Evaluation of Various Mass Transportation Alternatives for the University of Central Florida Commuters

Summer 1980

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EVALUATION OF VARIOUS MASS TRANSPORTATION ALTERNATIVES
FOR THE UNIVERSITY OF CENTRAL FLORIDA COMMUTERS

BY

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B.S., Pahlavi University, 1975

THESIS

Submitted in partial fulfillment of the requirements
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in the Graduate Studies Program of the College of Engineering
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Summer Quarter
1980
This research evaluates various mass transportation alternatives for the commuting students, faculty and staff of the University of Central Florida (U.C.F.), located at Orlando. The alternatives considered in this research are bus service, van service / minibus service, vanpool, carpool, and bicycle and pedestrian modes. During the lifetime of the University the private automobile has been the only prevalent mode of transportation used by the U.C.F. commuters.

Opinion surveys conducted in the summer of 1979 indicated that the U.C.F. commuters are confronted with a number of transportation problems including lack of parking spaces on campus, traffic congestion on the access roads to the University and the high cost of commuting using automobiles. Other surveys which were required for the evaluation process were taken during the same academic year. These included location survey, traffic study, intersection delay study, and parking study. Based on the results of these surveys the different transportation modes considered feasible in this situation are analyzed.

According to the results of the comparative cost analysis, using present-worth and equivalent uniform annual cost methods, all the candidate modes were found to be economically advantageous.
over the existing auto transportation mode. However, with the existing rate of auto ownership by the commuters, the carpool program could be considered as the most realistic solution to the short-term transportation problems of the University, provided the legal obstacles are overcome before the implementation of the program.

The feasibility and legal considerations of the various modes are discussed in the closing chapter of this report.
ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

"Just for the routine home-to-work commuter trips, Americans use 1.8 million barrels of fuel each day," Secretary of Transportation Neil Goldschmidt points out, "and roughly 1.4 million of those barrels are burned by commuters driving back and forth each day alone" (16).

In order to understand the present and its influence on the future, one must study the past. In this section some of the facts regarding the present situation of the transportation system in the United States and the factors which led the system to this point are discussed briefly.

Billions of dollars have been spent on the building of highways resulting in urban sprawl and dispersed origin-destination patterns which, in turn, result in higher levels of energy consumption used in transportation, cause peak-hour traffic jams, and have paralyzed the movement of public transit. Auto industry coupled with oil industry destroyed the environment by promoting private auto transportation. One fed the other and more highways were built entangling government funds and taxes.

Through the years, cars became symbols of identity to the owners representing success, virility and youth. As a result, each
family in the U.S.A. owns, on the average, 1.7 cars. Millions of these cars are junked each year, more than what exist in many other industrialized countries. They are made to be junked by continuously changing models each year, so that more cars are sold by the car manufacturers.

In a bid to satisfy the automobile demand of consumers, a realistic approach to provide necessary transportation for the movement of people has been neglected. Public preferences and expectations have changed greatly through time. Mass transit must respond to these changes in transportation and adapt to the new patterns of urban development in order to be able to compete effectively with the private automobile. Instead, mass transit has been kept conservative, old fashioned, and resistant to change; consequently, it has not been able to satisfy its users. The concepts of transportation need to be redefined to speed the development of new models, in order to solve not only the short-term problems of the community, but to shape the future in a manner which provides for the interests of the people.

History of Transportation in the United States

The first European colonists who crossed the Atlantic for the new world found a vast wilderness interrupted only by streams and Indian trails. They built their first settlements along the ocean and, utilizing Indian trails, moved inland where navigable rivers were present. Connecticut Path, lying between Boston, Massachu-
settes and Hartford, Connecticut, was one of the oldest roads in the U.S.A. traveled as early as 1633. The Philadelphia-Lancaster Turnpike, completed in 1796, was the first road built using engineering fundamentals.

The invention of the steam boat in 1807 resulted in a growth of water transportation on the Mississippi and Ohio rivers. In 1850, with the introduction of the railroad as an overland transportation system, there began a decline in traffic on inland waterways and by 1880 steamboats had practically disappeared. During the same period the "Canal era" began with the opening of the Erie Canal in 1825, which connected the Hudson River at Albany, New York with Lake Erie at Buffalo, New York. The main era of canal building ended with the financial crisis of 1937. World War II spurred a revival of water transportation which has played a large role in intercity freight transportation continuing through the 1970's.

Excluding seacoasts and the Great Lakes, the U.S. has approximately 25,500 miles of navigable waterways.

Railroad construction began in the 1830's, particularly in New York, Pennsylvania, and New England, reached its peak in the 1880's when 70,000 miles of railroad line were constructed and declined drastically by 1910. The major factor for this decline was the competition introduced by the auto industry. In 1900 there were only 8,000 motor vehicles on the roads. This number increased to 20,000,000 by the year 1925.
A decade after the invention of gasoline automobiles, the first powered airplane flight took place in North Carolina. Air transportation was commercialized during the mid-twenties and World War II played a major role in the development of the air industry (see Table 1).

### Table 1

**INTERCITY FOR-HIRE PASSENGER TRAFFIC BY MODES, 1939-1976**

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroad</td>
<td>23.7</td>
<td>36.0</td>
<td>22.4</td>
<td>10.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Highway</td>
<td>9.5</td>
<td>24.0</td>
<td>20.4</td>
<td>25.3</td>
<td>25.1</td>
</tr>
<tr>
<td>Water</td>
<td>1.5</td>
<td>1.4</td>
<td>2.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Air</td>
<td>.8</td>
<td>7.8</td>
<td>30.0</td>
<td>109.5</td>
<td>152.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>35.5</strong></td>
<td><strong>69.2</strong></td>
<td><strong>75.3</strong></td>
<td><strong>149.7</strong></td>
<td><strong>191.6</strong></td>
</tr>
</tbody>
</table>

*Passenger-Miles in billions.*

The Demise of Mass Transportation

The factors which created the existing mass transit problems can be found in the history of the development of transportation in the United States. From 1926 to 1928 mass transit carried 14 billion passengers per year. By 1945 the number of people who utilized mass transit systems was 19 billion. This increase was due to a sharp decline in auto usage during World War II. During the postwar period, due to shorter work-time, more holidays, together with dispersion of industry and suburban sprawl, a rise and expansion of auto travel resulted which caused a 50 percent drop in mass transit ridership by 1964 (see Figure 1 and Table 1).

When public transit was first implemented, its success was due to the profit it made as a business rather than a social service. Because of the competition with the auto industry mass transit changed into a losing industry. Past experience proved that only those systems could survive which could attract public demand. Free public transit in Rome, free transportation in San Antonio, and the Public Transportation in Atlanta were three product-oriented systems which increased ridership by only 23 percent; meanwhile, the Shirley Freeway Project in Washington, D.C. and Public Services in Haddonfield and Toronto were two examples of successful consumer-oriented systems.

Public services should provide for the necessities of the urban community. The automobile met the needs and demands of the public more adequately and consequently governed the market over mass
Fig. 1. Comparative volumes of intercity passenger traffic (7).
transit. The expansion of the U.S. economy made it possible for more and more people to acquire private automobiles. In addition, the demise of public transit, together with the idea that the automobile provided the best means available for traveling within urban areas, facilitated the increasing trend of automobile ownership. Car ownership was further encouraged by the investment of millions of dollars each year in advertising. Consequent lack of demand in mass transit has made the public carriers face financial crises and the users experience a decrease in quality of service, which in turn have resulted in a lack of demand. This is the cycle which the mass transit system is caught in.

Legislations in Support of Mass Transportation

As mass transit became publicly owned, it caused a gradual awakening of people as one of the necessities of urban community life. The Housing Act of 1961 provided authorization for three programs in support of public transit. These included:

1. Urban Planning Assistance (transit planning was required to be a part of federally funded urban planning programs).
2. Demonstration grants (25 million dollars for transit demonstrations).
3. Loan programs (50 million dollars in loans were made available for mass transportation projects).

This was the first attempt to provide federal funds to directly help urban mass transportation.

In 1964, congress took action to provide capital funds for mass transit. In 1970, the House of Representatives approved the first
major federal program in support of urban mass transit. The amend-
ments to the Urban Mass Transportation Act of 1964 provided some
grants through the passage of legislation in the fall of 1974. At the end of June in 1977, the senate passed legislation providing $5.3 billion for mass transit, but this did not meet the expectations of the American Public Transit Association. More money was provided for mass transportation by the Surface Transportation Act of 1978 which was passed by congress in October, 1978.

In June of 1980 congress passed the Transportation Energy Initi-ative which provides a $13.2 billion ten-year public transportation investment program including $6.6 billion for rail improvements, $5.7 billion for modernization and extension of existing systems, and about $900 million for completion of new systems. There are three minor components to this program: $2.5 billion for auto use manage-
ment, $200 million for gas mileage improvement, and $800 million for research into the improvement of auto technology. This program will be funded with revenues from the windfall profits tax on oil.

Objectives

The factors which have affected the increase of interest in pub-
lic transportation on a national scale have also begun to show up in smaller urban communities. Traffic congestion, air pollution, and fuel shortage can be named as the most tangible causes of this trend. For a specific area the objectives should be defined if public trans-
portation is to have a significant role in improving the form and
operation of the community's activities.

In goal setting, during the planning process, the following steps should be considered before the implementation of the project can take place (34):

1. Community inventory
2. Determination of goals
3. Identification of practical alternatives
4. Selection of operational objectives
5. Design of the system

In small communities, such as a university, it is easier to study the public attitudes because of fewer types of people in the community. It is also more practical to use publicity and even restrictions if necessary in order to encourage or influence the individuals to accept and use a new system.

The University of Central Florida as a commuter institution is confronted with major transportation problems. Parking, traffic congestion, and money spent on commuting are the major problems which the commuters are suffering from. In order to alleviate these problems, a system has to be implemented to serve not only the people who have already been served, but also those who are deprived of educational opportunities due to the lack of access to the automobile.

To serve this purpose various modes of transportation were selected for evaluation as an alternative to the existing auto transportation mode. The alternatives evaluated were:

1. Bus service
2. Minibus service / Van service
3. Ridesharing systems;
   a. Vanpool
   b. Carpool
4. Bicycle and Pedestrian modes

To study the distribution of the commuters' residences, their opinions about the U.C.F. transportation problems, the trend of traffic entering and leaving the campus, the delays at intersections, and the parking situation on the campus, various surveys were conducted during the year 1979. Based on the results of these surveys the different modes of transportation were planned and evaluated. This evaluation is comprised of a cost comparison of the different alternatives to the auto transportation mode. Also, the feasibility of and legal problems involved in the programs are discussed within the closing chapter of this report.
CHAPTER II

BACKGROUND OF PROGRAM LOCATION

Florida

The United States acquired Florida from Spain in 1821 and on March 3, 1845 it became the 27th state in the United States. Florida, as a southern state, developed after the advent of the automobile; therefore, urban sprawl and auto transportation are more expanded here than the northern states. Agriculture and tourism are the main features of the Sunshine State.

East Central Florida

This region includes the counties of Orange, Seminole, Osceola, Brevard, Volusia, and Lake (Figure 2). Of the 8.5 million visitors who flew by air in the year 1977 (25), the Disney-Orlando area had the second highest tourist attraction after Miami. The current population of East Central Florida is approximately 1.3 million, which has increased by 30 percent within the last half a decade. In the 1960's, Cape Canaveral's Kennedy Space Center was greatly associated with the growth of this area. Later, Florida Technological University (presently known as University of Central Florida), the Naval
Fig. 2. East Central Florida (U.C.F. service area).
Training Center, and especially Disney World have attracted Floridians and visitors to this section of Florida. In 1978, the employment in the Orlando urbanized area rose by 4.5 percent. Major construction projects such as EPCOT (Experimental Prototype Community of Tomorrow) belonging to Disney World, the new Civic Center for the Orlando area, Little England, and Florida Mall, together with the expansion of the International Airport at Orlando and new industries will bring more and more people to this region within the next few years.

University of Central Florida (U.C.F.)

University of Central Florida, a member institution of the State University System of Florida, was founded in 1963. Classes began in October, 1968, with an enrollment of 1,891. In 1971, there were 6,137 attending the school. The 1979 student count reached 12,200.

The campus of the University of Central Florida (U.C.F.) is located 13 miles east of downtown Orlando in Orange County (Figure 3). There are also three off-campus resident centers in Central Florida which offer upper level and graduate courses.

The seven colleges at U.C.F. are the College of Business Administration, Education, Engineering, Health Related Professions, Humanities and Fine Arts, Natural Sciences, and Social Sciences. With the exception of the College of Health Related Professions, the remaining six colleges are offering master degree programs. The College of Engineering and Education are participating in a cooperative
Doctoral program with the University of Florida and Florida Atlantic University.

Fig. 3. Orlando and vicinity- U.C.F. campus.
CHAPTER III

APPROACH TO PROBLEM SOLUTION

U.C.F. Transportation Problems

The University of Central Florida is a commuter institution. Out of 13,600 attending U.C.F. in the Fall of 1979, only 414 students were accommodated in U.C.F. dormitories and about 1,500 lived in apartment complexes close to the campus. The remaining students, faculty and staff drove their private autos to the university. Even the people living close by the school used their cars for commuting.

Two two-lane, two-way roads are feeding the university; University Boulevard (SR. 436-A), and Alafaya Trail (SR. 520) (Figure 3). Both sections of the Alafaya Trail, i.e., north and south of campus, are used by the commuters to reach the school.

During the peak hours; 7:30 to 8:30 in the morning and 4:30 to 5:30 in the afternoon, the access roads become congested, especially at the signalized intersections, entrances, and exits of the U.C.F. campus (Figures 4 and 5). University Boulevard is the most crowded leg with an average daily traffic of 7,192 and a peak-hour volume of 817. Alafaya Trail, the section south of campus, has an average daily traffic of 6,898 and a peak-hour volume of 675. The values
Fig. 4. Traffic congestion during the morning peak hour.
Fig. 5. Traffic congestion during the afternoon peak hour.

