional wisdom. The overall findings of the survey of DWR employees led the authors to conclude that the conventional wisdom concerning the impact of flextime on carpooling was in error. Instead, they found that flextime appeared to offer a significant advantage to some classes of carpoolers. On the net, they concluded that flextime was definitely a factor in the increased share of carpooling relative to the single occupancy automobile.[43]

In the Sacramento study, transit ridership increased among those employees who reported changes in travel behavior as a result of flextime. The avoidance of peak-hour crushes and travel delays characteristic of rush-hour transit service, and the elimination of wasted "wait-time," were key factors causing this modal shift.[44] It is impractical for transit systems to adjust their schedules to suit individual riders, but the riders can easily adjust to more convenient transit schedules under flextime.

Overall, the impact of flexible working hours on carpooling and transit use was positive in the Sacramento study. The following results were observed for those persons who changed their travel behavior:

carpooling increased by 9 percent;

sole-driving declined by 20 percent; and

regular transit use increased by 15 percent;[45]

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[43] Ibid., pp. 25-30.

[44] Ibid., p. 26.

[45] Ibid., p. 25.

Some of the transportation mode shift which occurred among DWR employees in Sacramento could be attributed to other causes, but the study done by Jones, Nakamoto and Cilliers concludes that flexible working hours may have a positive, and not a negative, impact on carpooling and transit use as previously assumed. Thus, it appears that rigid work hours may not be the "glue" that holds carpools together, and, in fact, may be more likely to be a factor which frustrates the formation of common-origin/multiple-destination carpools.[46]

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[46]Ibid., p. 27.

CHAPTER III

THE NASHVILLE CASE STUDY

Introduction

Flextime is a relatively new work scheduling technique in the United States and, as yet, has not been widely practiced. In the Nashville, Tennessee area, flextime has not been implemented on a large scale, but a few small governmental operations have experimented with it. Three such agencies form the basis for the case study presented below.

The Division of Air Pollution Control of the Tennessee Department of Public Health, the Tennessee Energy Authority and the Nashville office of the Federal Highway Administration have been working on flextime for a period of one to two years. These agencies were determined suitable for study, in combination, because they had the following common characteristics:

1. All had previously maintained a rigid 8:00 a.m. to 4:30 p.m. work schedule for all employees.
2. All are located in the Nashville, Tennessee, central business district.
3. All were engaged in the same basic type of work — administrative and regulatory.
4. All were governmental agencies employing comparable percentages of management, professional and clerical personnel.

5. All used a similar variation of flextime wherein employees were required to maintain a particular set of working hours once they, as individuals, chose a work schedule.

The employees of the three governmental agencies described above were surveyed in order to obtain information concerning their experiences with flextime. The survey instrument used as the basic research tool of the case study consisted of a questionnaire containing 16 questions, some of which had a number of subparts. The questionnaire was developed primarily to address issues related to the impacts of flextime on the travel behavior of the employees of the agencies involved in the case study. However, in order to aid the organizations which cooperated in the case study, a number of other questions dealing with the impact of flextime on the work environment were asked. The responses to these questions are shown in Table III-1. The questions contained in the survey instrument which dealt with the transportation impacts of flextime were designed to answer the basic research questions described in Chapter I. The questionnaire, which is shown in the Appendix, was designed to obtain the following information:

Questions 1, 2 and 3 asked for basic data related to each employee: job title (management or nonmanagement); frequency of work in the Nashville office; and present working hours.

Question 4 asked each employee what impact flextime had had on activities directly or indirectly related to his/her travel to and from work.

Table III-1

Summary of Responses to Questions Concerning Personnel and Productivity Aspects of Flextime for Managers and Nonmanagers

THE FREQUENCY OF ABSENTEEISM AND SHORT-TERM LEAVES:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	16.0%	27%	46%	5.5%	0	5.5%
Non-Managers	14.0%	17%	43%	0	0	26.0%

THE ABILITY TO ASSEMBLE MEETINGS AND CONDUCT TEAMWORK:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	0	8%	43%	35.0%	8%	6.0%
Non-Managers	9.0%	16%	39%	11.0%	1%	24.0%

THE ABILITY TO COVER INCOMING PHONE CALLS AND PUBLIC INQUIRIES:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	0	19%	46%	19.0%	8%	8.0%
Non-Managers	14.0%	24%	29%	4.0%	3%	26.0%

THE QUALITY OF STAFF/MANAGEMENT RELATIONS:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	5.5%	32%	40%	14.0%	3%	5.5%
Non-Managers	13.0%	21%	45%	0	0	21.0%

THE TIME AND PAPERWORK ASSOCIATED WITH PAYROLL AND SCHEDULING:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	0	6%	59%	16.0%	0	19.0%
Non-Managers	3.0%	3%	51%	1.0%	3%	39.0%

THE OVERALL PRODUCTIVITY OF YOUR UNIT:

	Major Positive	Minor Positive	No Impact	Minor Negative	Major Negative	No Opinion Not Relevant
Managers	8.0%	19%	45%	3.0%	3%	22.0%
Non-Managers	20.0%	26%	43%	0	0	11.0%

Questions 5, 6 and 7 were asked at the request of the agencies surveyed and have no direct relationship to this thesis. However, the responses to these questions are shown in Table III-1.

Questions 8, 9, 10 and 14 asked employees for basic travel data: how they got to and from work; if they carpooled with persons who had different work hours or worked at a different location; and how far they traveled to and from work and how long this trip took.

Questions 11, 12, and 13 asked employees to state how their choice of travel mode would be affected if they were forced to work on a rigid 8:00 to 4:30 work schedule.

Questions 15 and 16 asked employees if they had changed their mode of travel since they started working on flextime and why they changed, if they did.

The three governmental agencies chosen for study were very similar in organizational structure and type of work performed. Prior to the distribution of the study questionnaire, interviews with key management personnel within each organization were conducted in order to establish survey procedures and to gather insight from the management perspective relative to the functioning of flextime within their particular work environments. Supervisory personnel, as anticipated, were not overly concerned with the impact of flextime on how employees got to and from work, but were very interested in the work performance aspects of this new form of work scheduling. Although such managerial matters are not

the concern of this thesis, a brief discussion of them is presented prior to the detailed description and analysis of the survey data related to the impacts of flextime on carpooling and transit use.

After testing and refining the questionnaire, copies were distributed to 125 employees of the Division of Air Pollution Control of the Tennessee Department of Public Health, the Tennessee Energy Authority and the Nashville office of the Federal Highway Administration during January and February of 1980. A total of 107 usable questionnaires were returned for a response rate of 85.6 percent. The results of the survey and the implications of these results on the travel behavior of the respondents involved in the case study are discussed in the following sections of this chapter.

Flextime and the Work Environment

The successful implementation of any new program depends largely on the continued support and supervision by management personnel. The implementation of flextime in all of the organizations involved in the Nashville case study was no exception to this general rule. Although upper level management in all of the organizations studied was at first somewhat skeptical of the workability of flextime, especially in terms of its impact on productivity, all later agreed that most of this skepticism had been unwarrented. Those interviewed reported that little overall impact on day to day work performance was evident.[1] One

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[1] Interviews with selected supervisory personnel of the Division of Air Pollution Control of the Tennessee Department of Public Health, the Tennessee Energy Authority and the Nashville office of the Federal Highway Administration, Nashville, Tennessee, January through March 1980.

supervisor felt that, in his opinion, employee morale and some types of work performance had shown improvement since flextime was implemented, and that he had, on occasion, used the existence of flextime in his organization as a recruiting incentive.[2] All supervisors interviewed did admit to some initial concern about the potential abuse of work hours, especially by those employees who arrived early or left late. However, all agreed that once flextime programs within their agencies were established, little abuse occurred.[3] Two managers stated that some minor abuse of working hours occurred when rigid work schedules were used and that no appreciable change was noted after flextime was implemented.[4] This observation corresponded with experiences of other past studies of flextime programs.[5]

Since the management of the organizations involved in this case study was very concerned with the personnel and productivity aspects of flextime, it was agreed that several questions related to such aspects would be included in the survey questionnaire. A summary of the responses to these questions by management and nonmanagement personnel is shown in Table III-1.

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[2]Interview with section manager in the Division of Air Pollution Control of the Tennessee Department of Public Health, Nashville, Tennessee, January 1980.

[3]Interviews with selected supervisory personnel, 1980.

[4]Ibid.

[5]Sylvia Lewis, "'We Love It!' Say People Who Work Under Flextime," *Planning*, January 1978, pp. 15-16.

The Survey

The questionnaires which were distributed to employees of the Division of Air Pollution Control of the Tennessee Department of Public Health, the Tennessee Energy Authority and the Nashville office of the Federal Highway Administration were tabulated and analyzed. The following section of Chapter III describes the general results of the survey, explores, in detail, the survey results related to the impact of flextime on carpooling and transit use, addresses the basic research questions of this thesis and describes specific findings relative to the case study.

