Austin Tomorrow

Technical Report

Transportation

Austin Tomorrow: Transportation

A Transportation Analysis: Past, Present and Future

CITY OF AUSTIN

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ACKNOWLEDGEMENTS

It is rather difficult, yet perhaps necessary, that someone try to bring together in one integrated view the whole transportation development of a city. Any such broad picture must inevitably sacrifice detail on particular topics.

Professor Christopher Shane Davies who provided more than just direction and I have tried not merely to inform, but also to stimulate by posing relevant and provocative questions and by suggesting ways of thinking to enable the reader to tackle such questions.

We wish to acknowledge all who helped us in the completion of this document. Planning Director Richard Lillie for guidance and support; Tracy Watson for coordination; Ed Triggs, Joe Ferguson, and George Hotchkiss for design and production; Jean Page and Ray Campos for graphics; Lynne Johnson for photography; Wanda Crum, Helen Fremin, Delores Metcalf, and Caroline Schreffler for typing and proofing; and, the invaluable suggestions from my colleagues in the Planning Department, Bill Bullock and Bill Moore in the Urban Transportation Department and Max Ulrich at the Austin Transportation Study Office.

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The shortcomings of present transportation systems exemplify a failure to either solicit or properly operationalize citizen input and support. If the transportation planner is to effect a physical setting that produces a satisfactory life for all members of the community the values and needs considered important by the inhabitants should be incorporated into transportation planning policy. This is occurring in Travis County, where attempts are being made by the Urban Transportation Department, the Planning Department, the Austin Transportation Study Group and cooperative agencies to assess the attributes the community expects from an effective transportation system.

Citizen participation in transportation planning is the requisite goal. To achieve this it seems necessary to devise measures of community transportation satisfaction, which are aggregative in nature if the input is to be of much use to transportation planning policy. "Why" a person wants a particular transportation system mix in his community is the important view to obtain, as is "how much" he is prepared to pay to achieve this goal. Merely that he wants a specific transportation mode is of little or no use to planners, but the question "why" is of the foremost importance and is being thoroughly researched through the

Austin Tomorrow Program.[1]

Entrepreneurs in the 19th century CBD-dominated U.S. city, of which Austin is an example, found rail transit to be the most feasible shipment mode given available technology. At that time the within city movement of goods was by horse and wagon resulting in higher costs for moving goods relative to people. Given this difference in transport costs, firms found it preferable to locate near the rail freight terminals in the core area in order to minimize the distance from their plant to the rail yards. This reduced their total transport costs by
2 lowering the cost of goods movement. Minimizing the costs of assembly and labor through a concentrated center of production produced scale economies[2].

The decline of the industrial core in the inner-city can be attributed to the introduction of the truck, the automobile and other related factors. The truck contributed, particularly between 1900 and 1920, to reducing the costs of moving goods relative to people. This resulted in a consequent decline of goods handling in the core, and to the relocation of industries in suburban areas. The automobile allowed industries to draw labor from a dispersed low density population.

Three major factors accelerated the post World War II suburbanization of industry: transportation innovations, communication changes and merchandizing improvements. Although the movement of industries to the suburbs has not been that pronounced in Austin it nevertheless has occurred and continues to do so at a rapid rate. The automobile permitted the spatial separation of workplace and residence, and transportation innovations such as the "piggy-back" and "containerized" shipment processes provided flexibility of movement and line haul economies between industrial, retail and wholesale activities and the rail yard, allowing for their geographic separation.[3]

Because of high taxes, the rising cost of land, and the externalities of pollution and congestion to be found in the central city, industries requiring sizeable lots moved towards the city periphery. Automation and the development of single story plants, with its greater space needs speeded this outward movement. Communication innovations such as the telephone, copy machines and computers further permitted the separation of office and factory functions. These innovations diffused the need for a concentrated grouping of service and manufacturing functions in the central city, permitting the decentralization of facilities to the suburbs. Merchandizing innovations such as the supermarket and shopping mall followed the outward residential movement, creating self-contained urban villages on the periphery of the city. The functions that retained locations within the Austin CBD--banking, finance, administration and law-require much face-to-face contact, speed and flexibility of service, and easy entry and exit to workspace.

The dispersion of employment and residential sites, has had a significant impact on Austin's pattern of passenger travel. These patterns are characterized by large numbers of relatively uniform, low volume, criss-cross movements which makes the design of a satisfactory public transit system difficult. More efficient public transit systems are
4 only successful along corridors of high density travel demand, rather than the pattern exhibited locally.[4]

Austin's street system, in general, is good in terms of capacity and volume of traffic, street surface and maintenance; and the transit system is good in terms of level of service. Financially, the time-span for the completion of construction projects is relatively short. Public awareness and efficient governmental planning, has provided a fairly efficient base for the planning of an improved and effective transportation program. With programs like Austin Tomorrow and the Joint Transportation Study Office, now underway, the City of Austin continues to keep its present position as being justifiably concerned with the quality of life of its residents and future development patterns of the area as a whole.

This report is written with the intent of outlining, albeit on a limited scale, the characteristics of Austin's transportation system, the transportation problems presently being experienced by the city, and potential solutions available to the metropolitan area. The purpose is to appraise the reader of aspects of the metropolitan transportation problem so that an individual perspective can be obtained.

The report is presented in a sequence of seven chapters. Chapter I presents an historical perspective of how Austin's shape has changed over time with the introduction of new transportation technology. Chapter II assesses Austin's transportation relationships with its region through its air, auto, rail and bus passenger connections. This is important since an appraisal of a city's transportation system is incomplete without an assessment of the city's position within its regional network. Chapter III presents an analysis of Austin's internal transportation characterisitics. Traffic volumes, control and regulations, street assessments and parking facilities, accident prone areas and the various modes utilized in the city are briefly discussed.

Physical, social and environmentally related transportation problems presently faced by the city and their possible solutions are presented in Chapter IV. Suggestions on how to curtail congestion, parking and peak load problems, and to remedy such transportation externalities as pollution and urban sprawl principally through non-capital solutions are outlined. The specific transportation problems associated with the poor, the elderly and the physically impaired are discussed. Following this assessment, research conducted in Austin on why people choose their transport mode for work, shopping and recreational trips is presented in Chapter V.