Fig. 6. Traffic congestion on the campus.
which correspond for the north section of Alafaya Trail are 4,082 and 517.

As the university population grows each year traffic congestion on the campus is going to be more noticeable to the commuters (Figure 6). According to the results of the opinion survey conducted in the summer of 1979 nineteen percent of the commuters referred to traffic congestion as one of the U.C.F. transportation problems.

Parking at U.C.F. campus is the major problem, especially to the students. The majority of those who answered the questionnaire (Appendix A) on the U.C.F. transportation problems saw the nature of the problem as parking. The capacity of the paved parking lots at U.C.F. is 2,820, while there were 5,500 vehicles parked on the campus on a Wednesday morning in the fall of 1979 (Table 2). This shows that almost half of the commuters had to park in temporary parking lots, roadside curbs, and under the trees, after they failed to find any space in the existing paved lots (Figures 7, 8, and 9).

With the increase in student enrollments, the lack of parking spaces will cause a serious problem in U.C.F. transportation, unless the university authorities devote a lot of land and money to end this conflict or provide a new transportation alternative to the commuters.

According to the University Police reports, 63 property damage accidents occurred on the campus from May 1979 to April 1980. More than 90 percent of the accidents took place in the parking lots. There are other consequences associated with this inconvenient park-
Fig. 7. Parking situation on the campus.
Fig. 8. Parking shortage on the campus.

Fig. 9. Temporary parking lot.
ing situation, such as tardiness to classes, getting stuck in the sand, and destruction of landscape. The existing U.C.F. transportation problems also have long-term impacts on the people and the environment which will be discussed in later sections of this report.

Mass Transit System Inventory

The main public mass transportation carrier in Orange County, as well as in the Orlando urbanized area is, Orange-Seminole-Osceola Transportation Authority (OSOTA). The OSOTA system runs 23 fixed routes in the city of Orlando and Orange County (Figure 10). Of 23 routes, one extends to Seminole County and 2 express bus routes provide service to Martin Marietta Corporation and Walt Disney World. Seven routes provide 30 minute headway and 14 routes have a one hour service. The current fare for adults and students is 50¢, and during off peak hours it is 25¢ for senior citizens and handicapped. There is a 5¢ charge for transfers and no charge for the children of age 6 and under.

The city of Winter Park operates a minibus system with two routes within the city limits. The Orange County Department of Community Affairs also operates a minibus system in the rural parts of Orange County (Figure 10). There are other special transit service programs which provide service for elderly, handicapped, and low income residents within the Orange County area, such as T.H.E. Wayfarer Inc., Retired Senior Volunteers Programs, Central Florida FISH, Inc., Adult Education, American Red Cross, and Catholic School
Fig. 10. Existing mass transit routes (32).
Services (32). The Orange County School Board provides school bus service to approximately 40,000 students in the county. The private operators in the area which provide public bus service from locations in Orange County to outlying cities and states are Intercity Bus Service and Tourist Service.

Taxi service is provided by one main consortium of cab companies which is owned by Mears Motor Livery.

Transportation Alternatives to the U.C.F. Commuters

As an alternative to the prevalent auto transportation at U.C.F., a different mode of transportation would be able to function if it is economical, acceptable, and simple. Considering these factors and the existing conditions in the area the following modes of transportation are selected for evaluation as a second option to the U.C.F. commuters:

1. Bus service
2. Minibus service / Van service
3. Ridesharing systems:
   a. Vanpool
   b. Carpool
4. Bicycle and Pedestrian modes

Bus service

Although the bus system does not provide the same capacity and efficiency as the rail transit in urban areas, it has some advantages over the rail system, such as its relative ease of adjustment to any change in travel patterns, a comparatively low capital cost, and relatively trouble-free technology. Buses may be grouped as minibus,
standard, and high capacity with a range of capacity between 20 and 130. High capacity and standard buses are best suited for relatively high density areas and long distances (5). Regular bus service is usually provided on a fixed-route / fixed-schedule basis. During hours of low demand dial-a-bus service can be operated instead of regular buses. And a park-and-ride system can be used if the density is not high enough. This would concentrate boardings at single spots.

Various types of bus networks are designed to fit different origin-destination configurations. Among these are radial patterns, grid-type networks, radial criss-cross, branches and loops, and through routing (5). In route planning, some of the major factors which affect the process of planning are residential density, safety considerations, pedestrian access, and financing constraints (5).

Scheduling is another major consideration in design and operation of a bus system. The system should be able to handle the passenger loads during the peak hours and provide a high level of service.

Minibus service / Van service

The capacity of vans ranges between 8 to 15, and minibuses carry 15 to 25 passengers (41). This type of service is usually provided in low-density and rural areas. Because of their low capital and operating costs, they might be able to operate on the routes which were considered economically impractical for the regular bus services. In fixed-route service, the operating cost of minibuses would not be much cheaper than standard size buses due to the fact that the
largest single item of expense is the driver's wage. While the capital cost of minibuses and vans is lower, the life span of buses is longer, which offsets the cost difference in the long-run. Considering the maneuverability and lower unit costs of these vehicles, they are preferred to buses where the density is low and dispersed.

Ridesharing systems

Vanpool: Vanpool is defined as a system which consists of 8 to 12 people whose residences are geographically clustered and who share the expenses of owning and operating a van for commuting to a common destination (33). One of the riders will voluntarily operate the vehicle as the driver in exchange for a free ride to the destination and use of the van as a second automobile. There are also other arrangements in owning or leasing a van. This could be done either by the employer or a third party, such as a credit union. Regardless of the type of ownership, a vanpool program is operated as an organized operation in which the participants take their specific responsibilities.

Carpool: Carpool programs are more widely known concepts than vanpool. Although the carpool and vanpool have a similar conceptual basis, they differ in some organizational and operational aspects. Shared-riding carpool involves 2 to 6 people as a group riding in a car owned by the driver. The participants share the commuting expenses and each group is responsible to sustain and support the program. In shared-driving carpool each person shares using his or her car for commuting to a common destination. However, for the purpose
of this study a new concept in ridesharing, "Pay and Ride" carpool, developed by Mohan et. al., (18) at the University of Central Florida, has been selected as a transportation alternative to the U.C.F. commuters. In this program, unlike the traditional carpool, riders would be picked up at carpool stops. The commuting expenses would be shared by the riders through the exchange of coupons which would be sold and redeemed through a campus office.

**Bicycle and Pedestrian modes**

Bicycle, as a mode of transportation and not just for recreational purposes, can satisfy the short-distance travel needs within the urban areas. It can also provide a link between the residential units and mass transit stations. This would save the space and the money required for the construction of parking facilities. The basic factors which affect bicycle usage are climate, topography, and the availability of safe bike paths. Bikeways can be provided exclusively or as a part of the pedestrian or parking lane. Safety is a major concern in this mode of transportation, especially when the other modes are involved.

Walking, being the most versatile linkage between transportation modes, can be considered as a vital means of internal movement within the urban environment. Therefore, it can be considered as a mode of transportation, and the pedestrian system's development should be approached as systematically as the other transportation systems.
CHAPTER IV

OPINION AND TRAFFIC SURVEYS

Location Survey

To determine the residential locations of the commuters, the listings of the students, faculty and staff during the summer quarter of 1979 were used. To make this task easier, the listings were sorted according to the zip codes. Since the addresses were not printed under the same column in the listings, further usage of the computer facility was not possible.

The residential locations of the commuters were first located on the local coded maps, and then, were plotted with pins on the larger maps for the final use (Figures 11, 12, and 13). This survey indicated that approximately 70 percent of the commuters live in the Greater Orlando Area. Most of the high density areas in the Orlando urbanized area are the apartment complexes located on Semoran Boulevard, Alafaya Trail, Golden Rod Road, U.C.F. Boulevard, Aloma Avenue, Curry Ford Road, and Conway Road. Ten percent of the commuters are living in Brevard County. Four percent are coming from Volusia County. And the rest of the commuters are residing in the cities of Kissimmee, Leesburg, Gainesville, Sanford, Deland and St. Cloud.
Fig. 11. Density map of the students' residences (Orange County).
Fig. 12. Density map of the students' residences (Seminole County).
Fig. 13. Density map of the faculty and staff residences (Orange County).
Opinion Survey

To determine the existence of the U.C.F. transportation problems, acquire information relating to the commuters, and study their attitudes toward an alternative to the auto transportation mode, an opinion survey was conducted in the summer quarter of 1979. A questionnaire was prepared and distributed to the students through a class project (Appendix A).

Four hundred and fifty people, 5.4 percent of the total population attending the school, were questioned through this survey. In order to get a more complete and reliable response to the questionnaire, the format was made to be readily understood, requiring a minimum of time to complete, and which could be coded for analysis using the computer facility. A computer program was developed to give the results of the survey (Appendix A). Some hand calculations were also done on the questions which could not be coded for the purpose of a more detailed analysis (Appendix A).

According to the results of this survey: 51 percent of respondents were male and 49 percent were female; 92 percent were white, 6 percent were black, and 2 percent were of other races; 15 percent saw the transportation problem to be mild, 42 percent saw it as in-between, and 20 percent felt that the problem was serious; 67 percent mentioned parking as the main problem, 33 percent considered the money spent on commuting as a problem, and 19 percent saw the problem being the traffic congestion on the access roads to school;
27 percent of the cars driven by the commuters were sub-compact, 46 percent were compact, and 22 percent were big. The one-way average mileage was found to be 18.8 miles. There may be some inaccuracy in this rate due to the fact that most of the people have a better conception of time rather than distance of travel. Fiftythree percent selected bus service as an alternative for the U.C.F. commuters. Fifty-nine percent agreed with the proposed carpool program as a solution to U.C.F.'s transportation problems. And fifty-six percent stated that they would participate in the carpool program if implemented. In relation to the problems involved in the program during its implementation phase, a number of respondents referred to the conflict in schedules, reliability and possibility of crimes as possible deterrents from the usage of the program (Appendix A).

Five percent of the interviewees who answered the questionnaire were randomly selected and contacted by telephone to verify the validity of the survey. This was done during the fall quarter of 1979. The following results were obtained:

1. Seventy percent recalled answering the questionnaire. Fifteen percent were no longer students at U.C.F. No contact was possible with the remaining fifteen percent.

2. Out of seventy percent who recalled the interview:
   a. Ninety percent had answered the questionnaire immediately.
   b. Ten percent took it home.
   c. Eighty percent gave some thought to the questions.
   d. Twenty percent were in a hurry.
   e. Eighty percent were now more aware of the U.C.F. transportation problems.
   f. Twenty percent were having less trouble during commuting.
g. Ninety percent were now more in favor of the carpool program.
h. Ten percent felt the same towards the problem.

Traffic Study

To study the trend and characteristics of the traffic entering and leaving the university, vehicular counts were conducted to serve this purpose. Although manual counts usually result in relatively high costs and are subject to the limitations of human factors, this method was used to run the study because of the following reasons:

1. Inadequate number of mechanical counters.
2. A need for recording the vehicle occupancy rate.

A few traffic counters were available through the school for the traffic study, but there was a need for twice that number to conduct the survey. The Traffic Engineering Department of the City of Orlando, Orange County, and Seminole County and a private firm were contacted for the extra counters. Due to the seasonal conditions, they were all in use. Therefore, the manual count method was used to obtain the necessary data. This method could also provide the information on the vehicle occupancy rate.

This survey was done in the fall quarter of 1979. Since this quarter has always been the busiest in the academic years of the university, it could provide the most useful data for the purpose of this study. Some field data sheets were prepared to be used by the observers to record the traffic counts and the vehicle occupancy rate (Appendix B).

Tuesday and Wednesday were chosen as two typical days of the
week for this survey. A 12-hour counting period was considered for each day. Also, the counting periods were scheduled to avoid any special event. In order to cover all the entrances and exits, four observers were needed at each counting station. Each person had to record the number of cars entering and leaving the campus and the number of people in each car. The counting period on each day was divided into six two-hour shifts for the convenience of the observers and to reduce fatigue. The results of this traffic study are shown in Figures 14 through 17. The vehicle occupancy rate was found to be 1.17 (Appendix B).

Intersection Delay Study

Intersection delay is one of the major factors in the analysis of traffic congestion. It can be affected by physical factors of the intersection, traffic factors, and traffic controls. Of the different methods for field measurement of intersection delay, the method of stopped time delay was selected to find the total delay, since the losses due to deceleration and acceleration were not the main interests of this study. This method involves the counting of the number of vehicles stopped at the intersection at successive time intervals.

Out of four intersections east of campus i.e., entrances and exits, three were considered for delay study. The reason for this selection was that one of the intersections had almost no delay compared to the others. From these three intersections, one was a
NOTE: Hourly traffic at 8:00 includes all traffic from 7:30 to 8:30.

Fig. 14. Hourly traffic entering the University (Tuesdays).

Fig. 15. Hourly traffic entering the University (Wednesdays).
NOTE: Hourly traffic at 8:00 includes all traffic from 7:30 to 8:30.

Fig. 16. Hourly traffic leaving the University (Tuesdays).

Fig. 17. Hourly traffic leaving the University (Wednesdays).
four-way signalized intersection, and the other two were three-way intersections with no traffic lights.

This study was done in the same week as the traffic flow survey was run but on different days i.e., Monday and Thursday. Based on earlier traffic counts the peak periods from 7:30 to 9:30 in the morning and 3:30 to 5:30 in the afternoon were selected as the time intervals for conducting the survey. Field data sheets were prepared to record the observations (Appendix C).

According to this study the total delay was found to be 153,890 vehicle-seconds (48 hours) on Monday and 30,960 vehicle-seconds (9 hours) on Thursday during the peak 4 hours. Detailed analysis is given in Appendix C.