General Survey Results

A total of 107 persons responded to the questionnaire. Of this total, 48 or 44.9 percent stated that their working hours differed from the 8:00 a.m. to 4:30 p.m. work schedule to which they previously adhered. Table III-2 shows the distribution of work start and stop times for all respondents. A total of 59, or 55.1 percent, chose to continue to work from 8:00 a.m. to 4:30 p.m. Two respondents reported that their work start and stop times varied because of particular job requirements, but that their schedules fell somewhere between 7:00 to 8:30 a.m. and 3:30 to 5:00 p.m.

The means by which the respondents traveled to and from work is of primary importance to this study. Table III-2 shows the working hours of survey respondents by travel mode. Table III-3 shows the home-to-work travel mode distribution of all respondents. A total of 57, or

Table III-2

Working Hours of Survey Respondents by Travel Mode

Work Hours	Carpool		Bus		Drove Alone		Other		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
7:00 - 3:30	2	35.0	1	4.3	7	28.0	1	50.0	11	10.3
7:30 - 4:00	16	28.1	5	21.8	4	16,0	0	0	25	23.4
8:00 - 4:30	34	59.6	14	60.9	11	44.0	0	0	59	55.1
8:30 - 5:00	5	8.8	2	8.7	2	8.0	1	50.0	10	9.3
Variable	0	0	1	4.3	1	4.0	0	0	2	1.9
TOTAL	57	100.0	23	100.0	25	100.0	2	100.0	107	100.0

Table III-3

Home-to-Work Travel Mode of Survey Respondents

Number	Percent	Travel Mode
25	23.3	Drove a Car Alone
57	53.2	By Carpool
23	21.5	By MTA Bus
2	2.0	By Other Means (Bicycle, walk)
107	100.0	TOTAL

53.2 percent, of those surveyed traveled to work in carpools of 2 to 7 persons. A total of 25 persons, or 23.2 percent, drove a car alone to work; 23, or 21.5 percent, traveled by bus; and 2 persons walked or rode a motorcycle. The overall distribution of mode choice shown by the respondents compared favorably with a "Summary of Employee Commuting" performed by the Tennessee Department of Transportation in April of 1979, wherein 49.2 percent carpooled, 26.6 drove a car alone, 23.1 percent rode the bus and 1.0 percent used other means.[6] A more detailed analysis of flextime and travel mode choice is presented in later sections of this chapter.

This thesis does not attempt to delve into the relationship between flextime and home-to-work distance and travel time. However, for descriptive purposes and to aid in future research endeavors, the respondents were asked to indicate their home-to-work travel distance and travel time. The mean home-to-work one-way travel distances by mode were: 12.7 miles for carpoolers; 12.2 miles for those who drove alone; and 9.0 miles for bus riders. The mean home-to-work travel times by mode were: 25.0 minutes for carpoolers; 25.1 minutes for those who drove alone; and 25.8 minutes for bus riders. A more detailed description of home-to-work travel times and distances for the respondents is shown in the Appendix.

The questionnaire asked each respondent to assess the impact of flextime on a variety of personal activities:

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[6]Tennessee Department of Transportation, "Summary of Employee Commuting," Nashville, Tennessee, April 1979.

convenience in doing shopping and running errands;

ability to arrange time with family and friends;

ability to arrange for child care or getting the kids to school, and

satisfaction with job and work responsibilities.

The questionnaire used a scaling technique which allowed employees to respond: a major positive impact; a minor positive impact; no noticeable impact; a minor negative impact; a major negative impact; or, no opinion/not relevant. A summary of the responses to the questions concerning the impact of flextime on personal activities for those respondents who reported a change in working hours since flextime was implemented is shown in Table III-4.

Although the responses shown in Table III-4 are not directly related to the impact of flextime on travel mode choice, they do shed some light on nontravel related reasons why persons who chose to change working hours did so. One of the activities which was, to some degree, related to the avoidance of peak-hour travel congestion was "convenience in doing shopping and running errands." Of the respondents who changed working hours, 27, or 59 percent, reported that flextime had a positive impact on their ability to carry out this activity. There were no negative responses to this question.

A question which was relevant only to those respondents with children dealt with the impact of flextime on their "ability to arrange for child care or getting the kids to school." A total of 8, or 42.1 percent, of those persons who answered this question (excepting

Table III-4

Impact of Flextime on Personal Activity Scheduling
for Respondents Who Changed Working Hours

PERSONAL ACTIVITY		MAJOR POSITIVE	MINOR POSITIVE	NO IMPACT	MINOR NEGATIVE	MAJOR NEGATIVE	NO OPINION
Convenience in Doing Shopping and Running Errands	(Number)	15	12	14	0	0	5
	(Percent)	33	26	30	0	0	11
Ability to Arrange for Child Care or Getting the Kids to School	(Number)	6	2	11	0	0	27
	(Percent)	13	4	24	0	0	59
Ability to Arrange Time With Family and Friends	(Number)	16	10	16	0	0	4
	(Percent)	35	22	35	0	0	8
Satisfaction With Your Job and Work Responsibilities	(Number)	24	6	13	0	0	3
	(Percent)	52	13	29	0	0	6

those who answered no opinion/not relevant) indicated that flextime had a positive impact. Many of the positive responses to this question may be related to the fact that child care center and school hours frequently did not coincide with the standard 8:00 a.m. to 4:30 p.m. work schedule, and that flextime made it easier to make such schedules compatible. However, the fact that child care transportation activities could be carried out more quickly and easily during off-peak hours, thereby saving time for the working parent, was of some importance to respondents who elaborated on this subject when answering open-ended questions.

Flextime had a positive impact on respondents' ability to arrange personal social activities as indicated by 26, or 56.5 percent, who responded positively to the question about the "ability to arrange time with family and friends." There were no negative responses to this question. Flextime also had a positive impact on respondents' "satisfaction with their job and work responsibilities." A total of 30, or 65.2 percent, indicated a positive response to this question. There were no negative responses.

The choice of travel mode of the respondents appeared to have little relation to the way they responded to the questions concerning flextime and personal activity scheduling. Table III-5 shows a breakdown of responses, by travel mode, to the questions concerning the impact of flextime on personal activity scheduling for those respondents who changed hours. The responses were generally consistent with the overall findings, with the exception that an extremely high

Table III-5

Impact of Flextime on Personal Activity Scheduling
for Respondents Who Changed Working Hours
by Travel Mode

PERSONAL ACTIVITY		MAJOR POSITIVE			MINOR POSITIVE			NO IMPACT			MINOR NEGATIVE			MAJOR NEGATIVE			NO OPINION		
		Car pool	Bus	Drove Alone	Car pool	Bus	Drove Alone	Car pool	Bus	Drove Alone	Car pool	Bus	Drove Alone	Car pool	Bus	Drove Alone	Car pool	Bus	Drove Alone
Convenience in Doing Shopping and Running Errands	#	6	3	6	7	2	3	10	2	2	0	0	0	0	0	0	0	2	3
	%	26	33	43	30	22	21	43	22	14	0	0	0	0	0	0	0	22	21
Ability to Arrange for Child Care or Getting the Kids to School	#	2	3	1	1	0	1	8	2	1	0	0	0	0	0	0	12	4	11
	%	9	33	7	4	0	3	35	22	7	0	0	0	0	0	0	52	44	79
Ability to Arrange Time With Family and Friends	#	6	4	6	5	2	3	12	2	2	0	0	0	0	0	0	0	1	3
	%	26	44	43	22	22	21	52	22	14	0	0	0	0	0	0	0	11	21
Satisfaction With Your Job and Work Responsibilities	#	9	7	8	5	0	1	8	1	4	0	0	0	0	0	0	1	1	1
	%	39	78	57	22	0	7	35	11	29	0	0	0	0	0	0	4	11	7

percentage of bus riders reported a major positive impact on their job satisfaction and work responsibilities.

The responses to the questions concerning the impact of flextime on personal activity scheduling were consistent with surveys of employee attitudes toward flextime in Common Market nations and the United States to date.[7] The Nashville case study, like previous studies, indicates that personal activity scheduling flexibility is a factor in an employee's decision to change work hours under flextime.[8]

Impact of Flextime on Carpooling

Three of the research questions stated in Chapter I were concerned specifically with the relationship between flextime and carpooling. The research questions were:

> Is there any change in the number of persons carpooling before and after flextime was implemented?
>
> Does flextime influence whether or not persons carpool with persons who work in a different location?
>
> Does flextime influence whether or not persons carpool with persons who have different work hours?