Chapter VI describes the costs associated with the operation of various urban public transportation modes, principally the bus, rail rapid transit systems and taxi. The energy efficiency of various modes such as dial-a-bus and car and bus transit when measured in passenger miles per gallon are discussed. Finally, some of the new systems potentially adaptable to the present and future physical shape of the Austin SMSA such as dial-a-bus, personal rapid transit and pedestrian conveyor systems are addressed. This is to appraise the reader of the successes and failures of present transportation systems operating in other cities and provides the reader with a more rational base for analyzing the transportation mixes most suitable to the Austin SMSA.

Chapter VII discusses the federal, state, and local legislation and financing policies available to the city. Such things as revenue sharing, regulatory policies, capital financing and subsidy issues are addressed. The distribution of federal, state and local financing over highway construction and maintenance expenditures, signalization, safety and design and capital improvements are outlined. The final chapter summarizes the results of the study and outlines important transportation issues which concerned citizens need to address.

Spatial Change: An Historical Perspective: 1840-1974

Chapter I

Introduction

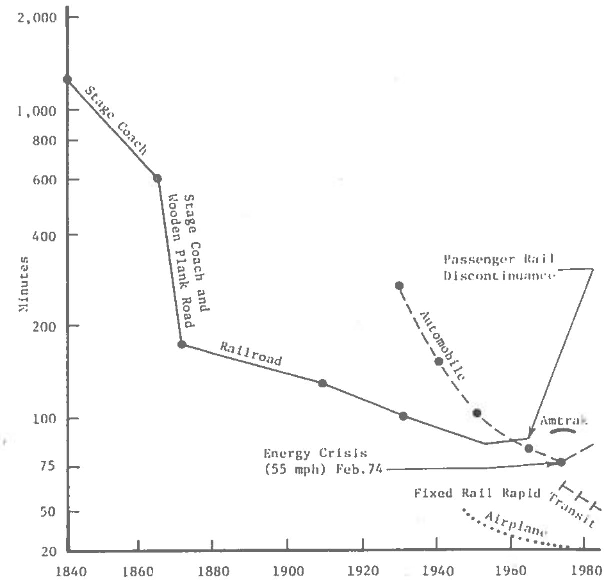
Advances in transportation technology have had a profound effect on the overall size and shape of the Austin Standard Metropolitan Statistical Area (SMSA). This chapter briefly discusses the transportation changes that have affected the physical form of Austin over the decades. Austin is endowed with unusual features ranging from the amenities provided by the "hill country", surrounding lakes, and abundant vegetation; to its population, distinctive in its character and composition.

The metropolitan area has developed along a "corridor concept" with high intensity uses occurring along major transportation corridors such as the Colorado River, IH 35 and Highway 183. The city's present dispersed development is the result of laissez-faire planning and economic forces. Austin's dispersed development, resulted from two distinct processes: low density "contiguous dispersal" from existing city boundaries and "leap frog development" with an "infill" of the empty spaces between the new development and the city.

The time-space convergence diagram is presented as an example of the effect technological advances in transportation can have in reducing travel time and physical distance (Figure 1-1). When related to travel within the city it illustrates how transportation changes have allowed the Austin SMSA to spread out into its present physical form (Figure 1-2). Transportation advances reduced travel time so that residences, industries and commercial activities were able to disperse over an extended area at low densities (Figure 1-3). In 1840 a stage coach travelling over rough terrain and one travelling over wooden planks would take roughly 1300 and 600 minutes respectively to cover the 85 miles between Austin and San Antonio. The introduction of the railroad around 1870 reduced this 85 mile distance to some 180 minutes. With some types of existing technology a non-stop rail rapid transit system on a fixed guideway between the two cities could further reduce travel time to 20 or 30 minutes. In particular, the automobile, truck and bus through the history of their development also contracted this distance as did the introduction of air service.

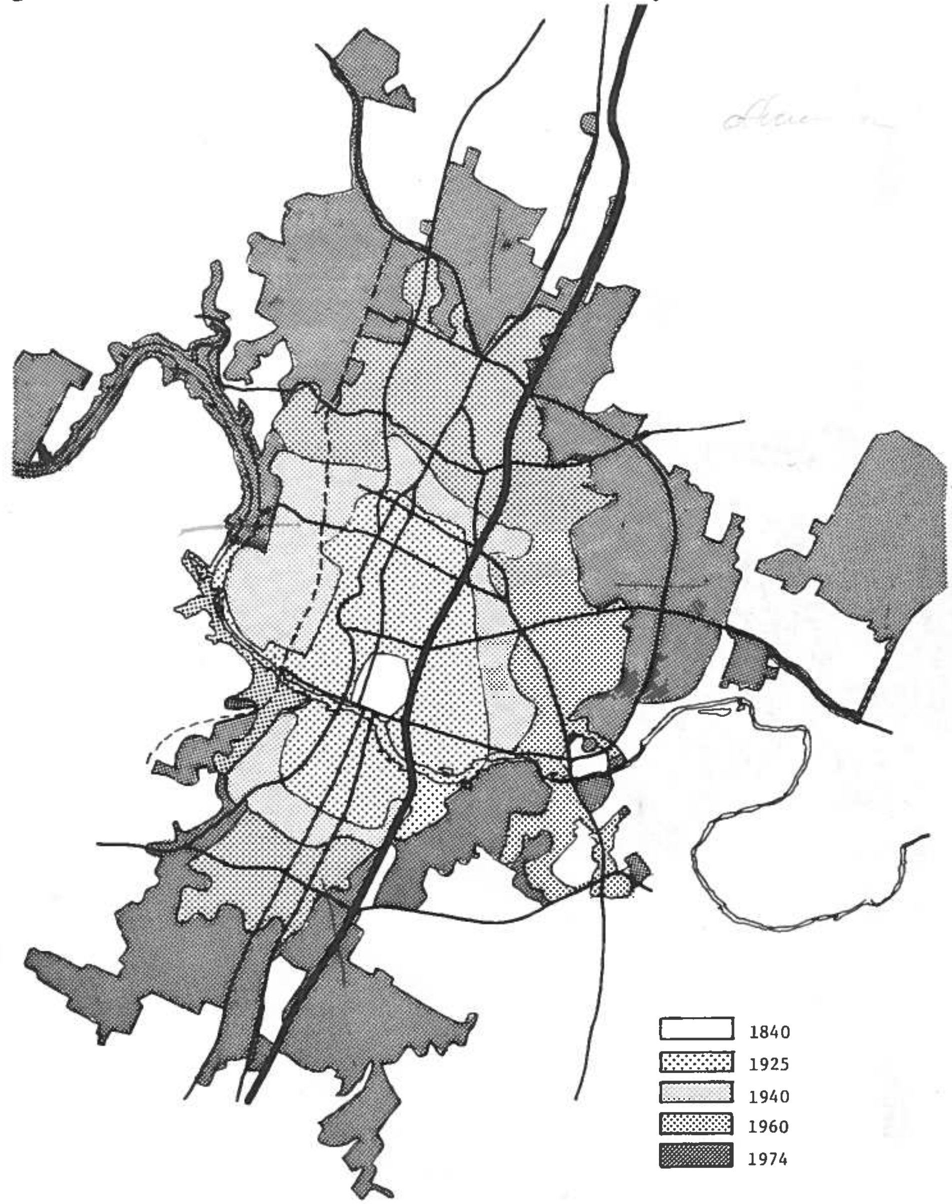
The early physical form of Austin resulted from an act of the Texas Congress in 1839 which provided a Capitol site and designated an agent to plan the town with the most valuable lots set aside for the Capitol and State buildings. Judge Edwin Walker was responsible for laying out the city in a grid pattern between Waller Creek and Shoal Creek. The