Parking Study

The main purpose of this study was to acquire information on parking supply, usage, and demand. The first step was to find the total capacity of the paved parking lots. This was done together with the marking and numbering of parking spaces for each parking lot to be used in the other phases of the survey. The number of paved parking spaces summed up to 2,820 (Table 2).

In the next phase, the total number of cars parked on the campus was counted. This count was taken on a Wednesday at 10:00 a.m. (based on police records for peak hour parking). The traffic flow data was available for a Wednesday of the fall quarter; therefore, this typical day of the week was selected for a parked vehicles...
The counting started a few minutes after 10:00 in the morning and ended before 11:00 in the morning, so that the error due to the cars coming to and leaving the campus would be minimal. When this survey was conducted in the fall quarter of 1979, 5,500 vehicles were parked on the campus (Table 2).

To find the turnover and usage of the parking lots the license plate check method was selected. Because of the difficulties associated with irregular patterns of parked cars in the unpaved areas, only the paved parking lots were considered for this phase of the study.

Since the majority of the classes start at either 8:00 or 9:00 a.m. and end at 3:00 or 4:00 p.m., a time period of eleven hours (7:00 a.m. to 5:00 p.m.), with a time interval of one hour, was considered for the purpose of this study.

Data sheets were prepared and handed to the observers before the study began (Appendix D). Because of the man-power limitation, this study could not be accomplished in one day. Usually, in cases when the survey is conducted on different days and for different study periods, the turnover rate is better to be expressed as vehicles per space per hour. But, in this case, since the study period was the same and we were interested in the turn-over rate based on the total number of spaces, the computations were done on this basis rather than per space per hour. The turn-over of the major paved parking lots are shown in Table 3. The parking usage of the parking lots are shown in Figures 19 through 26 and Table 4.
TOTAL NO. OF CARS PARKED ON THE CAMPUS
10:00 A.M., WEDNESDAY, FALL, 1979.

<table>
<thead>
<tr>
<th>Parking lot no.</th>
<th>Capacity</th>
<th>No. of cars</th>
<th>Parking lot no.</th>
<th>Capacity</th>
<th>No. of cars</th>
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<tbody>
<tr>
<td>1</td>
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<td>177</td>
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<tr>
<td>3</td>
<td>100</td>
<td>92</td>
<td>3W</td>
<td>109</td>
<td>104</td>
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<td>303</td>
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<td>4W</td>
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<td>271</td>
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<tr>
<td>7</td>
<td>175</td>
<td>175</td>
<td>V.C. CIRCLE</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>259</td>
<td>254</td>
<td>CENTRAL PLANT</td>
<td>10</td>
<td>8</td>
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<tr>
<td>OFF STREET</td>
<td>—</td>
<td>845</td>
<td>POLICE DEPT.</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>TEMP. LOT 200</td>
<td>—</td>
<td>415</td>
<td>EAST OF TENNIS COURTS</td>
<td>—</td>
<td>482</td>
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<tr>
<td>TEMP. LOT 300</td>
<td>—</td>
<td>1025</td>
<td>MAINT.</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>VISITORS</td>
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<td>36</td>
<td>PRINT SHOP</td>
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<td>8</td>
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</tbody>
</table>

Total 2820 5500

*For the description of the parking lots refer to Figure 18.
### TABLE 3

**TURNOVER OF THE PAVED PARKING LOTS**

<table>
<thead>
<tr>
<th>Parking lot no.</th>
<th>Parking code</th>
<th>Turnover</th>
<th>Parking lot no.</th>
<th>Parking code</th>
<th>Turnover</th>
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<td>1.76</td>
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<td>DR</td>
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<td>1W</td>
<td>D</td>
<td>1.56</td>
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<tr>
<td>3</td>
<td>ABH</td>
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<td>BCD</td>
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</tr>
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<td>D</td>
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<tr>
<td>6</td>
<td>C</td>
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<td>7</td>
<td>D</td>
<td>1.74</td>
<td>6W</td>
<td>D</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Average turnover = \( \frac{1.76 + 2.42 + \cdots + 1.70}{14} = 1.79 \)

*For an explanation of the parking codes see Figure 18.*
Fig. 18. University campus map.
Fig. 19. Hourly usage vs. time for parking lot no. 1.

Fig. 20. Hourly usage vs. time for parking lot no. 5.
Fig. 21. Hourly usage vs. time for parking lot no. 4.

Fig. 22. Hourly usage vs. time for parking lot no. 6.
Fig. 23. Hourly usage vs. time for parking lot no. 7.

Fig. 24. Hourly usage vs. time for parking lot no. 8.
Fig. 25. Hourly usage vs. time for parking lot no. 2W.

Fig. 26. Hourly usage vs. time for parking lot no. 4W.
## TABLE 4

**HOURLY USAGE (IN PERCENT) OF THE PAVED PARKING LOTS**

<table>
<thead>
<tr>
<th>Lot no.</th>
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<th>8:00</th>
<th>9:00</th>
<th>10:00</th>
<th>11:00</th>
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<th>1:00</th>
<th>2:00</th>
<th>3:00</th>
<th>4:00</th>
<th>5:00</th>
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<td>88</td>
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<td>99</td>
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<td>50</td>
<td>35</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>DR</td>
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<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>98</td>
<td>98</td>
<td>96</td>
<td>89</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ABH</td>
<td>14</td>
<td>41</td>
<td>81</td>
<td>89</td>
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<td>80</td>
<td>85</td>
<td>95</td>
<td>85</td>
<td>86</td>
<td>71</td>
</tr>
<tr>
<td>4</td>
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<td>73</td>
<td>89</td>
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<td>99</td>
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<td>89</td>
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<td>80</td>
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</tr>
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<td>90</td>
<td>73</td>
<td>53</td>
</tr>
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<td>55</td>
<td>89</td>
<td>90</td>
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<td>88</td>
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<td>72</td>
<td>52</td>
</tr>
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<td>—</td>
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<td>87</td>
<td>74</td>
<td>73</td>
<td>58</td>
<td>27</td>
<td>15</td>
</tr>
</tbody>
</table>
Programs Planning and Operation

Bus service

It was observed in the location surveys that except for sections of the Orlando urbanized area and apartment complexes close to the campus the population densities were low and dispersed within the U.C.F. impact area, indicating diffused travel patterns and small trip concentrations. A regular bus service as a fixed-route and fixed-schedule service could be relatively economical to function only in high density areas. It was determined from the location surveys that approximately 70 percent of the commuters were residing in the Greater Orlando Area. The opinion survey indicated that 53 percent of the respondents to the questionnaire agreed with a bus system as a solution to U.C.F.'s transportation problems. The traffic survey showed that 2,000 cars entered the campus during the morning peak-hour on a typical day of the week (Figure 14).

Based on the results of the surveys, and assuming half of the commuters would use the bus service, about 46 buses (36 seater) would be needed to cover the area, with a load factor of 0.5. For
a load factor of 0.75 the number of buses required for this type of service would be 30.

Since there is one common destination and scattered origins, a radial pattern network would be the best routing in this case. A one-hour frequency of service would be reasonable for the system according to the existing class schedules.

The parking study showed that the number of cars parked in the parking lots dropped at 5 p.m. and before 8 a.m. Therefore, a daily schedule of 7 a.m. to 6 p.m. should satisfy the commuters' transportation needs to and from the campus, unless the route length would require a different arrangement. Typical bus speed on arterial streets ranges from 10 mph (peak hour) to 15 mph (off-peak hour) (41).

During the implementation of the system, a peak to base ratio of 1.0 could be used to avoid any possible delay or inconvenience to the participants of the program. Peak-to-base-ratio is defined as "The ratio between the number of vehicles operated during the peak-hour compared to the number scheduled during the midday or base ratio" (5). Any type of transfers would be avoided to make the system less complicated and more dependable for the passengers. The proposed bus routes are shown in Figures 27 through 33. The following criteria have been considered in the layout of the bus routes:

1. Covering high density areas.
2. Having a minimum number of left turns.
3. Providing a one-hour headway.
4. Selecting main streets.
The incentive for the users would be the saving on the commuting costs.

**Minibus service / Van service**

This type of service in many ways resembles the regular bus service, except for the size of the vehicles and their better maneuverability. Based on the same factors and results of the surveys which were considered in the planning process of the bus service, the number of vans and minibuses required to handle the passenger loads during the peak-hours is determined in this project.

Considering a load factor of 0.5, about 68 minibuses (24 seater) or 117 vans (15 seater) would be required for this type of service. The required number of minibuses and vans would be respectively, 46 and 74, if a load factor of .75 is considered for the service.

The routing and scheduling would be the same as for the bus system. The minibus / van routes are shown in Figures 27 through 33. The incentive for the commuters would be the reduction in cost of transportation. On campus lockers could be used as an additional incentive for the users of the above services (30). This would provide a place for the commuters to keep their belongings.

**Ridesharing systems**

**Vanpool:** The main components of a vanpool program are the regular riders who usually number between 8 and 12, the driver and the party which provides the administrative and the capital support for
Fig. 27. Proposed bus / minibus / van routes (Winter Park, Semoran).
Fig. 28. Proposed bus / minibus / van routes (Orlando, Goldenrod).
Fig. 29. Proposed bus / minibus / van routes (Pine Castle).
Fig. 30. Proposed bus / minibus / van routes (Lake Underhill, Edgewood).
Fig. 31. Proposed bus / minibus / van routes (Maitland).
Fig. 32. Proposed bus / minibus / van routes (Casselberry).
Fig. 33. Proposed bus / minibus / van routes (Oviedo).
Fig. 34. Proposed bicycle paths.
the operation of the system. In case of a university, the vans could be provided either by the school or by the Student Government. Another option would be ownership of the vans by the students; however, many social, regulatory, and insurance problems can be circumvented if a single owner is involved in the program.

Typically, in a vanpool system, the expenses are shared among the riders by an exchange of cash. As another option, coupons could be substituted for the cash. There could be two different arrangements for the program's operation. Either the commuters sign up as vanpool riders and their time-origin-destination would be matched by an office at the campus, or this arrangement can be done by the commuters residing in the same neighborhood. In the second case, the vanpool riders would wait at the designated vanpool stops (Figures 35 and 36) to be picked up by the drivers heading towards the school. Assuming the same number of commuters who would use the other mass transit modes would utilize this system, 560 vans with a vehicle occupancy rate (VOR) of 8, or 450 vans with a VOR of 10 would be required to handle the commuters' transportation needs.

The incentive for the riders will be the money they save during commuting to the university. If the system is efficient the vanpool riders will stay in because of the convenience and the camaraderie. Drivers will be responsible for picking up the riders, driving them to school, and taking care of the daily maintenance of the van. In exchange for their duties, they will receive a free ride to the university and the use of the van on weekends.
Carpool: A typical ridesharing carpool requires common origins and destinations and a regular time schedule i.e., same departure and returning times. An initial matching of time-origin-destination should also be provided for the participants in order to have an efficient performance.

In case of a university, the class schedules change every quarter and they vary for different students. And despite the unique destination, the origins are quite different and dispersed. Therefore, the "Pay and Ride" carpool program is considered as one of the alternatives to the commuters of the University of Central Florida (18). In this system, carpool stops would be provided at suitable locations along the roadside within a reasonable walking distance from the residential units. The results of the opinion survey showed that half a mile would be an acceptable walking distance to almost half of the respondents. The proposed carpool stops are shown in Figures 35 and 36.

In the first stage of the program road signs would be erected at the designated points to represent the location of the carpool stops (Figures 37). As a futuristic view of the program, when the "Pay and Ride" carpool is established as a dependable and efficient system, better and more convenient carpool stops could be provided to the users. Sheltered stops, equipped with benches and public telephones would probably attract more people to the program (Figure 38) (18).
In this program the riders will have coupons to pay in exchange for a one-way ride. These coupons will be sold and redeemed at the university campus. The riders will carry stickers on the bumpers of their cars to show their active participation in the program. After an exchange of identification at the carpool stops the riders will be picked up for a ride to the university. There will be corresponding stops on the campus for the homeward trips (18).

While the program is functioning, parking restrictions might be applied as additional incentives for the carpoolers and for the promotion of the system's efficiency. This can be started by cheaper and/or closer parking for the users of the program. If further parking restrictions were needed, no freshmen and sophomores would be allowed to use the parking facilities on the campus. Consideration of higher parking fees for the lone drivers could be used as the next step. And finally, campus parking would be restricted to handicapped and participants in the carpool program only (18).

**Bicycle and Pedestrian modes**

The generalized topography of the U.C.F. area varies from 50 feet to 100 feet above sea level. An average high temperature of 82.6 degrees Fahrenheit, and an average low temperature of 62.1 degrees Fahrenheit, with an average mean of 72.4 degrees Fahrenheit have been recorded at Herndon Airport in the Orlando area (32). Therefore, two out of three basic requirements for a good cycling environment i.e., climate and topography are met in this area.
Fig. 25. Designated carpool (vanpool) stops (Orange County).
Fig. 36. Designated carpool (vanpool) stops (Semiole County).
Fig. 37. Proposed carpool (vanpool) stop sign.
Fig. 38. Futuristic layout of the carpool stops (18).
Compared to 12,500 automobiles registered each quarter at the university, only 150 bicycles were registered in 1979. According to the survey conducted by the Orange County Planning Department during the years 1978-79, over 40 percent of the students would utilize the University Blvd. bike path if provided (37).

During 1978, 245 accidents involving bicycles occurred in Orange County. This number increased to 408 during the year 1979 (37).

The bicycle paths, proposed within a radius of 5 miles from the university campus, are shown in Figure 34, and could be used as a transportation alternative by the U.C.F. commuters. These paths could also be utilized by the pedestrians. The incentives for the users would be the saving on commuting expenses and recreational enjoyment from riding.

It should be mentioned that none of the above proposed systems would serve the total population of the university. While a program is implemented successfully it could be extended to cover more area.