In addition, another research question, "What factors related to flextime influence a person's choice of travel mode?" is strongly related to the flextime/carpooling questions. In order to address the

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[7] David W. Jones, Takuya Nakamoto, and Matthys P. Cilliers, *Flexible Work Hours: Implications for Travel Behavior and Transport Investment Policy* (Berkeley, California: Institute of Transportation Studies, University of California, December 1977), p. 43.

[8] Ibid., pp. 42-44.

research questions stated above, the survey instrument utilized in the case study asked several questions. The responses to these questions are described below.

When asked, "Since you started working on a flextime schedule, do you carpool more frequently, less frequently or about the same as you did under a rigid 8:00 a.m. to 4:30 p.m. schedule?," the respondents' replies were:

50, or 87.7 percent, carpooled about the same;

6, or 10.5 percent, carpooled more frequently; and

1, or 1.8 percent, carpooled less frequently.

However, of the 57 persons who regularly carpooled to and from work, 34 continued to work on an 8:00 a.m. to 4:30 p.m. schedule. Since these persons did not change their work schedules, it is assumed that flextime had little direct impact on their choice of travel mode. A total of 23 respondents stated that since flextime was implemented, they had changed work hours. A detailed breakdown of their work hours is shown in Table III-2 on page 58. It is necessary to examine this group separately in order to get a true picture of the relationship between flextime and carpooling. Of those respondents who changed hours:

21, or 91.3 percent, carpooled about the same;

2, or 8.7 percent, carpooled more frequently; and

0 carpooled less frequently.

The responses shown above strongly indicate that flextime had no negative impact on the respondents' decisions to carpool, and, in fact, show a slight positive impact.

In an effort to substantiate the responses to the previous question, another question was asked relative to work hours and carpooling. When asked, "If you worked on a rigid 8:00 a.m. to 4:30 p.m. schedule rather than on flextime, would you carpool more frequently, less frequently or about the same?" the respondents who had changed work hours replied:

20, or 87.0 percent, would carpool about the same;

0 would carpool more frequently; and

3, or 13.0 percent, would carpool less frequently.

The responses to this question support the validity of the responses to the previous question and serve to substantiate the finding that flextime had no negative impact on the respondents' decisions to carpool. In addition, the fact that 13.0 percent of the respondents stated that they would carpool less if they returned to an 8:00 a.m. to 4:30 p.m. schedule indicated somewhat more strongly than the previous responses that rigid 8:00 a.m. to 4:30 p.m. work scheduling might have a slightly negative impact on workers' propensity to carpool to and from work.

The respondents who reported a change in work hours were asked to assess flextime in terms of its impact on "the ease of carpooling to work." The responses to this question were:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	7	6	6	1	0	3
%	30.4%	26.1%	26.1%	4.4%	0	13.0%

A total of 82.6 percent of the respondents indicated that flextime had either a positive impact or no impact on their ease of carpooling. Only 1 respondent indicated a negative impact.

Another question which was related to the impact of flextime on carpooling asked what impact flextime had on the commuters' "ability to avoid the peak of the commute hour crush." The respondents who carpooled and changed work hours answered:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	16	5	1	0	0	1
%	69.5%	21.7%	4.4%	0	0	4.4%

Most of the respondents indicated that flextime had a positive impact on their ability to avoid the peak of the commute hour crush. These responses seem to indicate that carpoolers realize the value of avoiding peak hour congestion and that by doing so can perhaps "make up" for some of the inconveniences of carpooling.

Of a total of 11 persons who responded to a question concerning the impact of flextime on the "ability to arrange for child care or getting the kids to school" 3, or 27.3 percent, reported a major positive impact and the remainder reported no impact.

Of those respondents who changed working hours, 6, or 26.1 percent, carpooled with persons who worked in a different location. A total of 5, or 21.7 percent, carpooled with persons with a different set of working hours than 8:00 a.m. to 4:30 p.m. When asked "If you worked on a rigid 8:00 a.m. to 4:30 p.m. work schedule, rather than on

flextime, would you be more or less likely to carpool with persons who worked in a different location?," 5 of those respondents who presently carpooled with persons who worked in a different location, responded that they would be less likely to do so. When asked "If you worked on a rigid 8:00 to 4:30 work schedule, rather than on flextime, would you be more or less likely to carpool with persons who have different working hours than 8:00 a.m. to 4:30 p.m.?," all of those who presently carpooled with persons who had different working hours than 8:00 a.m. to 4:30 p.m. responded that they would be less likely to do so.

Of all of the respondents who carpooled and changed work schedules, 16, or 69.5 percent, stated that if they worked on a rigid 8:00 a.m. to 4:30 p.m. schedule, they would be less likely to carpool with persons who worked in a different location. A total of 18, or 78.3 percent, reported that if they worked on a rigid 8:00 a.m. to 4:30 p.m. schedule, they would be less likely to carpool with persons who worked different hours.

Two open-ended questions which dealt with the flextime/carpooling relationship were asked in order to allow the respondents, when necessary, to explain the specific reasons for their commuting behavior. The responses to these questions not only provided additional insight into why the commuters answered the other questions as they did, but also served to distinguish the impact of flextime from other changes in the travel environment which may influence travel behavior. The open-ended questions and a sampling of the responses to them were:

If you did change your commuting habits after flextime was implemented, please explain why and whether flextime was an important factor in that change.

"Flextime permits adjusting hours so that my wife and I can drive one car to work rather than driving separately."

"A secondary benefit is less traffic in both directions — about a 10 minute savings each way."

"Flextime allowed our carpool to avoid heavy traffic."

"Flextime allowed us to arrive in time to obtain free parking."

If working on a rigid 8:00 a.m. to 4:30 p.m. schedule would change your commuting habits, please explain why and how.

"Would require the use of second car more frequently."

"All persons with whom I carpool work from 7:30 to 4:00. Therefore, I would have to drive alone if I worked from 8:00 to 4:30."

"I would not be able to drop my son and his carpool off at school."

"Commuting would be more time consuming and aggravating due to increased traffic congestion."

Survey results. The results of the survey which pertain to the impact of flextime on carpooling are summarized below:

1. A large percentage of carpoolers (59.9%) chose to continue to work on an 8:00 a.m. to 4:30 p.m. schedule. There could be several reasons for respondents to continue to work on an 8:00 a.m. to 4:30 p.m. schedule, but one which was expressed by several respondents was that the established carpools, of which they were members, were geared to an 8:00 a.m. to 4:30 p.m. schedule. Although flextime had no direct impact on the respondents' decisions to choose to work from 8:00 a.m. to 4:30 p.m., it did enable them to do so if they so desired. In

many cases this freedom enabled them to continue existing ridesharing arrangements.

2. Flextime had no negative impact on carpooling among those respondents who changed from their former 8:00 a.m. to 4:30 p.m. work schedule. A small positive impact was shown by the number of respondents who indicated that they carpooled more often under flextime than under their former 8:00 a.m. to 4:30 p.m. schedule. Although other factors such as energy costs and automobile availability may have played some role in this shift toward carpooling, the open-ended question responses indicated that flextime frequently enabled respondents to carpool with persons who worked on different schedules than 8:00 a.m. to 4:30 p.m. This was especially true in cases of husband/wife and parent/child carpools.

3. The respondents indicated that flextime had a slightly positive effect on their perception of the ease of carpooling. Even more significant was the fact that practically no respondents indicated that flextime had impacted negatively on their ability to carpool. This is contrary to prevailing assumptions concerning flextime and carpooling.

4. The ability to avoid the peak of the commute hour "crush" was important to carpoolers. Since carpooling is generally less convenient and more time-consuming than driving one's own car alone, it stands to reason that carpoolers would be keenly aware of any improvement in travel conditions brought about by traveling during off-peak hours. Also, since carpoolers jointly pay the expenses of commuting, the cost savings due to more economical travel, and, in some cases, decreased

parking costs, resulting from off-peak travel, contributed to a strong positive response to flextime.

5. Flextime had a slight positive impact on the ability of respondents to arrange for child care and school transportation.

6. Flextime was a positive factor enabling respondents to carpool with persons who worked at a different location. The increased ease of traveling during off-peak periods, and the ability to adjust schedules so as not to waste time waiting for a carpool, offered by flextime, made carpooling with persons who work at a different location less inconvenient than under a rigid 8:00 to 4:30 work schedule.

Impact of Flextime on Transit Use

One of the research questions stated in Chapter I was concerned specifically with the relationship between flextime and transit use. The research question was: Is there any change in the number of persons using transit before and after flextime was implemented? Another research question concerned with the flextime/transit use relationship was: What factors related to flextime influence a person's choice of travel mode? In order to address these research questions, the survey instrument asked several questions, the responses to which are described below.