Figure 1-1: Time-Space Convergence, Austin and San Antonio, 1840-1980, 85 Miles



Source: Planning Department, City of Austin.

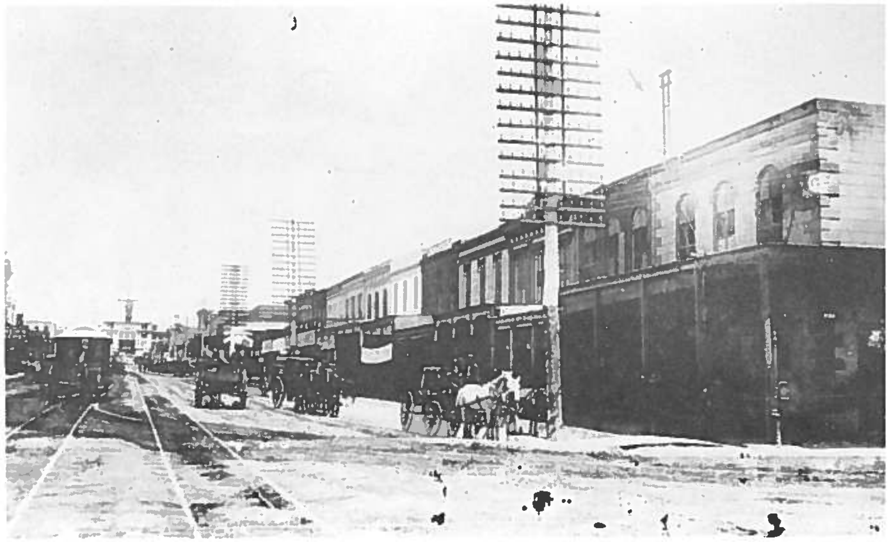
Figure 1-2: Territorial Growth of the City of Austin 1840-1970



Source: Planning Department, City of Austin.

Figure 1-3 A: A Pictorial Review

Figure 1-3 B: A Pictorial Review



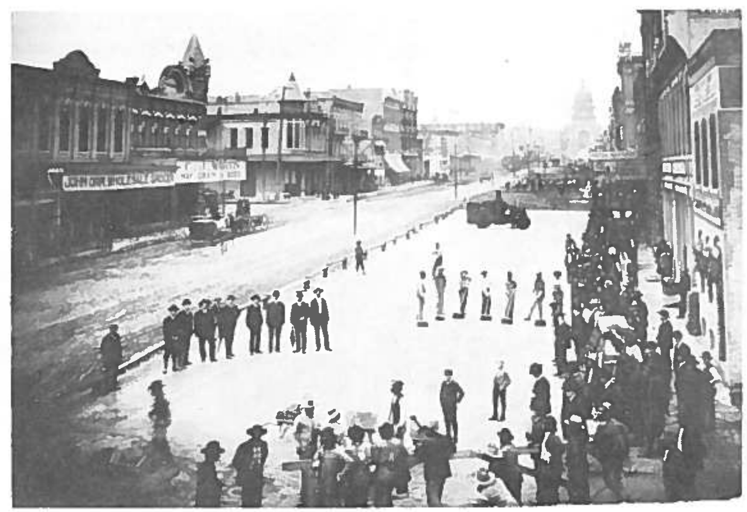
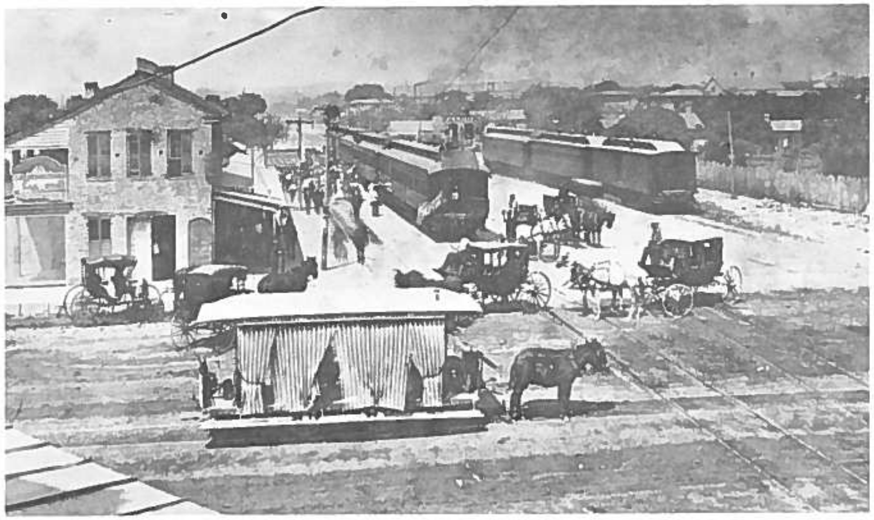