Programs Management

Bus service

In a mass transit program, as in any other program, the role of management is to conduct the system's activities towards established objectives. To run the university bus service a general manager would be needed to handle the process of planning, organizing the resources, supervising the employees, and coordinating
the various activities within the system. Under this top management, three broad groups would be functioning; maintenance, operations and accounting. The maintenance would be responsible for servicing the vehicles, purchasing the necessary parts, and maintaining the plant. The operations division would be responsible for the activities related to the bus operators, scheduling, routing, surveying and dispatching. And the accounting section would take care of bookkeeping, payroll, and the records.

In the planning process, both short-term and long-term planning would be considered by the management system. In short-term planning, the events and the program's performance should be studied and evaluated and necessary actions should be taken to alleviate the deficiencies of the system. As a long-term planning function, the expansion of the system and its effects on the users and the public would be considered and inspected. The task of organizing resources such as vehicles, maintenance facilities and garages would be another concern of the manager.

Employees are always the most important element of a system. Therefore, supervision of subordinates in such a manner as to promote the highest productivity and to provide the highest satisfaction to the employees would be one of the major responsibilities of the general manager. Since each group is concerned with specific activities within his framework, the top management has the duty of coordinating the activities of various groups in order to provide the highest performance for the system.
The organization chart of a medium-size bus system (11 to 50 buses) can be represented as follows:

Manager-
  Maintenance supervisor-
    Mechanics
    Servicemen
  Safety supervisor
  Operations superintendent-
    Bus operations
    Dispatcher
  Sales manager-
    Routing
    Scheduling
    Advertising
    Public information
  Information supervisor-
    Information
    Accounting
  Senior Secretary-
    Secretaries
    Clerical staff

Minibus service / Van service

The management of this type of service, in many aspects, would be similar to the bus service. The only difference would be in the number of the unit vehicles which would involve more operators in the system. Therefore, more attention would be devoted to the coordination of the individual groups within the system. In this type of service the system has a higher degree of flexibility due to the increased number of vehicles. Thus, the task of routing and scheduling would be a more detailed and variable process.

Ridesharing systems

Vanpool: In this system, there could be different arrangements
concerning the ownership of the vehicles:

1. The institution owns and/or leases the vans.
2. The commuters own or lease the vans.
3. A third party (a credit union, for example) owns/or leases the vans.

Regardless of the type of ownership of the vans, a vanpool program is operated as a formal business operation in which the participants assume very specific responsibilities. However, a typical management team could be as follows:

- Vanpool Project Administrator- responsible for overall administration and program activities.
- Project Coordinator- responsible for the operation of the system.
- Vanpool Maintenance Coordinator- responsible for maintaining the vans.
- Computer Coordinator- responsible for matching involved with vanpooling.
- Vanpool Accountant- responsible for accounting associated with the program.
- Legal Staff- responsible for legal considerations regarding the implementation and extension of the system.
- Evaluation Team- responsible for data collection and evaluation of the project.

Carpool: For the purpose of supervising and decision making during the implementation and operating phase of the program a committee has been formed of the following university members:

- Representative of the University Administration.
- Representative of the Student Government.
- Representative of the University Staff Council.
- Faculty member from Transportation area.
- Representative of the Faculty Senate.

Funds have been allocated by the University Administration to plan the experimental phase of the program. Federal and state agen-
cies would be approached to provide the funding for the implementation of the program (18).

**Bicycle and Pedestrian modes**

The construction of bikeways would require funding from the government, Florida Department of Transportation and Orange County. Therefore, there should be a coordination among these agencies for a successful completion of the project. After the construction of the facilities by a local construction firm, Orange County will be responsible for signing, intersection striping and maintenance and other associated tasks (37). Parking racks for the bicycles on campus, would be required during the operation of the program.

**Cost Analysis**

In this section cost criterion has been used for comparative analysis of the various transportation alternatives. The reason for cost to be the major selective criterion is that the quantitative evaluation of other parameters such as reliability, safety, convenience and the system's impact on the community, includes both considerable experience and value judgments, making the evaluation process a very complex and somewhat controversial task. However, these parameters will be discussed briefly in this chapter.

The procedures used for the cost analysis are:
1. Present-worth method.
2. Equivalent uniform annual cost method.

These methods are commonly used because of the clarity in which they
show the economic advantages of one alternative over another.

The modes included in this analysis are:
1. Bus service
2. Minibus service
3. Van service
4. Vanpool
5. Carpool
6. Private automobile

The exclusion of the bicycle mode from the analysis is due to the fact that this mode would provide for a smaller service area. Bike-way facilities are constructed and maintained by the County and the bicycle is operated by external force, while the other modes function using internal power. However, the cost of providing this service for the commuters has been considered separately at the end of this section.

To determine the expenses of implementing the candidate transit modes the local existing mass transportation systems were approached for the necessary data. The planning engineer for the Orange-Seminole-Osceola Transportation Authority was contacted for information on bus services in March of 1980. For the minibus service, the planning department of the City of Winter Park Minibus System was approached in April of 1980. For the van service, the president of Rabbit Bus Lines was contacted in May of 1980.

It should be mentioned here that all the alternatives selected for the comparative cost analysis have the same service area with a target population of 4,500. Also, the candidate modes have been
compared over the same number of years, and since these modes have different useful life spans, the mode with the longest useful life span has been chosen as the base for comparison (Figure 39). Two types of vans have been used in this study: maxivan (15 passenger) for the van service, and regular van (12 passenger) for the vanpool program. The useful life-span considered for the various modes are as follows:

1. Bus- 12 years
2. Minibus- 8 years
3. Maxivan- 4 years
4. Van- 4 years
5. Automobile- 10 years

In order to have comparable results all the calculations have been based on 1979 prices.
Fig. 39. Cost vs. time for the various modes of transportation.
Initial Cost of the Various Modes of Transportation

Bus service

Price/bus (36 seater): $100,000 (4)

Inspection garage/bus: $13,530 at $29.00 per sq.ft. (5) (Typical price in 1975)

Inflated price for 1979: $13,530 x 1.276 = $17,264

Total cost/bus: $100,000 + $17,264 = $117,264

Subtotal cost of the system: \( C_s \)

\[ C_s = \text{No. of buses} \times \text{total cost/bus}. \]

for the load factor 0.5: 46 x $117,264 = $5,394,144

for the load factor 0.75: 30 x $117,264 = $3,517,920

Cost of providing the offices: $260,000

4,000 sq.ft. (4) at $65.00/sq.ft. (see Appendix E)

Cost of stop signs: $13,500 at $50.00/unit (see Appendix E)

Total initial cost of the system: \( C_t \)

for the load factor 0.5:

\[ C_t: \$5,394,144 + \$260,000 + \$13,500 = \$5,667,644 \]

for the load factor 0.75:

\[ C_t: \$3,517,920 + \$260,000 + \$13,500 = \$3,791,420 \]
Minibus service

Price/minibus (24 seater): $25,000 (2)

Inspection garage/minibus: $11,567 (see Appendix E)

Total cost/minibus: $25,000 + $11,567 = $36,567

Subtotal cost of the system:
  for the load factor 0.5: 68 x $36,567 = $2,486,556
  for the load factor 0.75: 46 x $36,567 = $1,682,082

Cost of providing the offices: $260,000 (see Appendix E)

Cost of stop signs: $13,500 (see Appendix E)

Total initial cost of the system: $t$
  for the load factor 0.5: 
  $C_t$: $2,486,556 + $260,000 + $13,500 = $2,760,056
  for the load factor 0.75: 
  $C_t$: $1,682,082 + $260,000 + $13,500 = $1,955,582
Van service

Price/van (15 seater): $12,000 (13)

Inspection garage/van: $6,905 (see Appendix E)

Total cost/van: $12,000 + $6,905 = $18,905

Subtotal cost of the system:
  for the load factor 0.5: 117 x $18,905 = $2,211,885
  for the load factor 0.75: 74 x $18,905 = $1,398,970

Cost of providing the offices: $260,000 (see Appendix E)

Cost of stop signs: $13,500 (see Appendix E)

Total initial cost of the system: $t$
  for the load factor 0.5: $C_t: \$2,211,885 + \$260,000 + \$13,500 = \$2,485,385$
  for the load factor 0.75: $C_t: \$1,398,970 + \$260,000 + \$13,500 = \$1,672,470$
Vanpool

Price/Van (12 seater): $10,000 (39)

Subtotal cost of the system:
  for VOR of 8: 560 x $10,000 = $5,600,000
  for VOR of 10: 450 x $10,000 = $4,500,000

Cost of providing the offices: $26,000
  400 sq.ft. at $65/sq.ft. (see Appendix E)

Cost of stop signs: $5,000 (see Appendix E)

Total initial cost of the system: $C_t$
  for VOR of 8:
  $C_t: \$5,600,000 + \$26,000 + \$5,000 = \$5,631,000$
  for VOR of 10:
  $C_t: \$4,500,000 + \$26,000 + \$5,000 = \$4,531,000$
Carpool

Price/car (American standard): (36)

Subtotal cost of the system:
- for VOR of 3: 1,500 x $6,500 = $9,750,000
- for VOR of 4: 1,125 x $6,500 = $7,312,500

Cost of providing the offices: $26,000 (see Appendix E)

Cost of stop signs: $5,000 (see Appendix E)

Total initial cost of the system: \( C_t \)
- for VOR of 3: \( C_t: 9,750,000 + 26,000 + 5,000 = 9,781,000 \)
- for VOR of 4: \( C_t: 7,312,500 + 26,000 + 5,000 = 7,343,500 \)

Private automobile

Price/car (American standard): $6,500 (40)

Total initial cost of the system: \( C_t \)
- for VOR of 1.7: \( C_t: 3,846 x 6,500 = 25,000,000 \)
Operating Cost of the Various Modes of Transportation

Bus service

Total operating cost/bus-hour: $18.00* (4)

Total operating cost/year: $Cy$

\[ Cy = \text{number of buses} \times \text{number of work-hours/day} \times \text{number of work-days/year} \times \text{cost/hour}. \]

For the load factor 0.5:

\[ Cy: \ (46 \times 12 \ \text{hrs/day} \times 150 \ \text{days/yr} + 23 \times 12 \ \text{hrs/day} \times 50 \ \text{days/yr (summer quarter)}) \times $18.00/\text{hr} = $1,738,800 \]

It should be mentioned here that the commuter population would be dropped to half during the summer quarter.

For the load factor 0.75:

\[ Cy: \ (46 \times 12 \ \text{hrs/day} \times 150 \ \text{days/yr} + 23 \times 12 \ \text{hrs/day} \times 50 \ \text{days/yr (summer quarter)}) \times $18.00/\text{hr} = $1,341,800 \]

Minibus service

Total operating cost/minibus-hour: $13.00 (42)

Total operating cost/yr: $Cy$

For the load factor 0.5:

\[ Cy: \ (68 \times 12 \ \text{hrs/day} \times 150 \ \text{days/yr} + 34 \times 12 \ \text{hrs/day} \times 50 \ \text{days/yr (summer quarter)}) \times $13.00/\text{hr} = $1,856,400 \]

For the load factor 0.75:

\[ Cy: \ (46 \times 12 \ \text{hrs/day} \times 150 \ \text{days/yr} + 23 \times 12 \ \text{hrs/day} \times 50 \ \text{days/yr (summer quarter)}) \times $13.00/\text{hr} = $1,255,800 \]

*As stated earlier in chapter 5, typical bus speed has been assumed to be 15 mph. As for the records of OSOTA, an average operating cost of $1.20 is incurred per bus-mile.
Van service

Total operating cost/van-hour: $10.20 (13)

Total operating cost/year: $t$

for the load factor 0.5:

\[ C_y = (117 \times 12 \text{ hrs/day} \times 150 \text{ days/yr} + 58 \times 12 \text{ hrs/day} \times 50 \text{ days/yr (summer quarter)}) \times $10.20/hr = $2,484,720 \]

for the load factor 0.75:

\[ C_y = (74 \times 12 \text{ hrs/day} \times 150 \text{ days/yr} + 37 \times 12 \text{ hrs/day} \times 50 \text{ days/yr (summer quarter)}) \times $10.20/hr = $1,585,080 \]

Vanpool

Annual mileage-related operating cost: \( C_{ym} \)

\[ C_{ym} = \text{number of vans} \times \text{one-way daily mileage} \times 2 \times \text{number of days/yr} \times \text{cost/mile}. \]

for VOR of 8:

\[ C_{ym} = (560 \times 18.00 \text{ mi/day (Appendix E)} \times 2 \times 150 \text{ days/yr} + 280 \times 18.00 \text{ mi/day} \times 2 \times 50 \text{ days/yr (summer quarter)}) \times 14\$\text{/mi (Appendix E)} = $493,920 \]

for VOR of 10:

\[ C_{ym} = (450 \times 18.00 \text{ mi/day} \times 2 \times 150 \text{ days/yr} + 225 \times 18.00 \text{ mi/day} \times 2 \times 50 \text{ days/yr (summer quarter)}) \times 14\$\text{/mi = $396,900} \]

Annual ownership cost: \( C_{yo} \)

\[ C_{yo} = \text{number of vans} \times \text{cost of (insurance + tag + finance)} \]

for VOR of 8:

\[ C_{yo} = 560 \times $1,219 \text{ (see Appendix E)} = $682,640 \]

for VOR of 10:

\[ C_{yo} = 450 \times $1,219 = $548,550 \]

Administration cost: \( C_{ya} \)

salaries: 1 clerk + 1 typist = $16,000/yr (U.C.F. Personnel Office)
office overhead: $2,500/yr
\[ C_{ya} = 16,000 + 2,500 = 18,500 \]

Total operating cost: \( C_y \)
\[ C_y = C_{ym} + C_{yo} + C_{ya} \]
for VOR of 8:
\[ C_y: 493,920 + 682,640 + 18,500 = 1,195,060 \]
for VOR of 10:
\[ C_y: 396,900 + 548,550 + 18,500 = 963,950 \]