When asked, "Since you started working on a flextime schedule, do you ride the bus more frequently, less frequently or about the same as you did under a rigid 8:00 a.m. to 4:30 p.m. schedule?," the respondents' replies were:

14, or 61.0 percent, rode the bus about the same;

9, or 39.1 percent, rode the bus more frequently; and

0 rode the bus less frequently.

Of the 23 persons who regularly rode the bus to and from work, 14 continued to work on an 8:00 a.m. to 4:30 p.m. schedule. Since these persons did not change their work schedule, it is assumed that flextime had little direct impact on their choice of travel mode. However, several of these respondents indicated that the bus which they rode maintained a schedule which necessitated that they work from 8:00 a.m. to 4:30 p.m. If they were given the opportunity to ride a bus with a different schedule, they might change work hours.

A total of 9 respondents indicated that since flextime was implemented, they had changed work hours. A detailed breakdown of their work hours is shown in Table III-2 on page 58. Of those respondents who changed work hours and rode the bus regularly to and from work:

6, or 66.6 percent, rode the bus about the same;

3, or 33.4 percent, rode the bus more frequently; and

0 rode the bus less frequently.

The responses indicate that flextime had no negative impact on the respondents' decisions to ride the bus and, in fact, had a fairly strong positive impact. In addition, all three of the respondents who reported that they rode the bus more often, also stated that they drove alone less often, indicating a shift from driving alone to transit since flextime was implemented.

When asked, "If you worked on a rigid 8:00 a.m. to 4:30 p.m. schedule rather than on flextime, would you ride the bus more frequently, less frequently, or about the same?," the respondents who changed work hours replied:

8, or 89 percent, would ride the bus about the same;

1, or 11 percent, would ride the bus less often; and

0 would ride the bus more often.

The responses to this question support the validity of the responses to the previous question concerning the number of respondents who would ride the bus about the same. However, two of the respondents indicated that they would not return to driving alone if they had to work on a rigid 8:00 a.m. to 4:30 p.m. schedule, indicating that factors other than bus scheduling or flextime prompted their decision to ride transit.

The respondents who reported a change in work hours were asked to assess flextime in terms of its impact on their "ease of using the bus." The responses to this question were:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	9	0	0	0	0	0
%	100%	0	0	0	0	0

All of the respondents indicated that flextime had a major positive impact on their ease of using the bus.

Another question which was related to the impact of flextime on transit use asked what impact flextime had on the commuters' "ability

to avoid the peak of the commute hour crush." The respondents who changed work hours answered:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	5	1	1	1	1	0
%	56.0%	11.0%	11.0%	11.0%	11.0%	0

A total of 67 percent of the respondents indicated that flextime had a positive impact on their ability to avoid the peak of the commute hour crush. Transit users, for the most part, realized the benefits of traveling during off-peak periods. Less crowded coach conditions and improved travel times are obvious benefits associated with off-peak transit use. Flextime, in some cases, also allowed bus users to ride on buses with schedules that were more convenient to them, and which caused considerable wasted "wait-time" when they worked on an 8:00 a.m. to 4:30 p.m. schedule. Of those respondents who reported a negative impact on the ability to avoid the peak hour crunch, one indicated that the bus which he rode was an express and ran only once each morning. He, therefore, realized little change when he went on flextime. The other negative respondent did not elaborate on why he felt a negative impact.

An open-ended question which dealt with the flextime/transit use relationship was asked in order to allow the respondents, when necessary, to explain the specific reasons for their commuting behavior. The question and a sampling of the responses to it were:

If you did change your commuting habits after flextime was implemented, please explain why and whether flextime was an important factor in that change:

> "Started riding bus more after flextime; biggest reason — able to connect with early bus."
>
> "Less traffic lets me save time each way."
>
> "It represented a savings of time each day of about one hour."
>
> "I started working flextime because I could get home and be there when the kids got out of school so they wouldn't be there by themselves."
>
> "If bus schedule changed, I would need to change my working hours in order to commute to and from work by bus. Therefore, flextime appears to be an important factor available to me to adjust my schedule to get to and from work."

Survey results. The results of the survey which pertain to the impact of flextime on transit use are summarized below:

1. A large percentage of bus users (60%) chose to continue to work on an 8:00 a.m. to 4:30 p.m. schedule. There could be a variety of reasons why some persons chose to work on an 8:00 a.m. to 4:30 p.m. schedule, but the fact that transit service is largely geared to a similar schedule is a significant one. Transit express service, especially, is very limited, and in most cases is scheduled to arrive downtown between 7:30 and 8:00 a.m. An important fact exhibited by the responses, however, was that flextime had no negative impact on whether those persons who worked from 8:00 a.m. to 4:30 p.m. used transit. All apparently rode transit for other reasons such as energy costs, auto availability, etc., and through flextime were able to

continue to do so. The ability to change work hours was not considered important enough for them to switch to another travel mode.

2. Flextime had no negative impact on transit use among respondents who changed from the former 8:00 a.m. to 4:30 p.m. work schedule. A sizeable positive impact was shown by the percentage of respondents (33.4%) who rode the bus more often under flextime than under their former 8:00 a.m. to 4:30 p.m. schedule. All of the persons who changed mode shifted from driving alone to transit. Although other factors may have played some role in this shift to transit, the open-ended question responses indicated that flextime enabled respondents to adapt their schedules to off-peak bus schedules, thereby saving travel time and wait time.

3. The respondents indicated that flextime had a strong positive effect on their ease of using the bus. No respondent stated that flextime had a negative impact on his or her ease of using the bus. The primary reason indicated for increased ease of using the bus was that work hours could be tailored to closely match desirable transit schedules. In addition, wasted wait time was shortened or eliminated as a result of the ability to select one's own work hours to closely match established transit schedules.

4. The ability to avoid the peak hour crush was important to transit users. Transit travel time in Nashville is seldom competetive with other modes, and since buses must compete for space on local streets and highways, rush-hour delays for buses are equal to or greater than for other modes. In addition, peak hour crowding on transit

vehicles leads to more frequent stops, further lengthening transit travel times. The respondents were obviously aware of the travel delays on transit during peak periods, and frequently reported substantial time savings by traveling during off-peak hours.

Impact of Flextime on Sole Driving

Although a detailed analysis of those respondents who drove their cars to and from work alone is not directly related to any research question stated in Chapter I, some mention of the impact of flextime on their travel habits is nevertheless desirable. A total of 25 respondents indicated that they drove to and from work alone. Of this total, 14, or 56 percent, changed working hours after flextime was implemented. A detailed breakdown of their working hours is shown in Table III-2 on page 58. All of those persons who indicated that they drove alone after flextime was implemented, drove alone when they worked on a rigid 8:00 a.m. to 4:30 p.m. schedule. When asked if they would change their travel mode if they returned to a rigid 8:00 a.m. to 4:30 p.m. work schedule, 100 percent replied that they would continue to drive alone. The responses of sole drivers indicate that they have strong reasons for driving alone and are not likely to change modes of travel so long as they have a reasonable choice.

The respondents who reported a change in work hours were asked to assess flextime in terms of its impact on their ability to avoid the peak of the commute hour crush. The responses to this question were:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	11	2	0	0	0	1
%	79%	14%	0	0	0	7%

A total of 93 percent of the respondents indicated that flextime had a positive impact on their ability to avoid the peak of the commute hour crush. This was an even higher positive response than that indicated by carpoolers and transit users. Persons who drove alone to and from work obviously realize substantial benefit in time savings and convenience by traveling during off-peak hours.

Another question which was relevant to sole drivers and their travel habits asked the respondents who changed hours to assess flextime in terms of its impact on the ability to obtain a desired parking space. space. The responses to this question were:

	Major Positive Impact	Minor Positive Impact	No Impact	Minor Negative Impact	Major Negative Impact	No Opinion
No.	8	2	2	0	0	0
%	57%	14%	14%	0	0	0

A total of 71 percent of the respondents indicated that their ability to obtain a desired parking space was facilitated by flextime. This was particularly true for those who chose to arrive at work early, since all but one of those who arrived at work prior to 8:00 a.m. responded positively to this question. It should be noted that free parking is available for a small number of state employees on a first come-first serve basis.

The most significant aspect of the responses to the questionnaire by those who drove alone was that there was no increase in the number of persons driving alone after flextime was implemented. In fact, the survey results indicated that 2 of those persons who formerly drove alone switched to carpools after flextime and 3 switched to transit. The overall results of this mode change was, that for the 48 respondents who changed work hours after flextime was implemented:

transit use increased 27.3%;

carpooling increased 9.5%, and

driving alone decreased 10.4%.