Figure 1-3 C: A Pictorial Review



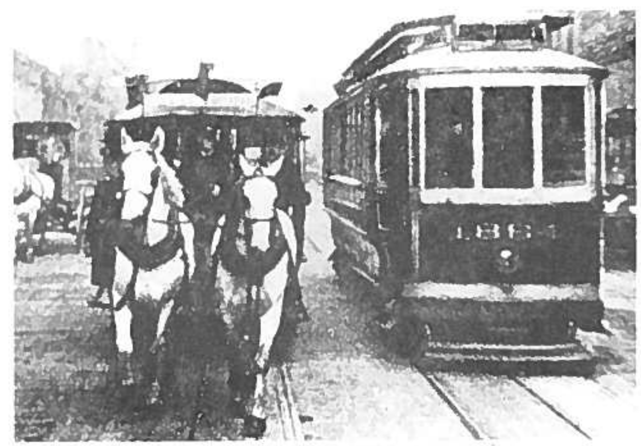


Figure 1-3 D: A Pictorial Review

original town consisted of one square mile; made up of 14 blocks from Water Street to North Avenue and 14 blocks from East Avenue to West Avenue. Normal street rights-of-way were 80 feet wide; East and West Avenues were 200 feet wide; and North Avenue was 100 feet wide. Austin was not built around only one public square, rather one square was set in the center of each fourth of the town. Four blocks, between 11th and 13th and Brazos and Colorado were reserved for the Capitol Complex. The hospital was planned at the northeast corner of town, at 15th and East Avenue.

In 1857 the office of Street Commissioner was created by the city, however, until 1870, the streets of Austin consisted solely of dirt. In 1873, a City Ordinance authorized the grading of streets, construction of curbstones and the paving of Congress Avenue with cobblestones.

The county courts were authorized to plan for ferries and roads and to appoint men to oversee their development. Road construction in early Travis County was the responsibility of the settlers and the courts decreed that men who lived in the different "beats" were to work and develop the roads in their vicinity.

The county roads were financed by a county tax which was 25 cents per $100 valuation in the first year. The courts were responsible for distributing this money to each precinct as needed. This means of financing was used for fifty years, until the county was given the authority to issue bonds in 1903.

In 1848, there was but one buggy in the City of Austin. At this time there were no spring wagons of any kind and the only lumber wagons were the old-fashioned Pennsylvania scoop-end type. Buggy wrenching, wagon stalling pitch holes were quite common in 1874. In 1912, $117,009 was requested for the paving of the numbered streets and in 1915, the Post Road between Austin and San Antonio was completed and is believed to be the first paved road in Texas. The roads in Texas were the responsibility of each county until 1917 when the Federal Road Act of 1916 led to the creation of the Texas State Highway Department and to the use of federal funds for building and maintaining roads. In 1927, Guadalupe was the second most important street after Congress Avenue; the main artery to the north; and the business street serving the University area. By 1954 Austin's street system totaled 606 miles.

The first bridge, a pontoon bridge near the East Brazos Street terminal generated toll charges and revenues of $15 a day. However, floods frequently made this bridge impractical. In 1875, a wooden toll bridge was constructed at an approximate cost of $100,000. It generated revenues of $40 a day. In 1884, a 910 foot bridge with a capacity of 2,000 pounds was constructed at the end of Congress Avenue. This served as a toll bridge for two years until its purchase by Travis County for $74,000.

The first ferry, begun in January, 1846, was operated by Sam Stone and provided a link in the transportation system between Austin and San Antonio--it was located one mile downstream from East Avenue. Grumbles ferry began in late 1846, charged 50 cents for a wagon or 10 cents for a man and horse, at the "old crossing" across the Colorado River. Around 1850 a free ferry existed at the mouth of Shoal Creek, however, by 1862, the only remaining ferry in Austin was Swisher's ferry which was in use until 1905, when it was replaced by a girder bridge. These ferries and bridges accelerated the development of Austin South of the Colorado River.

Between the years 1839 and 1880, the stage coach was the principal means of transporting passengers and light freight between Texas towns. In 1839, the firm of Starke-Burgess ran a stage from Austin to Houston twice a week. The trip cost 20 cents a mile and was scheduled to take three days but often took several days longer. Jones & Highsmith also ran a stage between Austin and Houston which left Austin every Thursday morning and arrived in Houston on Tuesday afternoon. Traveling by stagecoach was time consuming and expensive when compared to the transportation modes available today. In 1956, it cost $4.95 to fly one way to San Antonio, whereas in 1872 it cost $10 to take a stage. One of the more famous Texas stage coaches, the "General Sam Houston" made its first run between Austin and Brenham in 1841. This coach, pulled by six to eight mules, provided service between San Antonio and Brenham until 1873 when it was abandoned in an Austin alley. These stage coach lines served to enhance the accessibility of Austin and accelerated its growth.

Austin's urban form was affected by the Austin City Railroad Company which began on September 1, 1874 when a franchise for a horse railroad was granted by the Austin City Council. The streetcars were pulled by mules. The Austin City Railroad Company was granted the privilege to build and to maintain a horse railroad extending from the old H.&T.C. railroad depot, west to Congress Avenue, north to the Capitol, and thence to 22nd street via Lavaca and Guadalupe. From there, it extended south and east to Red River and 11th Street, via San Jacinto Street and terminated at Sholtz Garten. This method of transport lasted some 16 years with passenger fares never exceeding 10 cents from any point in the city to any other point. The system was located in and around Congress Avenue and eventually extended to Sholtz's Garten and Red River Street. The first track was laid along East 6th Street and Trinity Street, passing the first H.&T.C. depot at the corner of Trinity and 5th Streets. Twenty dollars a day maintained the expense of the road. With Saturday and Sunday service alone generating $16 it was a profitable concern in the town of 7,500 in 1875.