Carpool

Annual mileage-related operating cost: \( C_{ym} \)
\[ C_{ym}: \text{number of cars} \times \text{one-way daily mileage} \times 2 \times \text{number of days/yr} \times \text{cost/mi.} \]
for VOR of 3:
\[ C_{ym}: (1,500 \times 18.00 \text{ mi/day} \times 2 \times 150 \text{ days/yr} + 750 \times 18.00 \text{ mi/day} \times 2 \times 50 \text{ days/yr (summer quarter)}) \times 12.4\cent/\text{mi} (\text{Appendix E}) = 1,171,800 \]
for VOR of 4:
\[ C_{ym}: (1,125 \times 18.00 \text{ mi/day} \times 2 \times 150 \text{ days/yr} + 562 \times 18.00 \text{ mi/day} \times 2 \times 50 \text{ days/yr (summer quarter)}) \times 12.4\cent/\text{mi} = 878,068 \]

Annual ownership cost: \( C_{yo} \)
\[ C_{yo}: \text{number of cars} \times \text{cost of (insurance + tag + finance)} \]
for VOR of 3:
\[ C_{yo}: 1,500 \times 198 \text{ (Appendix E)} = 297,000 \]
for VOR of 4:
\[ C_{yo}: 1,125 \times 198 = 222,750 \]

Administration cost: \( C_{ya} \)

salaries: $16,000/yr (see Vanpool)
office overhead: $2,500 (see Vanpool)
\[ C_{ya} = 16,000 + 2,500 = 18,500 \]
Total operating cost: $Cy$

\[ Cy = C_{ym} + C_{yo} + C_{ya} \]

for VOR of 8:
\[ Cy: $1,171,800 + $297,000 + $18,500 = $1,487,300 \]

for VOR of 10:
\[ Cy: $878,068 + $222,750 + $18,500 = $1,119,318 \]

Private automobile

Annual mileage-related operating cost: $C_{ym}$

\[ C_{ym} = \text{number of cars} \times \text{one-way daily mileage} \times 2 \times \text{number of days/yr} \times \text{cost/mi.} \]

for VOR of 1.17:
\[ C_{ym}: (3,846 \times 18.00 \text{ mi/day} \times 2 \times 150 \text{ days/yr} + 1,923 \times 18.00 \text{ mi/day} \times 2 \times 50 \text{ days/yr (summer quarter)}) \times 12.4\text{¢/mi} = $3,004,495 \]

Annual ownership cost: $C_{yo}$

\[ C_{yo} = \text{number of cars} \times \text{cost of (insurance + tag + finance)} \]
\[ C_{yo}: 3,846 \times $198 \text{ (Appendix E)} = $761,508 \]

Total annual cost: $Cy$

\[ Cy = C_{ym} + C_{yo} \]
\[ Cy: $3,004,495 + $761,508 = $3,766,003 \]
Present-Worth Evaluation of the Various Modes of Transportation

\[ PW = P - SV(P/F, i\%, n) + RC(P/F, i\%, n) + AC(P/A, i\%, n) \]

- **PW** = Present-worth
- **P** = Initial cost
- **SV** = Salvage value
- **P/F** = Present-worth factor
- **i** = Interest rate (assumed to be 7\% for this analysis)
- **n** = Life in years
- **RC** = Renewal cost
- **AC** = Annual cost
- **P/A** = Present-worth factor for the annual cost

**Bus service**

- Life: 12 years (4)
- Salvage value: $15,000 (4)
- Study period: 12 years

For the load factor 0.5:
\[ PW = 5,667,644 - 46 \times 15,000(P/F, 7\%, 12) + 1,718,800(P/A, 7\%, 12) = \$19,172,050 \]

For the load factor 0.75:
\[ PW = 3,791,420 - 30 \times 15,000(P/F, 7\%, 12) + 1,134,000(P/A, 7\%, 12) = \$12,598,641 \]

**Minibus service**

- Life: 8 years (2)
- Salvage value: $4,500 (2)
- Study period: 12 years
For the load factor 0.5:
\[ PW = 2,760,056 - 68 \times 4,500(P/F, 7\%, 8) + 68 \times 25,000(P/F, 7\%, 8) - 68 \times 14,750(P/F, 7\%, 12) + 1,856,400(P/A, 7\%, 12) = 17,870,860 \]

For the load factor 0.75:
\[ PW = 1,955,582 - 46 \times 4,500(P/F, 7\%, 8) + 46 \times 25,000(P/F, 7\%, 8) - 68 \times 14,750(P/F, 7\%, 12) + 1,255,800(P/A, 7\%, 12) = 12,177,596 \]

Van service

Life: 4 years (13)
Salvage value: $2,500 (13)
Study period: 12 years

For the load factor 0.5:
\[ PW = 2,485,385 - 117 \times 2,500(P/F, 7\%, 4) + 117 \times 12,000(P/F, 7\%, 4) - 117 \times 2,500(P/F, 7\%, 8) + 117 \times 12,000(P/F, 7\%, 8) - 117 \times 2,500(P/F, 7\%, 12) + 2,484,720(P/A, 7\%, 12) = 23,585,756 \]

For the load factor 0.75:
\[ PW = 1,672,470 - 74 \times 2,500(P/F, 7\%, 4) + 74 \times 12,000(P/F, 7\%, 4) - 74 \times 2,500(P/F, 7\%, 8) + 74 \times 12,000(P/F, 7\%, 8) - 74 \times 2,500(P/F, 7\%, 12) + 1,585,080(P/A, 7\%, 12) = 15,125,609 \]

Vanpool

Life: 4 years (39)
Salvage value: $3,300 (39)
Study period: 12 years

For VOR of 8:
\[ PW = 5,631,000 - 560 \times 3,300(P/F, 7\%, 4) + 560 \times 10,000(P/F, 7\%, 8) - 560 \times 3,300(P/F, 7\%, 12) + 1,195,060(P/A, 7\%, 12) = 19,348,557 \]
For VOR of 10:
\[ PW = 4,531,000 - 450 \times 3,300(P/F, 7\%, 4) + 450 \times 10,000(P/F, 7\%, 4) \]
\[ = 4,531,000 - 450 \times 3,300(P/F, 7\%, 8) + 450 \times 10,000(P/F, 7\%, 8) \]
\[ - 450 \times 3,300(P/F, 7\%, 12) + 963,950(P/A, 7\%, 12) = 15,582,899 \]

Carpool

Life: 10 years (40)
Salvage value: Zero (40)
Study period: 12 years

For VOR of 3:
\[ PW = 9,781,000 + 1,500 \times 6,500(P/F, 7\%, 10) \]
\[ - 1,500 \times 5,200(P/F, 7\%, 12) \]
\[ + 1,487,300(P/A, 7\%, 12) = 23,087,877 \]

For VOR of 4:
\[ PW = 7,343,500 + 1,125 \times 6,500(P/F, 7\%, 10) \]
\[ - 1,125 \times 5,200(P/F, 7\%, 12) \]
\[ + 1,119,318(P/A, 7\%, 12) = 17,354,182 \]

Private automobile

Life: 10 years (40)
Salvage value: zero (40)
Study period: 12 years

For VOR of 1.17:
\[ PW = 25,000,000 + 3,846 \times 6,500(P/F, 7\%, 10) - 3,846 \times 5,200(P/F, 7\%, 12) + 3,766,003(P/A, 7\%, 12) \]
\[ = 58,742,079 \]
Equivalent Uniform Annual Cost Evaluation of the Various Modes of Transportation

EUAC = $P(A/P, i\%, n) - SV(A/F, i\%, n) + AC$

EUAC = Equivalent uniform annual cost

P = Initial cost
A/P = Capital recovery factor
i = Interest rate (assumed to be 7% for this analysis)
n = Life in years
SV = Salvage value
A/F = Sinking fund factor
AC = Annual cost

Bus service

For the load factor 0.5:
EUAC: $5,667,644(A/P, 7\%, 12) - 46 \times $15,000
(A/F, 7\%, 12) + $1,738,800 = $2,413,785$

For the load factor 0.75:
EUAC: $3,791,420(A/P, 7\%, 12) - 30 \times $15,000
(A/F, 7\%, 12) + $1,134,000 = $1,586,184$

Minibus service

For the load factor 0.5:
EUAC: $2,760,956(A/P, 7\%, 8) - 68 \times $4,500
(A/F, 7\%, 8) + $1,856,400 = $2,288,801$

For the load factor 0.75:
EUAC: $1,955,582(A/P, 7\%, 8) - 46 \times $4,500
(A/F, 7\%, 8) + $1,255,800 = $1,563,125$

Van service

For the load factor 0.5:
EUAC: $2,485,385(A/P, 7\%, 4) - 117 \times $2,500(A/F, 7\%, 4) + $2,484,720 = $3,152,601$
For the load factor 0.75:

EUAC: $1,672,470(A/P, 7\%, 4) - 74
- $2,500(A/F, 7\%, 4) + $1,585,080 = $2,037,176

Vanpool

For VOR of 8:
EUAC: $5,631,000(A/P, 7\%, 4) - 560
- $3,300(A/F, 7\%, 4) + $1,195,060 = $2,441,275

For VOR of 10:
EUAC: $4,531,000(A/P, 7\%, 4) - 450
- $3,300(A/F, 7\%, 4) + $963,950 = $1,967,171

Carpool

For VOR of 3:
EUAC: $9,781,000(A/P, 7\%, 10) + $1,487,300 = $2,879,918

For VOR of 4:
EUAC: $7,343,500(A/P, 7\%, 10) + $1,119,318 = $2,164,885

Private automobile

For VOR of 1.17:
EUAC: $25,000,000(A/P, 7\%, 10) + $3,766,003 = $7,325,503


### Table 5

**Comparative Costs of the Various Modes of Transportation**

<table>
<thead>
<tr>
<th>Transportation mode</th>
<th>Initial cost ($)</th>
<th>Annual operating cost ($)</th>
<th>Present-worth ($)</th>
<th>Equivalent uniform annual cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private auto</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR 1.17</td>
<td>25 000 000</td>
<td>376 003</td>
<td>58 742 079</td>
<td>732 5503</td>
</tr>
<tr>
<td><strong>Bus service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF 0.5</td>
<td>5 667 644</td>
<td>1 738 800</td>
<td>19 172 050</td>
<td>2 413 785</td>
</tr>
<tr>
<td>LF 0.75</td>
<td>3 791 420</td>
<td>1 134 000</td>
<td>12 598 641</td>
<td>1 586 184</td>
</tr>
<tr>
<td><strong>Minibus service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF 0.5</td>
<td>2 760 056</td>
<td>1 856 400</td>
<td>17 870 860</td>
<td>2 288 801</td>
</tr>
<tr>
<td>LF 0.75</td>
<td>1 955 582</td>
<td>1 255 800</td>
<td>12 177 596</td>
<td>1 563 125</td>
</tr>
<tr>
<td><strong>Van service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF 0.5</td>
<td>2 485 385</td>
<td>2 484 720</td>
<td>23 585 756</td>
<td>3 152 601</td>
</tr>
<tr>
<td>LF 0.75</td>
<td>1 672 470</td>
<td>1 585 080</td>
<td>15 125 609</td>
<td>2 037 176</td>
</tr>
<tr>
<td><strong>Vanpool</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR 8</td>
<td>5 631 000</td>
<td>1 195 060</td>
<td>19 348 557</td>
<td>2 441 275</td>
</tr>
<tr>
<td>VOR 10</td>
<td>4 531 000</td>
<td>963 950</td>
<td>15 582 899</td>
<td>1 967 171</td>
</tr>
<tr>
<td><strong>Carpool</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR 3</td>
<td>9 781 000</td>
<td>1 487 300</td>
<td>23 087 877</td>
<td>2 879 918</td>
</tr>
<tr>
<td>VOR 4</td>
<td>7 343 500</td>
<td>1 119 318</td>
<td>17 354 182</td>
<td>2 164 885</td>
</tr>
</tbody>
</table>
Initial Cost of Bicycle Mode

i. Bike path 8 feet wide: $5.54/ft (including grading site preparation, drainage, right of way) (34).

ii. Signing: $35.00 each (34).

iii. Intersection striping: $25.00 each (34).

University Blvd.:

Bike path: 6.1 miles x 5,280 ft/mi x $5.54/ft = $178,432
Signing: 28 x $35.00 each = $980
Intersection striping: 8 x $25.00 each = $200
Guardrail on Econlockhatchee River Bridge: $520
Total $180,132

Alafaya Trail North

Bike path: 5 miles x 5,280 ft/mi x $5.54/ft = $146,256
Signing: 20 x $35.00 each = $700
Intersection striping: 3 x $25.00 each = $75
Total $147,031

Alafaya Trail South

Improvement on existing path: $30,000
Signing: 8 x $35.00 each = $280
Total $30,280

Cost of Bicycle racks: \( C_b \)

Average cost/unit: $11.5 (local bike dealers)
Target population: 2,000 (from location surveys)
\( C_b = 2,000 \times \$11.5/each = \$23,000 \)

Total cost of the system: \( C_t \)
\( C_t = \$180,132 + \$147,031 + \$30,280 + \$23,000 = \$403,443 \)
The results of the cost analysis show that all the candidate modes of transportation could provide a more economical service to the commuters than the existing auto transportation mode. However, with the existing rate of auto ownership by the commuters, the "Pay and Ride" carpool could be considered as the most realistic solution to the short-term transportation problems of the University, providing the legal problems involved in this program are overcome before the implementation of the system (see Appendix F). The annual savings versus the vehicle occupancy rate for the carpool program is shown in Figure 40. These figures are based on the use of the system by all the commuters (see Appendix E).
Fig. 40. Annual savings vs. vehicle occupancy rate for the carpool program.
Systems Requirements

For a system to be able to compete with the existing auto transportation mode at U.C.F. it should be acceptable to the commuters. Of major concern to the riders, reliability, user cost, safety and convenience are referred to most often.