Impact of Flextime on Traffic Congestion in Nashville, Tennessee: A Projected Program for Government Employees

Chapter II examined the impact of individual flextime programs on travel congestion, but all such programs were either in large transit-oriented cities such as Toronto or New York or consisted of small groups of employees at a particular site. The purpose of this section of Chapter III is to project the possible impact of a fairly large flextime program on urban travel congestion in a medium sized automobile-oriented city. In order to accomplish this purpose, a projection of the possible impact of flextime for a large group of employees working in the central business district of Nashville, Tennessee, is made. Through the use of the informaton gathered in the Nashville case study described in the preceding section of this chapter, the impact of such a flextime program on peak-period travel congestion is estimated.

General Characteristics of Travel in Nashville-Davidson County

The street and highway system of Metropolitan Nashville-Davidson County is composed of six major interstate legs, numerous radial and circumferential state highways and a supporting local street system. The transit system in Nashville consists of a fleet of 150 vehicles, 120 of which operate during peak travel periods. The transit system operates throughout most of the heavily developed areas of the county and virtually all routes terminate in the central business district.[9] A map of the major streets and highways in Nashville-Davidson County is shown in Figure III-1.

Very few major capacity problems are experienced on Nashville's roadway or transit systems except during "rush-hours," and then such problems generally last one-half hour or less. The street and highway system in Nashville may be characterized as generally operating at a relatively good level of service (level of service D or above during most of the day), having relatively high operating speeds and having relatively balanced traffic flows among most of the major radial corridors.[10] However, during peak-periods several problems become evident:

1. Access to major radial interstate and arterial highways, especially near the central business district, is poor,

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[9]Metropolitan Planning Commission of Nashville and Davidson County, "Staggered Working Hours Study," Nashville, Tennessee, 1979.

[10]Ibid., p. 4.

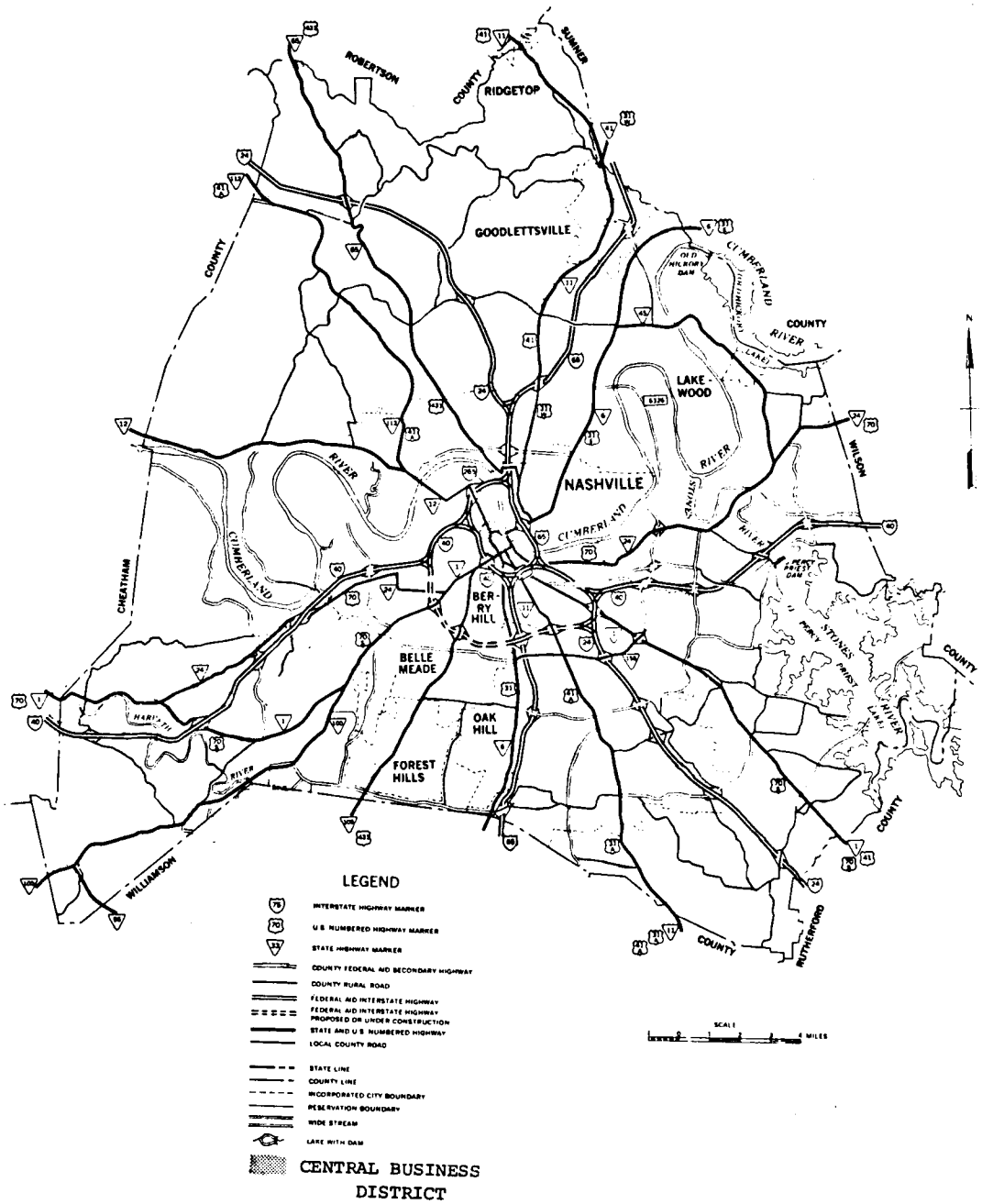

Figure III-1. Roadway System of Nashville-Davidson County.

Source: Tennessee Department of Transportation

with traffic volumes frequently exceeding roadway capacity. Significant delays often occur which increase start and stop driving and idling time and subsequently contribute to increased energy consumption and air pollution.

2. The street and highway system experiences a high rate of accidents, due in part to the previously mentioned capacity problems.
3. The high traffic density, relatively narrow local streets and the small radius of the inner interstate loop cause intermittent congestion problems in the core area.[11]

The fact that peak period traffic congestion is a problem in Nashville is evidenced by the typical peaked pattern of directional traffic volumes shown in Figure III-2. This diagram was developed through a sample of 88 radial arterial and interstate traffic count locations. The inbound counts were used for the morning hours and outbound counts for afternoon and evening hours.[12] Figure III-2 shows that the peak morning travel period is between 7:00 and 8:00 a.m., with the peak of the peak occurring shortly before 8:00 a.m., at which time approximately 9-1/2 percent of total daily travel occurs. The afternoon peak is somewhat "flatter," with most of the travel occurring between 4:30 and 6:00 p.m. The peak of the afternoon peak occurs around 5:00 p.m. when approximately 8-1/2 percent of total daily travel occurs. Although the afternoon peak is not as sharp as the morning peak, it is longer and

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[11] Ibid.

[12] Ibid., p. 7.