A considerable impetus to Austin's growth occurred with the entry of steam railroads in the 1870's. The Houston and Texas Central came in 1871 followed by the International and Great Northern in 1877. A narrow gauge railroad was also created between Austin and Burnet to transport the stone used in the construction of the Capitol in 1881.

Around May, 1889, a Mr. Shipe of Abilene, Kansas, was granted a franchise for an electric street railway within the city and extending some 10 miles out into the country. It was authorized to carry both passengers and freight and was called the Austin Rapid Transit Railway Company. The latter Company began operation on February 27, 1891. As of 6 pm on the first day of business they had carried over 2,000 people. Passenger travel demand intensified and additional capital stock had to be purchased. The Company was allowed to operate their railways along those streets or avenues within the existing and future corporate limits of the City of Austin which were not traversed by the Street Railway. The route to Holland Switch was completed in 1891 with subsequent extensions made to Hyde Park, City Cemetery, along First Street to Comal Street, along Sixth Street to the Confederate Home; over Robertson Hill to 12th Street; and from Lavaca to the Institute for the Blind.

The new trolley car speed was set at 10 mph except on Congress and other business streets where it was not allowed to exceed eight mph, and around curves four mph. These elegant cars were often used for social events. The company was responsible for paving between the rails and one foot either side and passenger fare was not to exceed five cents between any two points in the city.

The old horse-drawn Austin City Railroad Company, realizing they could not compete with electric power, solicited and received from the City Council an amendment to their franchise allowing them to use electric power or other motive power except steam over their system. Several other charters were granted to prospective companies in the city around this time such as The Capital City Rapid Transit Company and a Col. George W. Brackenridge.

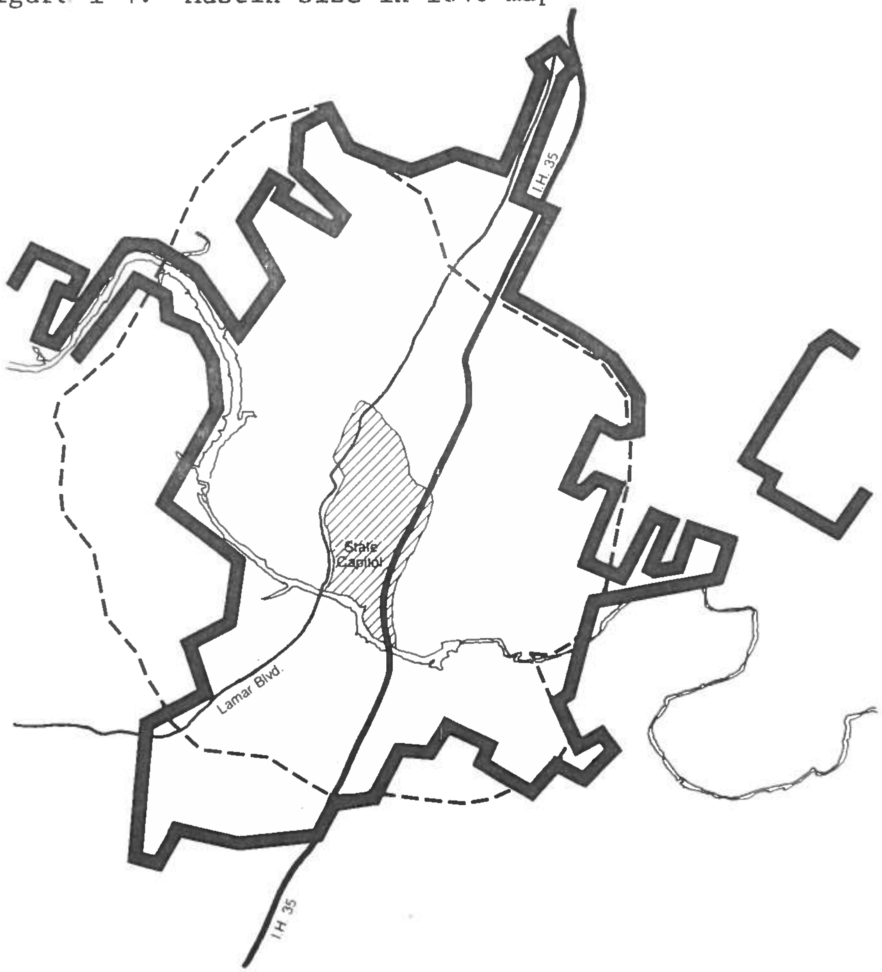
Considerable friction occurred between the Austin City Railroad Company and the new Austin Rapid Transit Railway Company. A severe fire reduced the stock of the horse railroad on May 8, 1891, destroying both electric cars and some 40 mules. Talk of consolidation began to occur between the two companies and finally occurred on June 5, 1891. On November 14, 1891 the entire street car system of Austin was operated by electric motors, at which time the company had 20 cars and 15 miles of track of which eight miles were double. Extensions to areas hitherto unserved were greeted with considerable delight by the "buggy owning"
22 residents. These extensions further encouraged the spread of the city.

In October, 1891, what was thought to be the last horse-drawn vehicles were removed from Austin Streets. However, the disastrous flood of April 7, 1900 destroyed the dam on the Colorado River and the power house. This left the city without water, light, power and street railway facilities. The street railway company reverted to the never-failing mules to pull their cars. In September, five months later, the electric street car resumed operation.

As an indication of the success and progress of the electric car rail system after 3 1/2 years of operation some four million passengers had been carried a distance of 1,500,000 mile. Around May 7, 1902, the Austin Rapid Transit Company ceased to exist and the Austin Electric Railway Company came into creation. Within one year the capital stock of this company increased from $200,000 to $350,000 and fares increased from five to seven cents. In 1907, conductors and motormen were paid 14 cents an hour. Congress Avenue bridge was built around 1910 and the electric street car lines were extended across the Colorado River to South Austin with the company paying bridge rental to the city. By 1912 some 18.7 miles of track were in operation and the convertible trolleys were adaptable for summer or winter use.