The bus and minibus services, as well as the van service, working as fixed-route/fixed-headway services, should be able to provide the required punctuality to the commuters. In vanpool and carpool programs, after a short period of time, the poolers should get to know one another within each team, consequently there should be a significant rise in cooperation among the participants resulting in fewer delays and missing of classes. Mohan et. al., suggest the use of minibuses or vans as a supplement to the carpool program to avoid such incidents.

According to the cost analysis discussed in this chapter, all the selected modes of transportation showed an economic advantage over the auto transportation mode. Therefore, the factor of user cost as a requirement for the systems would be met by the different services.

Safety has always been a major concern to the users of a transportation system. Any accident, no matter of what nature, would have an adverse effect on the acceptibility of the programs. The "Highway Research Board Task Force On Urban Mass Transportation Safety Standards" refers to bus and rail transit as the safest modes
of transportation in the United States. The minibus/van used as small buses, should be able to provide the same factor of safety to the transit users.

Safety of the bicycle mode might be the least compared to the other transportation modes if some safety considerations are not taken into account, especially in automobile involved accidents. By educating the cyclist with the bicycle safety laws, causes of bicycle/auto accidents, good riding and signaling techniques, the risk of this mode could be reduced to a minimum.

A number of interviewees at U.C.F. stated crime as a problem involved in the proposed carpool program. Mohan et. al., recommend the following measures to serve the program; carpoolers would be advised to use the system during the daytime only, carpool stops would be located along busy and safe roads, the exchange of the identification cards would assure that the carpoolers are all attending the same institution, and female students would be advised not to ride with, or give rides to, male carpoolers with whom they are not familiar. The U.C.F. Police Department would cooperate with the system management to monitor crime.

Convenience refers to the overall comfort of the system including riding, lack of necessity to transfer, good off-peak hour service, and good waiting facilities. Because of the relatively confined age group of the commuters at U.C.F., their level of expectation would probably be lower than other groups in the society. However, the above factors have been considered in the proposed
transportation systems in order to satisfy the participants in the programs. In order to cut the initial investment, the provision of good waiting facilities is not considered in the short-term planning of the programs until they are widely accepted by the commuters.

To meet the community requirements as a social act the implementation of any of the described services would provide opportunities to the people who desire to study at U.C.F., but do not have access to the automobile.

According to the Environmental Protection Agency evaluation, Orange County has been listed as a nonattainment area. To consider the impact of the systems on the air environment, the air pollutant emission factors of different types of vehicles are compared in Table 6.
### TABLE 6

**Projected Carbon Monoxide, Hydrocarbon, and Nitrogen Oxides Exhaust Emission Factors of Different Types of Vehicles for Calendar Year 1979.**

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Carbon (gr/mi) monoxide</th>
<th>Hydro- (gr/mi) carbons</th>
<th>Nitrogen (gr/mi) oxides</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light-duty, gasoline powered vehicles</td>
<td>2.8</td>
<td>0.27</td>
<td>0.24</td>
<td>3.31</td>
</tr>
<tr>
<td>Light-duty, gasoline powered trucks</td>
<td>9.8</td>
<td>1.00</td>
<td>2.8</td>
<td>13.1</td>
</tr>
<tr>
<td>Heavy-duty, gasoline powered vehicles</td>
<td>117</td>
<td>6.00</td>
<td>11.4</td>
<td>134.4</td>
</tr>
</tbody>
</table>


Definitions used in Table 6:

- **Light-duty vehicle (passenger car)**—Any motor vehicle designated primarily for transportation of persons and having a capacity of 12 persons or less.

- **Light-duty truck**—Any motor vehicle designated primarily for transportation of property and rated at 8,500 pounds or less and having a load carrying capability that exceeds that of passenger cars.

- **Heavy-duty vehicle**—A motor vehicle designated primarily for transportation of property and rated at more than 8,500 pounds or designed for transportation of more than 12 persons.
CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The implementation of any of the transportation modes described in the preceding sections would provide the following benefits to the commuters and the public:

1. Reduction in cost of transportation.
2. Improvement of the parking situation on the campus.
3. Improvement of peak-hour mobility.
4. Expansion of mobility for the non-car users.
5. Reduction in the requirements for additional roads in the area.
6. Solution to a long-range transportation problem.
7. Encouragement of a desirable regional growth pattern.

The feasibility and chances of success for the systems are geared to the acceptance by the legal authorities in the region, the U.C.F. Administration and the users. The legal considerations involve insurance, possible conflict with the existing systems and or possible violation of the Florida Statutes.

For the bus service, minibus service and the van service, insurance should be handled as a routine matter with no real difficulties. The regular bus service, owned and operated by the Orange-Semincle-Osceola Transportation Authority (OSOTA), would be able to
receive State and Federal grants to support the system. Otherwise, the University should approach these agencies for funding and reduce the conflict with OSOTA by implementing the program as a non-competitive educational based system. However, the service would be regulated by the Public Service Commission. These are the measures which should also be considered for the operation of the two other services (minibus and van). The opinion surveys conducted in the summer of 1979 indicated that 53 percent of the respondents accepted the bus service as a solution to U.C.F.'s transportation problems (see Appendix A).

The bicycle mode would have no immediate conflict with the existing transportation facilities. Although the traffic on the University Boulevard is already in excess of the design capacity, due to the increasing construction costs and decreasing gas tax revenues, the Florida Department of Transportation has delayed the improvement of U.C.F. Boulevard to four lanes until 1987-88 (34). The Orange County Planning Department has already received formal support from the U.C.F. Administration, the Faculty Association, and the Student Government Association for the construction of this facility. According to the surveys conducted by the same department, over 40 percent of the students living in the vicinity of the campus would utilize the bike path instead of driving their private autos if this facility were provided.

The implementation of the ridesharing systems (vanpool and carpool) might violate the Florida Public Service Commission Common
Carrier Statutes. To prove that these systems are not profit-making ventures, the owner-driver must keep accurate records. Otherwise, the programs may be subject to taxation or come under State regulation as a common carrier. The above consideration was among the problems pointed out by University officials regarding the implementation phase of the "Pay and Ride" carpool program. Another question raised was concerning the change in car insurance premiums to cover riders' liability. Since the State of Florida is a "no-fault" state, and according to the policies of some local insurance companies, there should be no additional changes in car insurance premiums of the drivers participating in the carpool program. Some of the efforts regarding the pre-implementation phase of the carpool program are reflected in Appendix F. The University Authorities are concerned about the above legal considerations due to the fact that the University would be the agent in the money exchange. According to the results of the opinion surveys, 56 percent of the interviewees stated that they would participate in the proposed carpool program if it were implemented (Appendix A).

However, any of the programs backed as an educational based system, with the support of the University Administration, would have a higher chance of success in overcoming the legal obstacles.

A multimodal transportation system was proposed for the University commuters in 1974. There were three modes included in the system; carpools, bicycles, and student buses. The carpool component of the system was considered to have the highest degree of
feasibility and success. This conclusion was based on the legal obligations, the cost factor, the customers' acceptance and the information obtained from the existing Student Government's carpool system at the time of the proposal. Problems involved in the program were insurance and conflict with the Orange-Seminole-Osceola Transportation Authority. However, the implementation and success of the system were determined by the University Administration and community.

The situation has grossly changed from six years ago to the present time. The population of the University has increased by 70 percent. The price of gasoline has risen approximately 120 percent within the last six years. As a result, the commuters are now suffering more from lack of parking space on the campus, traffic congestion on the access roads to the University, and cost of commuting. The public has also become more aware of the transportation problems within the urbanized areas and its adverse effects on the environment. With these unavoidable facts, it is an appropriate time to take action for the benefit of the transport users, the institution, and the public.

In order to serve the people, any change in the community should be public-oriented. And the awareness and appreciation of the public is required if the service is to be implemented successfully. The introduction of a public mode of transportation to the University community will gain a higher degree of success if the transport users have a better background in the area of public
transportation. To serve this purpose, specialized courses in this area should be recommended. University transportation programs should also be capable of meeting the requirements of the transit industry.
APPENDIX A

OPINION SURVEY

Questionnaire on U.C.F. Transportation

Computer Program

Calculations and Results
PROPOSED CARPOOL PROGRAM FOR UCF COMMUTERS

In a bid to alleviate the transportation problem of UCF commuters, a "Pay and Ride" carpool program is being considered. Carpool pick-up points would be located in the Orlando Urbanized area near UCF commuters' residences. Willing riders would wait at these designated spots. Willing drivers traveling to UCF would stop, and pick riders up after proper exchange of ID's. Riders would pay coupons to drivers. These coupons would be cashed at the university. Matching pick-up points would be located at the UCF campus for homeward rides.

QUESTIONNAIRE ON UCF TRANSPORTATION

1. Name and Address: ____________________________________________

2. Student, Faculty, Staff (circle one).

3. Sex: _M _F

4. Race: Black White Other

5. Do you see any transportation problems at UCF?
   _yes _no
   _Severe _In-between _Mild

6. Nature of Problem:
   _Parking _Congestion
   _Money _Other

7. Type of Car used:
   _Big _Compact _Sub-Compact

8. Daily Mileage: _____ miles

9. What, in your opinion, is the solution to this transportation problem?
   _Buses
   _Carpools
   _Others

10. Would you participate in the UCF carpool program outlined on the top of this page?
    _yes _no

11. What are the problems you foresee in this proposed carpool program?

12. What distance would you be willing to walk for a carpool pick-up point?
    _____ miles
THIS PROGRAM GIVES THE RESULT OF AN OPINION SURVEY RELATING THE UCF TRANSPORTATION PROBLEMS AND A PROPOSED CARPOOL PROGRAM FOR ITS COMMUTERS

DIMENSION M(500), A(500), B(500), C(500), D(500), E(500), F(500), G(500), H(500), T(500)

N: COUNTER SAME AS THE SAMPLE SIZE
POP: POPULATION SIZE
SAMP: SAMPLE SIZE

READ (5,101) N, POP, SAMP

101 FORMAT (I5,2F6.0)

M: CARD NUMBER

A: SEX
B: RACE
C: SERIOUSNESS OF THE PROBLEM
D: NATURE OF THE PROBLEM
E: TYPE OF CAR
F: ONE-WAY MILEAGE
G: SOLUTION TO THE PROBLEM
H: PARTICIPATION IN THE PROGRAM
T: WALKING DISTANCE

READ (5,102) (M(I),A(I),B(I),C(I),D(I),E(I),F(I),G(I),H(I),T(I),I=1,N)

102 FORMAT (I5,9F5.1)

WRITE (6,220)

WRITE (6,230) (M(I),A(I),B(I),C(I),D(I),E(I),F(I),G(I),H(I),T(I),I=1,N)

220 FORMAT (1X,A10,9F5.1)

WRITE (6,230) (M(I),A(I),B(I),C(I),D(I),E(I),F(I),G(I),H(I),T(I),I=1,N)

230 FORMAT (I5,9F5.1/

SIZE=SAMP/POP

MM=0
MF=0
MY=0

DO 10 I=1,N

22 IF (A(I).EQ.0.) GO TO 19
IF (A(I).EQ.1.) GO TO 1

1 MM=MM+1
GO TO 10

19 MY=MY+1
GO TO 10

10 CONTINUE

PMF: % FEMALE

PMM: % MALE

PMY: % NOT ANSWERED

PMM=FLOAT(MM)/SAMP

PMF=FLOAT(MF)/SAMP

PMY=FLOAT(MY)/SAMP

MV=0
MB=0
MO=0
M7=0

DO 20 I=1,N

33 IF (B(I).EQ.0.) GO TO 25
IF (B(I).EQ.2.) 2,3,4

2 MW=MW+1
GO TO 20

3 MB=MB+1
GO TO 20

4 MO=MO+1
GO TO 20
25 M2=M2+1
20 CONTINUE
PMW: % WHITE
PMB: % BLACK
PMO: % OTHER
PMZ: % NOT-ANSWERED
PMW=FLOAT(MW)/SAMP
PMB=FLOAT(MB)/SAMP
PMO=FLOAT(MO)/SAMP
PMZ=FLOAT(MZ)/SAMP
MD=0
MI=0
MS=0
MH=0
DO 30 I=1,N

44 IF (C(I).EQ.0.) GO TO 35
IF (C(I).LT.2.) 5,6,7
5 MD=MD+1
GO TO 30
6 MI=MI+1
GO TO 30
7 MS=MS+1
GO TO 30
35 MH=MH+1
30 CONTINUE
PMD: % ANSWERED MILD
PMI: % ANSWERED IN-BETWEEN
PMS: % ANSWERED SERIOUS
PMH: % NOT ANSWERED
PMD=FLOAT(MD)/SAMP
PMI=FLOAT(MI)/SAMP
PMS=FLOAT(MS)/SAMP
PMH=FLOAT(MH)/SAMP
MP=0
MN=0
MC=0
MX=0
DO 40 I=1,N