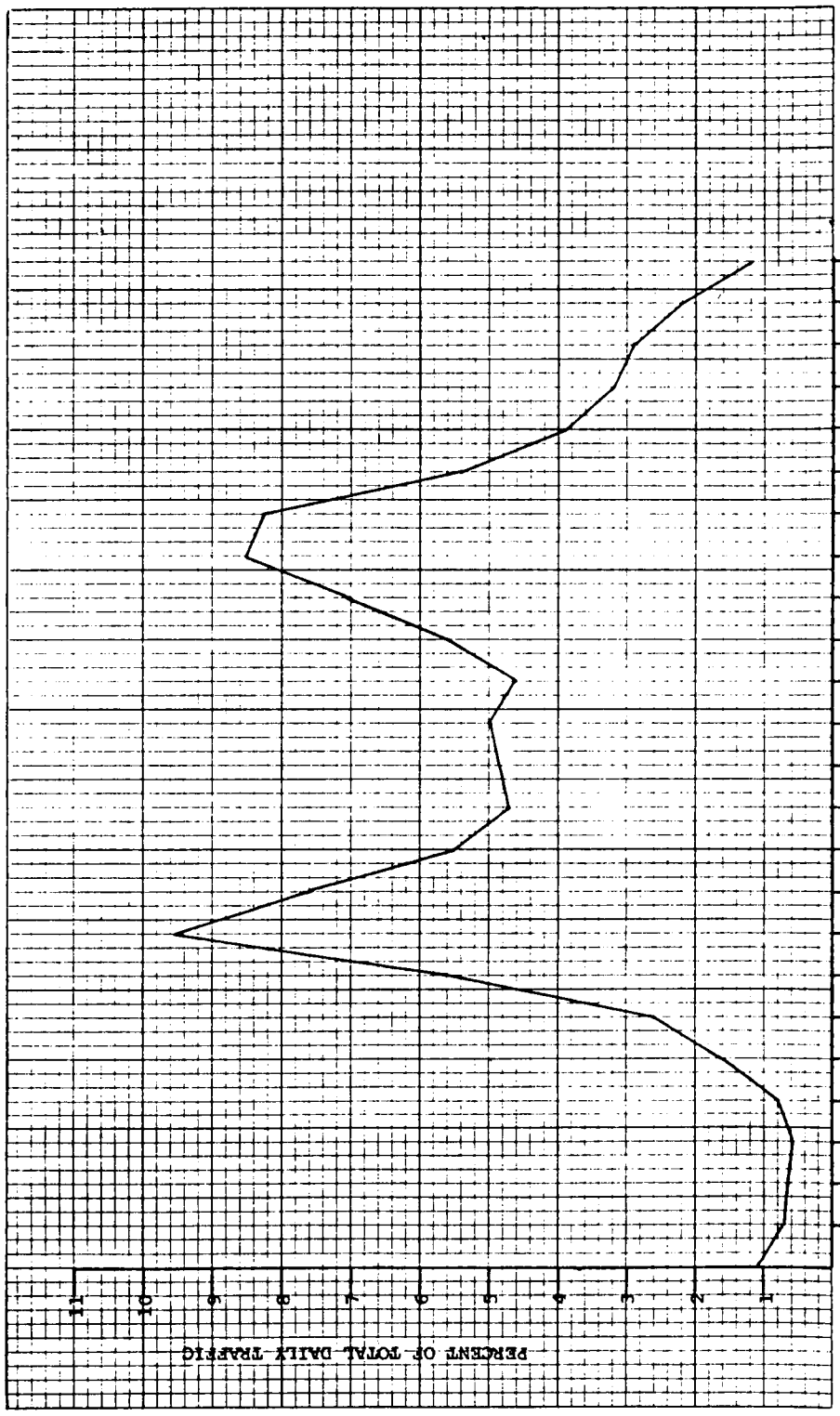

Figure III-2, Daily Traffic Volume Percentages for Nashville, 1979.

Source: Metropolitan Planning Commission of Nashville and Davidson County.

generally carries more total traffic.[13] It is during these two peak periods that the street and highway system in Nashville, especially that portion in and around the central core of the city, operates near or at capacity.

The peaking problem characteristic of the roadway system in Nashville is equally evident where transit operations are concerned. Metropolitan Transit Authority buses are generally filled near or to capacity during the two daily peak travel periods and are only marginally utilized during the rest of the day.[14] In addition, the overall traffic congestion which occurs during peak periods frequently causes delays for buses, as they must compete with automobiles and trucks for roadway space.

The morning and afternoon peaks in travel on the Nashville roadway and transit systems, as in virtually all cities, reflects the start and stop times of workers employed therein. The Metropolitan Planning Commission of Nashville-Davidson County estimates that approximately 56 percent of all employees in the area start work from 8:00 to 8:30 a.m., 10 percent start between 7:30 and 8:00 a.m. and 4 percent start between 8:30 and 9:00 a.m. The remainder report to work before 7:00 a.m. or after 9:00 a.m.[15] The afternoon peak is a reflection of the morning work start times with the exception that stop times are spread over a slightly longer time period.[16]

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[13] Ibid., p. 9.

[14] Ibid., p. 5.

[15] Ibid., p. 6.

[16] Ibid., pp. 7-9.

The Metropolitan Planning Commission estimates that there are approximately 14,000 government employees who work in the Nashville central business district and its immediate environs. Practically all of these government employees work on a rigid 8:00 a.m. to 4:30 p.m. schedule.[17] The local planning commission also estimates that these 14,000 employees make up approximately 7 percent of all vehicle trips into and out of the central business district between the hours of 7:30 to 8:00 a.m. and 4:30 to 5:00 p.m.[18]

Projected Impact of a Flextime Program for Government Employees

With the travel data described in the preceding section of this chapter at hand, it is possible to project the impact of a flextime program for all government employees working in downtown Nashville, Tennessee, on peak period travel congestion therein. Using the findings of the Nashville case study, previously described in this chapter, the following assumptions were made concerning the behavior of the 14,000 government employees working in downtown Nashville, if all worked on a flextime schedule:

1. The travel mode choice percentages exhibited by the subjects of the case study would apply to the total group of 14,000.
2. The percentage of employees who would change working hours from the original 8:00 a.m. to 4:30 p.m. schedule was projected to be 50 percent. Although the case study found

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[17] Ibid., p. 7.

[18] Ibid., pp. 9-10.

that 45 percent changed hours, it was anticipated that the ability of such a large group of workers to change hours would encourage a higher number of carpools to travel during less congested periods.

3. A total of 75 percent of the workers who would change hours would shift their work start times to 7:00 or 7:30 a.m. A total of 25 percent would shift their work start times to later than 8:00 a.m.

The net results of the above stated assumptions were that, of the 14,000 government employees presently working in downtown Nashville, 50 percent, or 7,000, would change hours from the existing 8:00 a.m. to 4:30 p.m. schedule. Of this 7,000, 75 percent, or 5,250, would arrive at work between 7:00 and 7:30 a.m. and 25 percent, or 1,750, would arrive between 8:00 and 8:30 a.m.

Given that 37.5 percent of all government employees would arrive at work prior to 7:30 a.m. under flextime, the percentage of total vehicle trips made from 7:30 to 8:00 a.m. would drop from 9.5 percent to 9.125 percent. An additional 12.5 percent of the total number of employees would arrive at work after 8:00 a.m. further reducing the peak half-hour percentage to 9.0 percent of total daily travel. A similar change in peak hour percentages would occur during the afternoon, from 4:30 to 5:00 p.m., when the present peak half hour percentage of 8.45 would be reduced to 7.95 percent of total daily vehicular travel. Figure III-3 graphically illustrates how the morning and afternoon peaks would be changed by the projected flextime program described above.

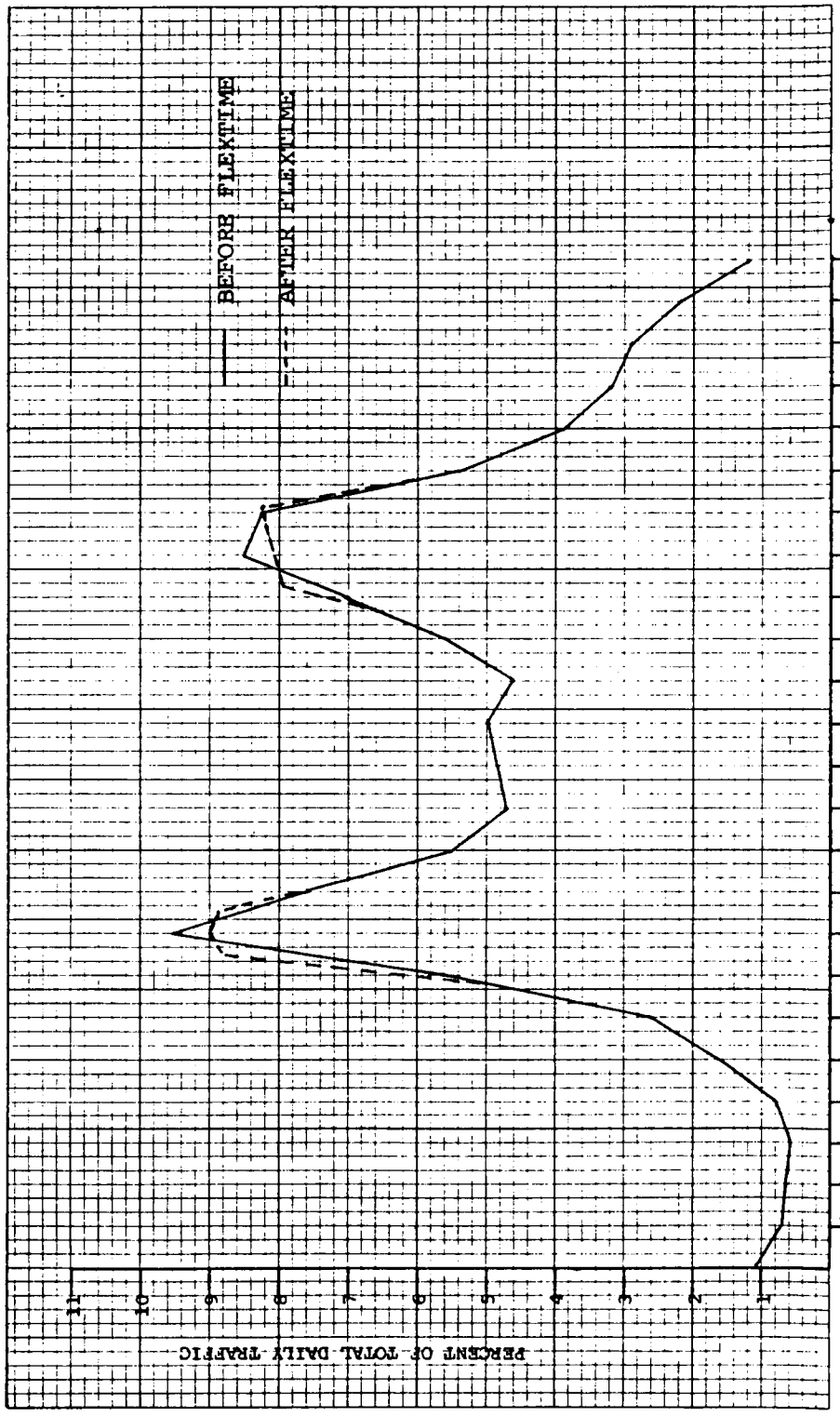

Figure III-3. Daily Traffic Volume Percentages for Nashville, 1979, Before and After Projected Flextime Program for Government Employees.