By 1918, the Austin Electric Railway Company began to feel the effect of buses and automobiles. From June 15, 1915, to July 5, 1929, the fare rose from five to ten cents. In 1919, the company operated at a loss of $1,300 a month and went into federal receivership. In 1915 a "jitney war" started. Jitneys were carrying close to 3,000 passengers a day often picking up people waiting for street cars and thus cutting the street car revenues. Between 1924 and 1933 some 23 miles of track existed, (Figure 1-6) but the impact of buses began to be felt. By 1939 only 17 miles of track existed while bus routes had increased to some 29 miles. The company operated at a loss of $62,500 in 1932 but showed improvements with profits ranging between $4,000 and

Figure 1-4: Austin size in 1840 map



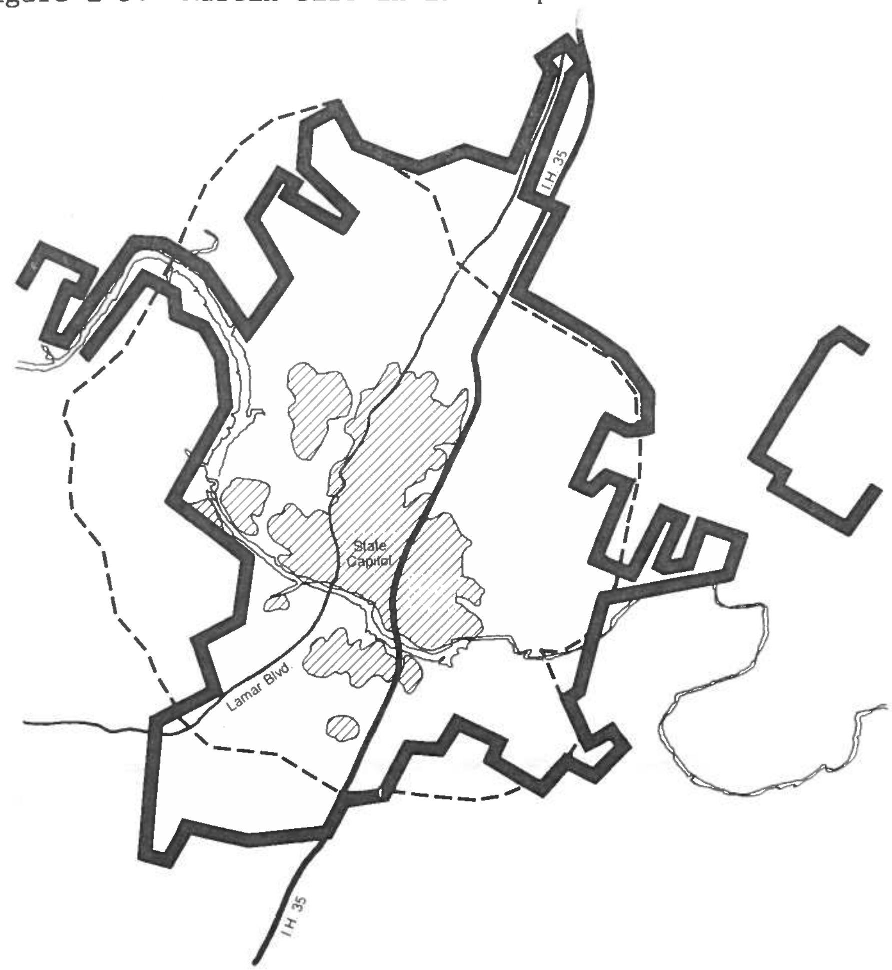
1970 City Limits

Loop 360

Land Use 1840

Source: Planning Department, City of Austin.

Figure 1-5: Austin size in 1927 map



1970 City Limits

Loop 360

Land Use 1927

Source: Planning Department, City of Austin.

$25,000 between 1936 and 1939.

In October, 1939, a city ordinance was adopted which required the substitution of buses on all streets where street cars were then operated. In 1939, the trolley fare was five cents and the new bus fare ten cents. February 7, 1940 was the last day of the electric car on the Mainline. Most of the rails over which the Austin trolley service operated were pulled up in June, 1940 and sold. The operation of the bus service was taken up by American Transit Corporation which ran it until July 30, 1970, when it went out of business with daily mileage around 4,535 miles. Transportation Enterprises took over, using school buses, on August 1, 1970. This continued until January 1, 1971, when the City Council subsidized the American Transit Corporation and purchased the transit contract. The city then purchased new buses on January 1, 1973 and has continued the operation since. As the following figures attest the basic coverage area remained fairly constant until the city purchased the system: January 2, 1967 - 5,387 miles/day - 53 buses; September, 1968 - 5,416 miles/day - 52 buses; September 1969 - 4,454 miles/day - 52 buses; April 1, 1971 - 5,387 miles/day - 54 buses. On January 1, 1973, night and Sunday service was initiated, with 36 buses in operation and a total daily mileage of

7,428 miles, an increase of 38 percent over April 1, 1971.

As to its regional links Austinites saw their first airplane, the "Vin Fiz" on Friday October 20, 1911. The landing strip was at 45th and Duval, and 3,000 people turned out for the event. The plane had flown in from Waco at a speed of 75 mph and at an elevation of 500 feet in 1 hour and 40 minutes. The first landing field, Penn, was developed in 1918 and covered a 318 acre area in the vicinity of St. Edward's University. In 1926, 40 acres paralleling Cameron Road near the extreme northwestern end of the Municipal Airport were leased and the Austin Air Service was inaugurated. The service continued until 1930 when the city bought the 40 acre tract. Ruff Airport, also known as the University Airport was in operation until 1950.