55 IF(D(I).EQ.0.) GO TO 45
IF ((D(I)-100).GT.0.) GO TO 12
IF (D(I).GT.100.) GO TO 14
IF(D(I).LT.2.) 8,9,11
14 IF(D(I).LE.-13.) 13,15,17
12 MP=MP+1
MN=MN+1
MC=MC+1
GO TO 40
8 MP=MP+1
GO TO 40
9 MN=MN+1
GO TO 40
11 MC=MC+1
GO TO 40
13 MP=MP+1
MN=MN+1
GO TO 40
15 MP=MP+1
MC=MC+1
GO TO 40
17  MN = MN + 1
   MC = MC + 1
   GO TO 40
40  CONTINUE
C
PMP: % ANSWERED PARKING
PMN: % ANSWERED MONEY
PMC: % ANSWERED CONGESTION
PMX: % NOT ANSWERED
PMX = FLOAT(MX)/SAMP
PMN = FLOAT(MN)/SAMP
PMC = FLOAT(MC)/SAMP
PMP = FLOAT(MP)/SAMP
NS = 0
NC = 0
NB = 0
NO = 0
DO 50 I = 1, N
66  IF (E(I) .EQ. 0.) GO TO 59
IF (E(I) = 2.) 21, 23, 27
21  NS = NS + 1
   GO TO 50
23  NC = NC + 1
   GO TO 50
27  NB = NB + 1
   GO TO 50
59  NO = NO + 1
50  CONTINUE
C
PNS: % OF SUB-COMPACT CARS
PNC: % OF COMPACT CARS
PNB: % OF BIG CARS
C
PNX: % NOT ANSWERED
PNS = FLOAT(NS)/SAMP
PNC = FLOAT(NC)/SAMP
PNB = FLOAT(NB)/SAMP
PNX = FLOAT(NX)/SAMP
NX = 0
DO 60 I = 2, N
J = I - 1
66  IF (F(J) .NE. 0.) GO TO 68
NX = NX + 1
68  IF (F(I) .NE. 0.) GO TO 67
NX = NX + 1
67  F(I) = F(I) + F(J)
60  CONTINUE
C
AVG: ONE-WAY AVERAGE MILEAGE
AVG = F(N)/(FLOAT(N) - FLOAT(NX))
LC = 0
DO 70 I = 1, N
79  IF (G(I) .EQ. 1.) GO TO 76
    GO TO 70
76  LC = LC + 1
70  CONTINUE
C
PLC: % AGREED WITH CARPOOL
PLX: % NOT ANSWERED OR OTHER
PLC = FLOAT(LC)/SAMP
PLX = 1. - PLC
LY = 0
DO 80 I = 1, N
83  IF (H(I) .EQ. 1.) GO TO 86
GO TO 80
86 LY=LY+1
80 CONTINUE

C PLY: % PARTICIPATING IN THE PROGRAM
C PLZ: % NOT ANSWERED OR OTHER
PLY=FLOAT(LY)/SAMP
PLZ=1.-PLY
DS=0.
DT=0.
DX=0.
DO 90 I=1,N
93 IF (T(I).EQ.0.) GO TO 98
IF (T(I).EQ.1.) GO TO 99
IF (T(I).EQ.2.) GO TO 97
96 DS=DS+1.
GO TO 90
97 DT=DT+1.
GO TO 90
98 DX=DX+1.
90 CONTINUE

C PDS: % WALKING 0.5 MILE
C PDT: % WALKING 0.5-1.0 MILE
C PDX: % NOT ANSWERED OR OTHER
PDS=DS/SAMP
PDT=DT/SAMP
PDX=DX/SAMP
WRITE (6,202)
202 FORMAT ('11',PERCENTAGES OF DIFFERENT SEXES ://)
WRITE (6,203) PMM,PMF,PMY
203 FORMAT (IX,MALE =,'F6.2/)
1 1X,FEMALE =,'F6.2/
1 1X,NOT ANSWERED =,'F6.2///)
WRITE (6,204)
204 FORMAT (IX,PERCENTAGES OF DIFFERENT RACES ://)
WRITE (6,205) PMW,PMB,PMO,PMZ
205 FORMAT (IX,WHITE =,'F6.2/)
1 1X,BLACK =,'F6.2/
1 1X,OTHER =,'F6.2/
1 1X,NOT ANSWERED =,'F6.2///)
WRITE (6,206)
206 FORMAT (IX,PERCENTAGES OF COMMUTERS SEEING THE PROBLEM TO BE ://)
1 1X,PROBLEM AS =,'F6.2/
WRITE (6,207) PMP,PM1,PM2,PM3
207 FORMAT (IX,MILD =,'F6.2/)
1 1X,IN-BETWEEN =,'F6.2/
1 1X,SERIOUS =,'F6.2/
1 1X,NOT ANSWERED =,'F6.2///)
WRITE (6,208)
208 FORMAT (IX,PERCENTAGES OF COMMUTERS SEEING THE PROBLEM AS ://)
1 1X,PROBLEM AS =,'F6.2/
WRITE (6,209) PMP,PM1,PM2,PM3
209 FORMAT (IX,PARKING =,'F6.2/)
1 1X,MONEY =,'F6.2/
1 1X,CONGESTION =,'F6.2/
1 1X,NOT ANSWERED =,'F6.2///)
WRITE (6,210)
210 FORMAT (IX,PERCENTAGES OF TYPE OF CARS DRIVEN BY THE COMMUTERS ://)
1 1X,BY THE COMMUTERS =,'F6.2/
WRITE (6,211) PNS,PNC,PNB,PNO
211 FORMAT (IX,SUB-COMPACT =,'F6.2/
1 \texttt{\textasciitilde\textasciitilde COMPACT = \textasciitilde\textasciitilde F6.2/}
1 \texttt{\textasciitilde\textasciitilde BIG = \textasciitilde\textasciitilde F6.2/}
1 \texttt{\textasciitilde\textasciitilde NOT ANSWERED = \textasciitilde\textasciitilde F6.2///)}
\texttt{\textasciitilde WRITE \textasciitilde (6,212) AVG}
\texttt{\textasciitilde FORMAT \textasciitilde (6,213) PLC,PLX}
\texttt{\textasciitilde 212 FORMAT \textasciitilde (1X,'ONE-WAY AVERAGE MILEAGE =',F6.2///)}
\texttt{\textasciitilde 213 FORMAT \textasciitilde (1X,"PERCENTAGE OF COMMUTERS WHO AGREED")}
\texttt{\textasciitilde 1 \texttt{\textasciitilde \\
1 \texttt{\textasciitilde \textasciitilde WITH THE CARPOOL AS A SOLUTION =',F6.2/}
1 \texttt{\textasciitilde \textasciitilde NOT ANSWERED OR OTHERS =',F6.2///)}
\texttt{\textasciitilde WRITE \textasciitilde (6,214) PLZ,PLZ}
\texttt{\textasciitilde 214 FORMAT \textasciitilde (1X,"PERCENTAGE OF THE COMMUTERS WHO WOULD")}
\texttt{\textasciitilde 1 \texttt{\textasciitilde \\
1 \texttt{\textasciitilde \textasciitilde PARTICIPATE IN THE PROGRAM =',F6.2/}
1 \texttt{\textasciitilde \textasciitilde NOT ANSWERED OR OTHERS =',F6.2///)}
\texttt{\textasciitilde WRITE \textasciitilde (6,215)}
\texttt{\textasciitilde 215 FORMAT \textasciitilde (1X,"LONGEST ACCEPTABLE WALKING DISTANCE :\textasciitilde///")}
\texttt{\textasciitilde WRITE \textasciitilde (6,216) PDS,PDT,PDX}
\texttt{\textasciitilde 216 FORMAT \textasciitilde (1X,"LESS THAN HALF A MILE =',F6.2/}
1 \texttt{\textasciitilde \textasciitilde BETWEEN HALF AND A MILE =',F6.2/}
1 \texttt{\textasciitilde \textasciitilde NOT ANSWERED OR OTHERS =',F6.2///)}
\texttt{STOP}
\texttt{END}
### Sample Input Data

<p>| | | | | | | | | |</p>
<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
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<td>1.0</td>
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**Explanation of the Codes Used in the Input Data**

<table>
<thead>
<tr>
<th>Column 1: Counter</th>
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</thead>
<tbody>
<tr>
<td>Column 2: Sex</td>
</tr>
<tr>
<td>1: Male</td>
</tr>
<tr>
<td>2: Female</td>
</tr>
<tr>
<td>0: Not answered</td>
</tr>
<tr>
<td>Column 3: Race</td>
</tr>
<tr>
<td>1: White</td>
</tr>
<tr>
<td>2: Black</td>
</tr>
<tr>
<td>3: Other</td>
</tr>
<tr>
<td>0: Not answered</td>
</tr>
<tr>
<td>Column 4: Seriousness of the problem</td>
</tr>
<tr>
<td>1: Mild</td>
</tr>
<tr>
<td>2: In-between</td>
</tr>
<tr>
<td>3: Serious</td>
</tr>
<tr>
<td>0: Not answered</td>
</tr>
<tr>
<td>Column 5: Nature of the problem</td>
</tr>
<tr>
<td>1: Parking</td>
</tr>
<tr>
<td>2: Money</td>
</tr>
<tr>
<td>3: Congestion</td>
</tr>
<tr>
<td>0: Not answered</td>
</tr>
<tr>
<td>Column 6: Type of car</td>
</tr>
<tr>
<td>1: Sub-compact</td>
</tr>
<tr>
<td>2: Compact</td>
</tr>
<tr>
<td>3: Big</td>
</tr>
<tr>
<td>0: Not answered</td>
</tr>
<tr>
<td>Column 7: One-way daily mileage</td>
</tr>
<tr>
<td>0: Not answered or living in U.C.F. dormitories</td>
</tr>
<tr>
<td>Column 8: Solution to the problems</td>
</tr>
<tr>
<td>1: Carpool</td>
</tr>
<tr>
<td>2: Other or not answered</td>
</tr>
<tr>
<td>Column 9: Participation in the carpool program</td>
</tr>
<tr>
<td>1: Positive</td>
</tr>
<tr>
<td>2: Negative or not answered</td>
</tr>
<tr>
<td>Column 10: Acceptable walking distance</td>
</tr>
<tr>
<td>1: Less than or equal to half a mile</td>
</tr>
<tr>
<td>2: Between half and one mile</td>
</tr>
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</table>
Results of the Opinion Survey
PERCENTAGES OF DIFFERENT SEXES:

MALE = 51.00
FEMALE = 49.00
NOT ANSWERED = 0.00

PERCENTAGES OF DIFFERENT RACES:

WHITE = 92.00
BLACK = 6.00
OTHER = 2.00
NOT ANSWERED = 0.00

PERCENTAGES OF COMMUTERS SEEING THE PROBLEM TO BE:

MILD = 15.00
IN-BETWEEN = 42.00
SERIOUS = 20.00
NOT ANSWERED = 23.00

PERCENTAGES OF COMMUTERS SEEING THE PROBLEM AS:

PARKING = 67.00
MONEY = 33.00
CONGESTION = 20.00
NOT ANSWERED = 23.00

PERCENTAGES OF TYPE OF CARS DRIVEN BY THE COMMUTERS:

SUB-COMPACT = 27.00
COMPACT = 46.00
BIG = 22.00
NOT ANSWERED = 5.00

ONE-WAY AVERAGE MILEAGE = 18.87

PERCENTAGES OF COMMUTERS WHO AGREED WITH THE CARPOOL AS A SOLUTION = 59.00
NOT ANSWERED = 41.00

PERCENTAGES OF COMMUTERS WHO WOULD PARTICIPATE IN THE PROGRAM = 56.00
NOT ANSWERED OR OTHERS = 44.00

LONGEST ACCEPTABLE WALKING DISTANCE:

LESS THAN HALF A MILE = 37.00
BETWEEN HALF AND A MILE = 21.00
NOT ANSWERED OR OTHERS = 42.00
Hand Calculations and Further Analysis of the Opinion Survey

Population size: 8,270
Faculty and staff: 1,200
Students: 7,070
Sample size: 450
Faculty and staff: 32
Students: 418
Sample-population ratio: 5.4%

Comments on the solution to U.C.F. transportation problems

- 53% selected bus as a transportation alternative for the U.C.F. commuters.
- 2% had commented on providing more parking spaces on the campus.
- 1% had suggested a mono-rail system.

Weighted average daily mileage

Sub-compact cars
Percent: 27
Average mileage: 17.18 miles

Compact cars
Percent: 46
Average mileage: 19.10 miles

Big cars
Percent: 22
Average mileage: 15.25 miles

Weighted average daily mileage =
\[
\frac{0.27(17.18) + 0.46(19.10) + 0.22(15.25)}{0.95} = 17.66 \approx 18.00 \text{ miles}
\]
Problems involved in the program

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percent answered</th>
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<tbody>
<tr>
<td>Reliability</td>
<td>37</td>
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<tr>
<td>Crime</td>
<td>7 (70% female, 30% male)</td>
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<tr>
<td>Acceptability</td>
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<tr>
<td>Not answered</td>
<td>25</td>
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<tr>
<td>Miscellaneous</td>
<td>26</td>
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APPENDIX B

TRAFFIC STUDY

Field Data sheet

Calculations
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<thead>
<tr>
<th>TIME</th>
<th>EASTBOUND</th>
<th>WESTBOUND</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculation of the Vehicle Occupancy Rate

Total number of cars which entered the campus between 7:30 a.m. and 7:30 p.m.

Tuesday: 9,556
Wednesday: 9,696

Total number of passengers in the cars:

Tuesday: 11,341
Wednesday: 11,292

Vehicle occupancy rate (VOR)

\[ VOR = \frac{11,341 + 11,292}{9,556 + 9,696} = 1.17 \]
APPENDIX C

INTERSECTION DELAY STUDY

Field Data Sheet

Calculations
<table>
<thead>
<tr>
<th>INTERSECTION</th>
<th>DATE</th>
<th>DAY</th>
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<tbody>
<tr>
<td>WEATHER</td>
<td></td>
<td>NAME</td>
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</table>

<table>
<thead>
<tr>
<th>TOTAL NO. OF VEHICLES STOPPED IN THE APPROACH AT TIME</th>
</tr>
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<tbody>
<tr>
<td>0 sec</td>
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</table>
Computation of the Intersection Delays

Total number of cars stopped during the peak-hours before entering the campus:

Monday: 15,389
Thursday: 3,090

Total delay: Total number observed x observational interval.