The figure shows that any decrease in peak period traffic volumes would increase volumes during less congested periods. However, the worst capacity problems currently occur between 7:30 and 8:00 a.m. and between 4:30 and 5:00 p.m.[19] Any lessening of traffic volumes during these two peak half-hour periods would improve traffic flow to some degree, thereby reducing travel delays. Such improvement in traffic flow would subsequently lead to reductions in accidents, air pollution and energy consumption.

A further reduction in peak hour traffic would be realized if the mode shift percentages exhibited in the Nashville case study were applied to those 7,000 government workers who would be likely to change hours. The case study showed a 9.5 percent increase in carpooling, a 27.3 percent increase in transit use and a 10.4 percent decrease in sole driving among those workers who changed hours. Although the magnitude of these percentages may vary if applied to an area-wide flextime program, the results of the case study indicate that some increase in carpooling and transit use and a decline in sole driving would occur. Such a mode shift would mean fewer vehicles on the streets and highways and improved traffic flow during peak two-hour periods. It is not likely however, that the number of employees shifting to transit would be significant enough to disrupt present transit operations. Any shifts that would occur, however, would serve to better utilize transit vehicles during off-peak periods, when they generally operate far below capacity.

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[19] Ibid., pp. 7-9.

If a large scale flextime program did result in isolated cases of transit disruption, appropriate rescheduling measures could be taken.

The preceding hypothetical application of flextime for government workers in the Nashville central city area illustrates general traffic congestion impacts. In order to better illustrate the probable impact of such a flextime program on traffic congestion, it is desirable to apply the previously described findings to a specific travel corridor. The following section of this chapter describes the impact of a flextime program for government employees on the northeastern travel corridor in Nashville-Davidson County.

The northeastern travel corridor is one of the most heavily used in the Nashville urban area and has the most pronounced peak of all of the major corridors.[20] The northeastern corridor consists of Inerstate 65, State Routes 6 and 11 and a local expressway (Ellington Parkway). All of the roadways in this corridor experience severe capacity problems during the morning and evening peak periods. Such capacity problems are worst between the hours of 7:30 to 8:00 a.m. and 4:30 to 5:00 p.m. when they frequently operate at or below level of service D.[21]

Using the assumptions developed for the preceding analysis, the impact of flextime on a.m. traffic volumes in the northeast corridor may be estimated. Table III-6 shows the redistribution of vehicle trips during a.m. peak half-hour periods which would result from the implementation of a flextime program for government employees in the core area

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[20]Ibid., pp. 20-21.

[21]Ibid.

Table III-6

Changes in Peak Half-Hour a.m. Traffic Volumes for the Northeastern Travel Corridor Resulting from a Projected Flextime Program for Government Employees in Nashville, Tennessee

	Peak Half-Hour Periods			
	6:30-7:00	7:00-7:30	7:30-8:00	8:00-8:30
1979 Traffic Volumes Before Flextime	2955	3469	4415	3072
1979 Traffic Volumes After Flextime	3081	3757	3863	3210
Percent Change	+4.25	+8.30	-14.29	+4.49

Source: Tennessee Department of Transportation.

of Nashville. These counts were made at a heavily traveled location approximately 1-1/2 miles northeast of the central business district. Table III-6 shows that traffic volumes during the 7:30 to 8:00 a.m. period would decrease approximately 14.3 percent if government employees were on flextime. Since this is the peak half-hour period of the morning, a small improvement in traffic flow would be realized. Volumes in the three other peak half-hour periods would increase slightly. However, none of these volumes would approach the number of trips which previously traveled during the 7:30 to 8:00 a.m. period. The peak would thus be extended, but at no time would traffic approach the previous peak which caused most of the capacity problems characteristic of this corridor during the morning rush-hour period. Afternoon peak period volumes would reflect a similar redistribution of trips after the projected flextime program was implemented.

Chapter IV develops overall conclusions from the case study described above, relates these conclusions to past studies of flextime and travel mode choice and identifies areas for future research.

CHAPTER IV

CONCLUSIONS

Introduction

The case study described in Chapter III serves as the basis for several conclusions relative to flextime and home-to-work travel. The following chapter states the conclusions, relates the conclusions to past studies and general theory concerning flextime and travel mode choice and suggests areas for future research.

Conclusions of the Nashville Case Study

Chapter III described, in detail, the responses to the questionnaire used in the Nashville case study and described specific findings related to the research questions stated in Chapter I. The purpose of this thesis is to study the impact of flextime on how people travel to and from work. With this purpose in mind, the following overall conclusions were developed:

1. Flextime does not discourage persons from carpooling to and from work. In some instances it enhances the ability of persons who formerly worked on different fixed schedules to coordinate work start and stop times, thereby increasing their propensity to form carpools. Flextime allows carpoolers the opportunity to travel during less congested periods, thereby increasing the speed and convenience of traveling to and from work. However, flextime does not disrupt

carpools which existed under a rigid work schedule, as the participants in such carpools can, and frequently do, retain their original working hours in order to maintain their respective carpools.

Flextime can enhance the ability of working parents to transport children to and from school as they can match their work schedules to generally inflexible school schedules. In addition, the increased ease of traveling during off-peak hours makes such diversions from direct home-to-work travel paths easier and less time consuming. The same is true where carpooling with persons who work in different locations is concerned.

2. Flextime does not discourage persons from using mass transit for home-to-work travel. In some instances flextime encourages persons, who have a choice of travel mode, to use transit by allowing them to adjust their working hours to existing transit schedules. Such individual coordination of work and transit schedules often shortens "wait time," thereby making transit travel more convenient. In addition, flextime often allows transit users to travel during less congested periods, thereby decreasing their travel time. However, flextime does not discourage persons from using transit during peak hours if they must, or simply desire to do so.

3. Flextime does not encourage persons to drive to and from work alone. Although flextime enables people to alter their work schedules to more closely match their personal activity schedules, they seldom change from carpooling or riding transit to driving alone in order to do so. Flextime does, to some degree, encourage persons to use transit

or join a carpool for home-to-work travel, thereby encouraging some sole drivers to change travel mode. However, most persons who drive alone do so for reasons which are independent of work scheduling. Despite the fact that sole drivers frequently enjoy the benefits of traveling during less congested periods when they are on flextime, their decision to drive alone is made with little regard to work scheduling.

Chapter II described the results of previous studies and stated general assumptions concerning flextime and travel behavior. The results of the Nashville case study generally support the results of previous studies which have addressed the relationship between flextime and travel mode choice and refutes most of the general assumptions concerning flextime which are held by a number of persons in the transportation "community."

The Nashville case study supports the previous studies concerned with the impact of flextime on carpooling and transit use. All of the studies cited in Chapter II reported an increase in carpooling and transit use after flextime was implemented. The Nashville study reflected a similar increase in the number of persons carpooling. Where transit use is concerned, the Nashville study is in agreement with the previous studies, with all reporting some degree of increased usage by those workers on flextime. Although carpooling and transit use increases described in all of the previously mentioned studies, including the Nashville study, are small, and the degree to which flextime influenced these mode choice decisions is unknown, the fact that there was no negative impact on carpooling and transit use is perhaps most significant.

Conventional wisdom concerning flextime and travel behavior stated that: If persons could vary their work hours and avoid peak hour travel congestion, they would do so and frequently at the expense of carpools and mass transit use. It was assumed that the added freedom provided by flextime would encourage workers to drive alone and that the concurrent work hours which originally held carpools together would be gone, therefore encouraging their breakup. The Sacramento study described in Chapter II found this conventional wisdom to be in error.[1] The Nashville study did likewise and further determined that most home-to-work travel mode decisions are made independent of work hour scheduling. This was especially true where sole driving was concerned, as no persons who had riden transit or carpooled before flextime, switched to driving alone after it was implemented. There may be numerous reasons why the anticipated "exodus" to single occupancy automobiles did not occur in the Nashville study, e.g., rising energy costs, limited income of government employees, psychological factors, etc., but an analysis of them is not within the scope of this thesis. The major conclusion is that the results of the Nashville case study strongly refute the conventional wisdom concerning the impact of flextime on carpooling and transit use.