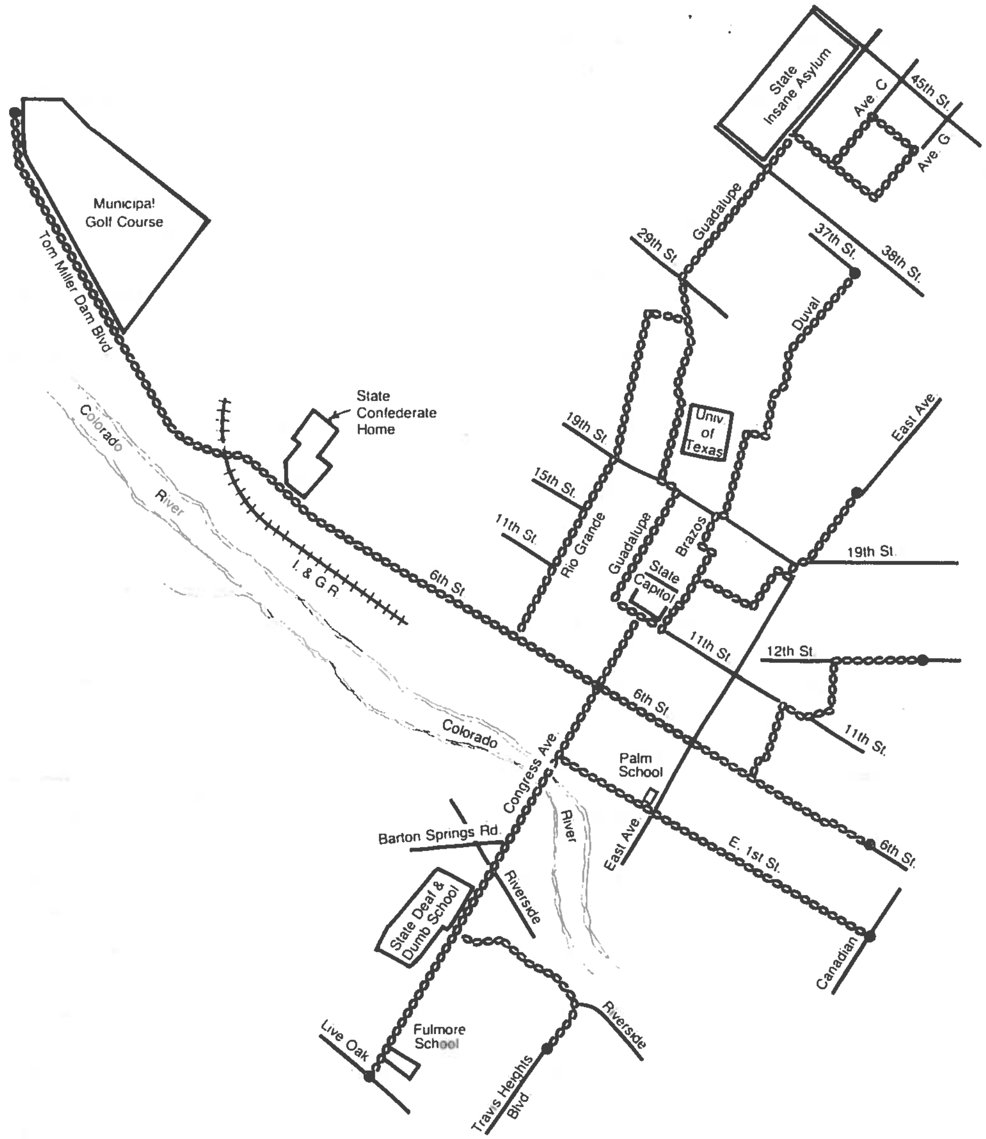
On February 6, 1928, Austin received and sent her first air mail; 20 lbs. of mail at five cents an ounce. On October 14, 1930, Austin Municipal Airport was dedicated in memory of City Councilman Robert Mueller. By 1935, the lines serving Austin were Braniff, American and Bowen. During that year a total of 1,345 passengers arrived, 1,502 passengers departed and mail out of Austin totaled 6,630 lbs. northbound and 765 lbs. southbound.

The Air Terminal Building was completed on May 27/28, 1961, at a total cost of $1,350,000. Airline passengers arriving and departing Austin increased from 1,556 in 1936 to about 106,000 in 1954. 80 to 90 aircraft were regularly based at the field and 4,700 take-offs were logged each month.

The motor car was introduced in Austin in 1901 and was limited to a maximum speed of 15 mph. 1914 saw the introduction of the motorcycle. These two modes, the car and the motorcycle, quickly gained acceptance over the horse and buggy and street car system. Along with the truck and bus, the car was to have a profound effect on the pattern and direction of Austin's growth.

In 1880, the city population was 11,013 people, and 27,028 persons resided in Travis County (Figure 1-4). Austin in 1930 extended over some 13,063 acres or 20.41 square miles and the city population was 53,120 compared to 77,777 for Travis County, and 5,824,715 for the State of Texas (Figure 1-5). The total labor force in Travis County for this same time period was 30,325, with the non-manufacturing category the highest employer with some 15,549 people. By 1940 the total labor force had reached 45,334. Enrollment at UT, opened in 1883, was 5,774 by this time. Motor vehicle registration in Travis County was 19,394 which included passenger cars and trucks.