Monday = 15,389 x 10 seconds = 153,890 veh-secs
Thursday = 3,090 x 10 seconds = 30,900 veh-secs

Total delay in hours:

Monday: 48 hours
Thursday: 9 hours

Delays at the intersections:

greater than 25 secs: Congested
Standard delays* between 10 and 25 secs: Typical
less than 10 secs: Efficient

### Intersection I

<table>
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<td>Morning</td>
<td>Afternoon</td>
<td>Morning</td>
<td>Afternoon</td>
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<tr>
<td></td>
<td>1 sec</td>
<td>12 secs</td>
<td>1 sec</td>
<td>9 secs</td>
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### Intersection II (signalized)

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<td>Afternoon</td>
<td>Morning</td>
<td>Afternoon</td>
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<td>76 secs</td>
<td>11 secs</td>
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### Intersection III

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<tr>
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<td>1 sec</td>
<td>12 secs</td>
<td>1/4 sec</td>
<td>1/2 sec</td>
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APPENDIX D

PARKING STUDY

Field Data Sheet

Calculations
Calculation of Turnover in Parking Lots

Turnover: The ratio between total number of cars parked during the study period and total capacity.

\[(T.O.)_n: \frac{T.O.}{T.O.} = \text{Turnover} \]
\[n = \text{Parking lot number}\]

- \[(T.O.)_1: \frac{314}{178} = 1.76\]
- \[(T.O.)_2: \frac{477}{197} = 2.42\]
- \[(T.O.)_3: \frac{205}{100} = 2.05\]
- \[(T.O.)_4: \frac{550}{303} = 1.81\]
- \[(T.O.)_5: \frac{249}{102} = 2.44\]
- \[(T.O.)_6: \frac{246}{203} = 1.21\]
- \[(T.O.)_7: \frac{306}{175} = 1.74\]
- \[(T.O.)_8: \frac{485}{259} = 1.87\]
- \[(T.O.)_{1w}: \frac{188}{120} = 1.56\]
- \[(T.O.)_{2w}: \frac{221}{121} = 1.82\]
- \[(T.O.)_{3w}: \frac{193}{109} = 1.77\]
- \[(T.O.)_{4w}: \frac{321}{272} = 1.18\]
- \[(T.O.)_{5w}: \frac{466}{256} = 1.82\]
- \[(T.O.)_{6w}: \frac{476}{280} = 1.70\]
APPENDIX E

COST CALCULATIONS

Cost of Driving Alone Compared to Cost of Ridesharing

Annual Savings for Riding in a Carpool Program

Bus Service

Minibus Service

Van Service

Vanpool-Carpool
Cost of Driving Alone Compared to Cost of Ridesharing

1. Annual depreciation cost of automobile... $646 (40)
2. Annual cost of insurance................. $223 (40)
3. Annual cost of licensing, registration, inspection and taxes................. $89 (40)
4. Annual finance charges.................. $70 (40)
5. Price per gallon of gasoline........... $1.00
6. Number of working days per year........ 200
7. Daily one-way mileage to school........ 18.0 miles
8. Annual mileage to school................ 7,200 miles
9. Annual non-work related mileage....... 6,667 miles
10. Miles per gallon of automobile........ 15 mpg (40)
11. Number of people in the carpool....... 3 or 4
12. Annual depreciation cost of van......... $1,675 (39)
13. Annual cost of insurance.............. $460 (39)

Cost of Driving Alone

14. Annual cost of licensing, registration, inspection and taxes.................... $120 (39)

15. Annual finance charges................ $399 (40)
16. Miles per gallon of van................ 10 mpg (39)
17. Number of people in the vanpool...... 8.0
18. Annual mileage-related operating cost for automobile:
   a. Gasoline 6.67¢/mi
   b. Oil, maintenance and repairs 5.73¢/mi
   Total.............................. 12.40¢/mi
19. Annual mileage-related operating costs (line 18 x line 8)..................... $893
20. The average annual ownership cost:
   a. Depreciation $646
   b. Insurance $223
   c. Tag, inspection $89
   d. Finance charges $70
   Total..................................... $1,028

21. Proportion of ownership costs allocated to school trip...................... 52%

22. The annual ownership cost for school trip................................. $534

23. The total annual cost for driving to school alone......................... $1,427

Cost for Ridesharing Carpool

24. Total annual operating costs for the school trip.............................. (VOR)\text{3}: $297

25. The annual ownership costs allocated to the school trip in a ridesharing
carpool........................................ (VOR)\text{3}: $178

26. The total cost for driving to school in a ridesharing carpool............... (VOR)\text{3}: $475

Cost for Ridesharing Vanpool

27. Mileage related operating costs:
   a. Gasoline 10¢/mi
   b. Oil, maintenance and repairs 4¢/mi (39)
   Total........................................ 14¢/mile

28. Annual mileage related operating costs.................................. $1,008

29. The average annual ownership costs:
   a. Depreciation $1,675
   b. Insurance $650
   c. Tag, inspection $170
   d. Finance charges $399
   Total........................................ $2,894
30. The total annual operating cost for the school trip. 

31. The annual ownership costs allocated to the school trip in a ridesharing vanpool.

32. The total cost for driving to the school in a ridesharing vanpool.

(VOR)8: $126
(VOR)10: $101

(VOR)8: $361
(VOR)10: $289

(VOR)8: $487
(VOR)10: $390
Annual Savings for Riding in the Carpool Program

Average number of cars going to U.C.F. per day:

Odd days: \(9,556 \times 2 = 19,112\)
Even days: \(9,696 \times 3 = 29,088\)
Total = 48,200
Average = 48,200/5 = 9,640/day

Mileage related operating cost for standard car:

Gasoline: 6.67¢/mi (40)
Oil, tires, maintenance, repairs: 5.73¢/mi (40)

Annual commuting mileage:
\((9,640 \times 150 \text{ days/yr} + 9,640 \times 50 \text{ days/yr}) \times 18 \text{ mi/day} \times 2 = 60,732,000 \text{ mi/yr}\)

Annual gas consumption:
\(60,732,000 \text{ mi/yr} / 15 \text{ mi/gal} = 4 \times 10^6 \text{ gal/yr}\)

Annual commuting cost:
\(60,732,000 \text{ mi/yr} \times 12.40\text{¢/mi} = 7.53 \text{ millions/year}\)

Savings due to raising the vehicle occupancy rate (VOR) from 1.17 to:

\((\text{VOR})_2: 7.53 \text{ mil./yr} \times \frac{(2-1.17)}{2} = 3.12 \text{ mil./yr}\)

\((\text{VOR})_3: 7.53 \text{ mil./yr} \times \frac{(3-1.17)}{3} = 4.59 \text{ mil./yr}\)

\((\text{VOR})_4: 7.53 \text{ mil./yr} \times \frac{(4-1.17)}{4} = 5.33 \text{ mil./yr}\)
Bus Service

Cost of bus stops:

Total mileage of the bus routes: 255 miles

Typical bus stop spacing:

  Limited-stop bus, urban: 2,000-5,000 feet (41)

Price/unit stop sign: $50 (see Carpool)

Cost of stop signs: \[ \frac{255 \text{ miles} \times 5,280 \text{ ft/mile}}{5,000 \text{ ft}} \times 50 = \$13,500 \]

Cost of providing offices:

Price/sq.ft.: $50*

Furnishing/sq.ft.: 10%*

Additional for engineering: 20%*

Area required: 4,000 sq.ft. (4)

Total cost: 4,000 x $65 = $260,000

Minibus Service

Cost conversion factor: \( \frac{\text{area covered by minibus}}{\text{area covered by bus}} = F_c \)

\[
F_c = \frac{25 \text{ ft} \times 8 \text{ ft}}{35 \text{ ft} \times 8.5 \text{ ft}} = 0.67
\]

25 ft: length of minibus (2)
8 ft: width of minibus (2)
35 ft: length of bus (4)
8.5 ft: width of bus (4)

Cost of inspection garage/minibus

\[
C_i = F_c \times \text{cost of inspection garage/bus}
\]

\[
C_i = 0.67 \times $17,264 = $11,567
\]
Van Service

Cost conversion factor: \( F_c \)

\[
F_c = \frac{18.5 \text{ ft} \times 6.5 \text{ ft}}{35 \text{ ft} \times 8.5 \text{ ft}} = 0.40
\]

18.5 ft: length of van (13)
6.5 ft: width of van (13)
35.0 ft: length of bus
8.5 ft: width of bus

Cost of inspection garage/van: \( C_i \)

\[
C_i = 0.4 \times \$25,110 = \$10,044
\]
Stop signs:

Ace Advertising Inc.
Cost estimate:
  regular design: $45
  three-sided: $170

Accurate Sign & Design
Cost estimate:
  regular design: $40
  three-sided: $200

Sign King
Cost estimate:
  regular design: $35
  three-sided: $150

Average price/unit:
  regular: $40 (on campus)
  three-sided: $175 (off campus)
  regular: $50 (including installation)
  three-sided: $200 (including installation)

Total cost:
  $1,000 (on campus)
  $4,000 (off campus)
  $5,000 (total)
APPENDIX F

LEGAL CONSIDERATIONS OF THE RIDE-SHARING PROGRAMS

Local Insurance Policies

Official Letters Regarding the Carpool Program

Discussion With a Law Firm
State Farm Insurance:

Title: "Transportation of friends, neighbors or fellow employees— Private Passenger Automobiles."

Statement: "If the total remuneration (reimbursement) does not exceed 15 cents a mile, it would usually be considered that a 'share-the-expense' arrangement exists. Therefore, the additional premiums would not be changed."

All State Insurance:

Title: "Automobile Liability Insurance Exclusions."

Statement: "Your insured auto while hired or rented to other for a charge, or any auto you are driving while available for hire by the public. This exclusion does not apply to shared expense carpool."
MEMORANDUM

TO: Drs. Mohan and Schrader
FROM: Mr. Bill D. Morris
       Director of Operations Analysis
DATE: August 15, 1979
SUBJECT: COMMENTS AND QUESTIONS ON PAY AND RIDE CARPOOL PAPER DATED AUGUST 1979

1. Mr. Goree is meeting with the President today on the allocation of the budget. An initial request will be included to fund the start of this proposal. The amount should be known by August 16.

2. Has this concept been discussed with University Legal office? Is university liable? Should a disclaimer be on coupons? I've given copy of proposal to Mr. Mahaffy for his advice.

3. Do we have approval from DOT, Orlando, Winter Park to erect signs?


5. The paper never says what the driver does with the coupons.

6. Some things that you need to do are:
   a. Prepare bid specifications for signs.
   b. Prepare requisition (bid?) for bumper decals.
   c. Prepare specifications for coupon books.

I have been told that special non-reproductable paper, different colors and small quantity may mean six months to get coupon books.

cc: Mr. Goree
MEMORANDUM

TO: Mr. Bill Morris
    Director, Operations Analysis

FROM: John D. Mahaffey, Jr.
       University Attorney

DATE: August 23, 1979

SUBJECT: "PAY & RIDE" CARPOOL CONCEPT

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I have examined the "Pay & Ride" Carpool scheme that was provided my office and wish to make a recommendation that this plan not be implemented pending resolution of what I believe to be some serious problems. Notable among them are the following:

1. We may be violative of the Florida Public Service Commission Common Carrier Statutes and thereby need to be certificated prior to entering into this type of a scheme. I am not really in a position to advise if we are or are not without doing considerable more research on the issue. If you wish this to be done, please let me know and I will do it. Although, I have what I believe to be well grounded fears that it is violative at the outset.

2. I am concerned about the Florida Guest Passenger Statute providing that the individual automobile chauffeurs will be considered to be driving for hire and possibly need to have in their possession chauffeur's driver's licenses as opposed to simply operator's licenses.

3. In addition, I am concerned, as I mentioned above, about the Guest Passenger Statute whereby public transportation on a "for hire" basis would be provided. In the event of accidents, I would not be a bit surprised if the individual insurers of these automobile drivers would deny coverage, thereby leaving their insureds exposed to tremendous liability.

4. The University could very likely be brought into the picture as a party defendant in the event of automobile accidents under these circumstances, possibly on the doctrine of respondeat superior (agency).

I believe the scheme needs further study prior to implementation. If you have further questions, don't hesitate to ask.

JDM:cm
MEMORANDUM

TO: Dr. Satish Mohan, Department of
Civil Engineering
Mr. John D. Mahaffey, Jr.
University Legal Counsel

FROM: Mr. Bill D. Morris, Acting Director
Operations Analysis

DATE: October 11, 1979

SUBJECT: Minutes of Meeting on Carpooling October 11, 1979

In attendance were Dr. Mohan, Mr. Mahaffey, Corporal Sanders, FHP and Mr. Morris.

Dr. Mohan summarized the shared ride proposal.

Mr. Mahaffey's questions on Public Service Commission rules and the possibility that a chauffeur's license would be required were discussed.

Cpl. Sanders had reviewed the proposal and Mr. Mahaffey's questions with the PSC and the chain of command in the Highway Patrol. It appears that all of the legal questions revolve around the university being the agent or middle man in the money exchange.

It was agreed that these problems needed to be resolved before any action is taken to implement the shared ride proposal. Cpl. Sanders has submitted the question on chauffeur's license to the Highway Patrol attorney who will ask for an interpretation from the Attorney General. Mr. Mahaffey will contact the Public Service Commission for an interpretation of their rules. It will take a few months to get these interpretations.

The carpooling committee will be convened to become aware of the proposal and the possible problems. The committee will also be used to stimulate other ideas and to gain publicity for carpooling concepts.

B.D.M.

cc Dr. Schrader
Dr. Fickett
Mr. Goree
Discussion With a Law Firm

Name of the firm: Akerman, Senterfitt, Eidson and Associates
Person contacted: Mr. Robert Nadeau

Discussions with the above named lawyer concluded that for the implementation of the Carpool Project, it would be best if the system is defined so that a certificate can be obtained from the Public Service Commission that public convenience and necessity requires such operation, or the section of the Florida Statute regarding the Common Carrier be modified to make the program legal, which would be a matter of time and money.
LIST OF REFERENCES


32. Transportation Element. Orlando, Florida Orange County Planning Department, July 1978.