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[1] David W. Jones, Takuya Nakamoto, and Matthys P. Cilliers, *Flexible Work Hours: Implications for Travel Behavior and Transport Investment Policy* (Berkeley, California: Institute of Transportation Studies, December 1977), p. 27.

Closing Remarks and Implications for Future Research

This thesis attempted to shed light on flextime as a means of reducing urban travel congestion and to examine its compatibility with two other congestion reducing measures — carpooling and transit use. Although the results of the case study were significant in that they indicated that flextime did not negatively affect carpooling and transit use, the study group that was used was small and, as a result, the magnitude of positive influences of flextime on mode choice was subject to question. Study of a larger group would provide more conclusive data. In addition, the study did not attempt to separate other causal factors involving mode choice such as energy costs, travel mode availability or overall economic conditions from the general work related and personal scheduling factors addressed in the survey. Future research into such factors would be useful.

Flextime has many variations and the Nashville case study dealt with only one. Other forms of flextime may produce different results. The group surveyed in the case study did not participate in any large scale and highly organized ridesharing program. If a group of workers were involved in such a program, the implications of flextime on its operation could be substantial. A study of flextime and highly organized ridesharing efforts should be undertaken so that any such future endeavors could be well planned. Adequate planning would decrease the chances of major disruption and would contribute to the overall success of the flextime program.

Flextime is still a new concept in work scheduling and, as a result, is not yet supported by enough documented experience and research to make it a broadly implementable concept. However, its potential benefits from the standpoints of workers, managers and transportation officials is significant. Hopefully, this thesis will contribute to the overall body of knowledge concerning flextime, thereby increasing its probability of implementation and the subsequent realization of its many and varied benefits.

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APPENDIX

FLEXTIME QUESTIONNAIRE

1. What is your job title? _____ ( )Management ( )Non-management

2. Approximately what percent of your workdays are spent in your Nashville work location? _____

3. What are your working hours at the present time? Arrive at work _____ Leave Work _____

The following questions deal with your assessment of flextime, both from a personal viewpoint and in terms of its impact on the work organization. First we'll ask questions about you as an individual.

4. How would you assess flextime in terms of its impact on your . . . . .

(Check the answers which describe your experience best)

	A major positive impact	A minor positive impact	No noticeable impact	A minor negative impact	A major negative impact	No opinion/ not relevant
Convenience in doing shopping and running errands	( )	( )	( )	( )	( )	( )
Ability to arrange time with family and friends	( )	( )	( )	( )	( )	( )
Ability to arrange for child care or getting the kids to school	( )	( )	( )	( )	( )	( )
Ease in using the bus	( )	( )	( )	( )	( )	( )
Ease in carpooling to work	( )	( )	( )	( )	( )	( )
Ability to avoid the peak of the commute-hour crush	( )	( )	( )	( )	( )	( )
Satisfaction with your job and your work responsibilities	( )	( )	( )	( )	( )	( )
Ability to obtain a desired parking space	( )	( )	( )	( )	( )	( )

Now, we'd like to assess flextime's impact on your work organization.

5. How would you rate flextime in terms of its impact on . . . . .

(Check the answers which describe your experience best)

	A major positive impact	A minor positive impact	No noticeable impact	A minor negative impact	A major negative impact	No opinion/ not relevant
The frequency of absenteeism and short-term leaves	( )	( )	( )	( )	( )	( )
The ability to assemble meetings and conduct teamwork	( )	( )	( )	( )	( )	( )
The ability to cover incoming phone calls and public inquiries	( )	( )	( )	( )	( )	( )
The quality of staff/management relations	( )	( )	( )	( )	( )	( )
The time and paperwork associated with payroll and scheduling	( )	( )	( )	( )	( )	( )
The overall productivity of your unit	( )	( )	( )	( )	( )	( )

6. Can you think of any benefits of flextime -- to you or to your work organization -- that were not mentioned above? (Please mention them)

_____

_____

_____

7. Can you think of any problems of flextime that were not mentioned above? (Please mention them) _____

_____

_____

The next questions deal with the impact of flextime on your commuting habits.

8. How do you usually get to work? . . . .

( ) By car without any other passengers

( ) By carpool (Number of persons in carpool, including yourself _____)

( ) By car after dropping off other members of my household

( ) By MTA bus (walk to stop)

( ) By MTA bus (ride to stop)

( ) By other bus (Greyhound, Trailblazer, etc.)

( ) By other means (Specify) _____

9. If you are in a carpool, do you . . . . . .

( ) Carpool with any persons who work in a different location than you?

( ) Carpool with any persons with a rigid set of working hours?

10. How far is it from your home to your place of work (one-way)? . . .

( ) less than 3 miles

( ) 3 to 6 miles

( ) 6 to 9 miles

( ) 9 to 12 miles

( ) 12 to 15 miles

( ) 15 to 20 miles

( ) 20 to 25 miles

( ) over 25 miles (specify _____)

11. If you worked on a rigid 8:00 a.m. to 4:30 p.m. schedule rather than on flextime, would you . . . . .

Carpool	( )More frequently	( )Less frequently	( )About the same (or not at all)
Take the bus	( )More frequently	( )Less frequently	( )About the same (or not at all)
Drive a car alone	( )More frequently	( )Less frequently	( )About the same (or not at all)

12. If you worked on a rigid 8:00a.m. to 4:30 p.m. schedule rather than on flextime would you . . . . . .

( )Be more likely	( )Be less likely	To carpool with persons who work in a different location than you
( )Be more likely	( )Be less likely	To carpool with persons who have different working hours than 8:00 to 4:30

13. If working on a rigid 8:00 a.m. to 4:30 p.m. work schedule would change your present commuting habits please explain how and why.

_____

_____

14. How long does it usually take you to get to work? . . . . .

( )Less than 5 minutes	( )15 to 20 minutes	( )30 to 35 minutes
( )5 to 10 minutes	( )20 to 25 minutes	( )Over 35 minutes (Specify _____)
( )10 to 15 minutes	( )25 to 30 minutes	

Questions 15 and 16 apply to those persons who have previously worked on a rigid 8:00 to 4:30 schedule.

15. Since you started working on a flextime schedule, do you . . . . . .

Carpool	( )More frequently	( )Less frequently	( )About the same (or not at all)
Ride the bus	( )More frequently	( )Less Frequently	( )About the same (or not at all)
Drive a car alone . . .	( )More frequently	( )Less frequently	( )About the same (or not at all)

16. If you did change your commuting habits, please explain why and whether flextime was an important factor in that change.

_____

_____

_____

THANK YOU FOR YOUR COOPERATION!

Table A-1

Home to Work Distances (One-Way) for Respondents by Travel Mode

Distance in Miles	Carpool	Bus	Drove Alone	Other	Total
Less than 3	0	0	0	1	1
3-5	7	7	4	0	18
6-8	9	4	3	1	17
9-11	9	5	6	0	20
12-14	12	4	3	0	19
15-19	7	3	4	0	14
20-24	4	0	2	0	6
Over 25	9	0	3	0	12
TOTAL	57	23	25	2	107

Table A-2

Home-to-Work Travel Times (One Way) for Respondents by Travel Mode

Travel Time (min)	Carpool	Bus	Drove Alone	Other	Total
10-14	5	2	3	2	12
15-19	14	3	7	0	24
20-24	12	6	3	0	21
25-29	10	5	3	0	18
30-34	5	4	4	0	13
Over 35	11	3	5	0	19
TOTAL	57	23	25	2	107

VITA

Robert Coleman Blakey was born in Hopkinsville, Kentucky, on November 17, 1948. He attended public schools in Hopkinsville and graduated from Murray State University, Murray, Kentucky, in June 1971 with a B.S. degree in Geography and Economics. After serving in the U.S. Army, he was employed as a transportation planner by the Tennessee Department of Transportation, Urban Transportation Planning Division in 1972. While in this position he assisted in the development of transportation plans for several cities throughout Tennessee including those for Knoxville, Tullahoma, Covington, McMinnville and Dickson.

In 1976 he received a Federal Highway Administration Research and Education Fellowship and attended The University of Tennessee, Knoxville, Graduate School of Planning. Upon completion of classwork in Knoxville he returned to Nashville and is presently a Mass Transit Analyst with the Tennessee Department of Transportation, Bureau of Mass Transit. He received the Master of Science in Planning Degree in August 1980.

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