Figure 1-6: Austin Railway Company Network, 1925-1930

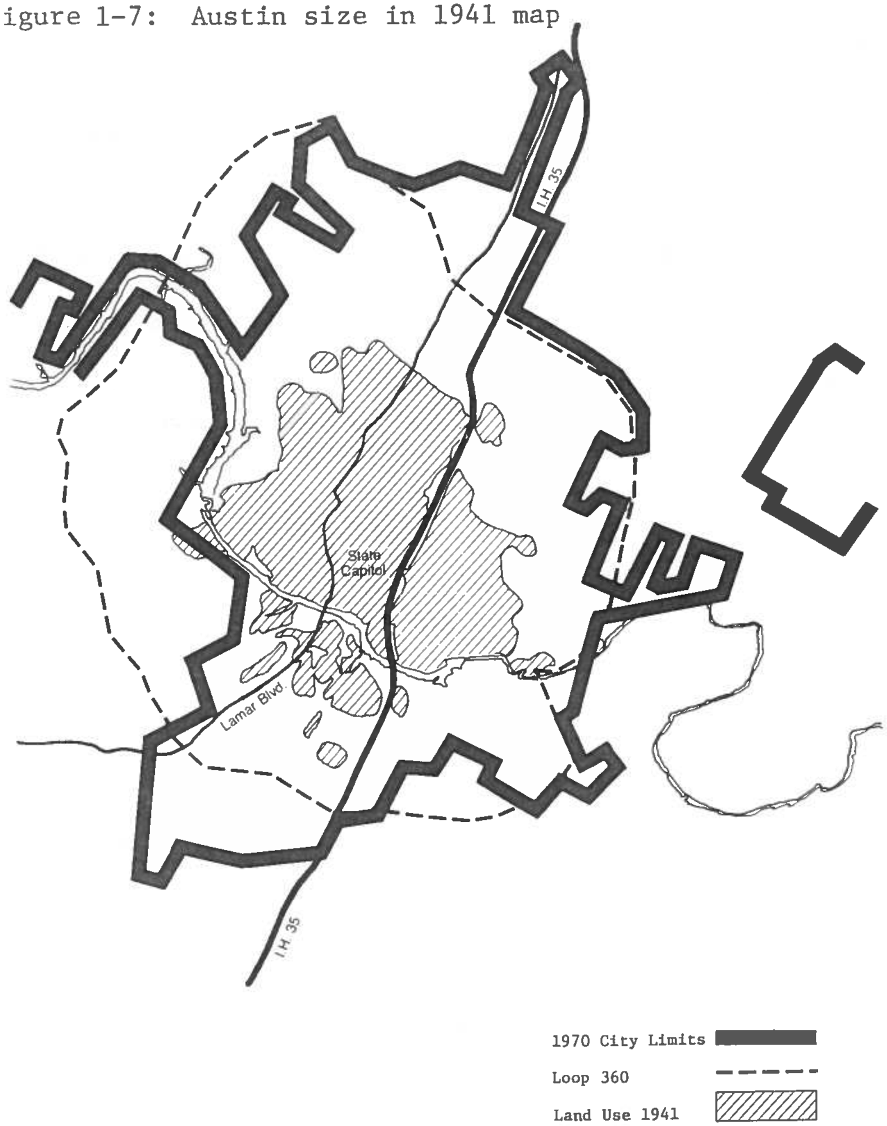


Source: Austin Travis County Collection.

Despite the economic depression of the thirties', Austin grew rapidly through expansion in both the public and private sectors. By 1940 the City of Austin had a population of 87,930 excluding university students, and Travis County 111,053 (Figure 1-7). This was a 65.5 percent increase over 1930. The city's land area had increased to 19,747 acres or 30.85 square miles, UT enrollment was 11,078, and total motor vehicle registration in Travis County was 30,687.

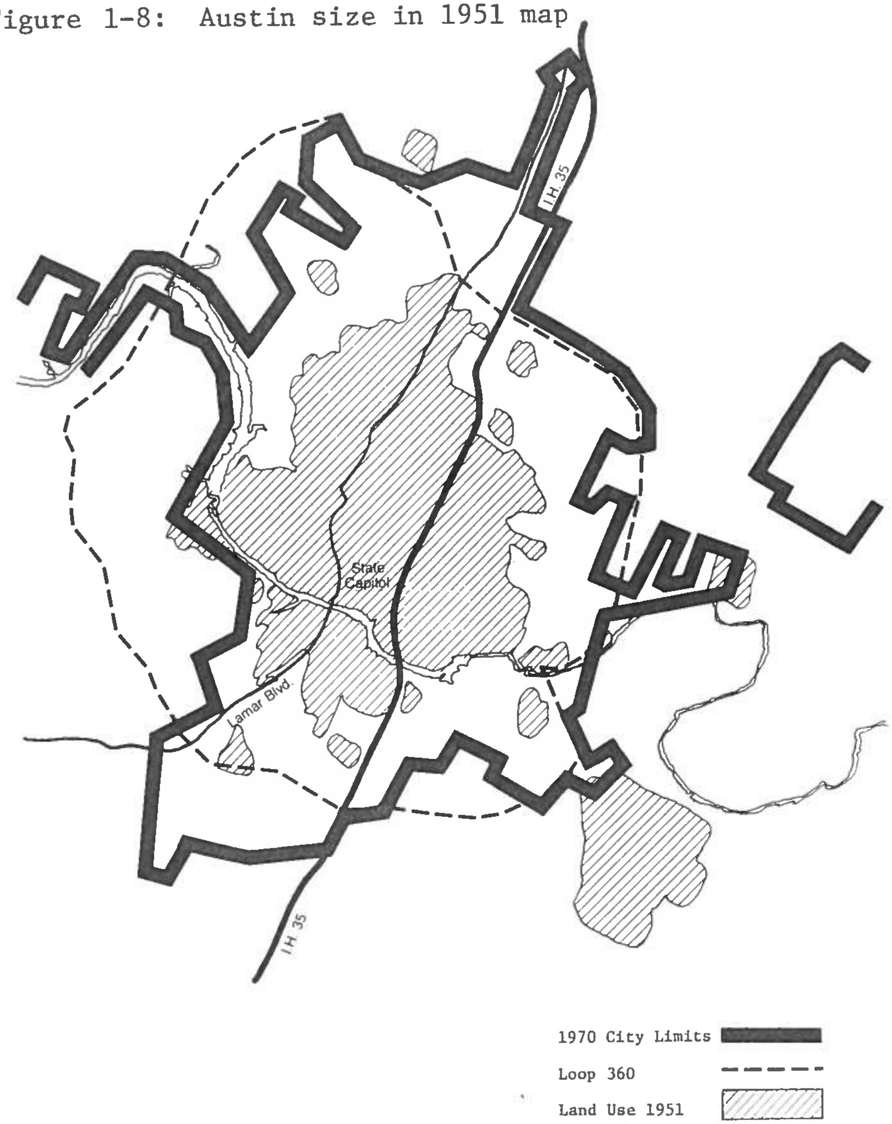
In 1955 the proportion of the county population living within the City of Austin was 93 percent, compared to 82.2 percent in 1950 (Figure 1-8). This relative increase in the city's population resulted from a series of annexations and variations in growth rates. In 1955 the city population was 178,900, compared to 193,800 in Travis County. Austin's total acreage in 1955 was 33,529 or 55.80 square miles (Figure 1-9). Population of the city for the same year was 132,459. There were 186,545 people in Austin in 1960, living in an area of 35,711 acres; these figures increased to 251,808 and 52,091 acres respectively, by 1970 (Figures 1-10 and 1-11). University of Texas enrollment doubled between 1960 and 1970 and currently has some 41,000 students. The Austin SMSA's population is estimated to be over 500,000 by 1990.

Figure 1-7: Austin size in 1941 map



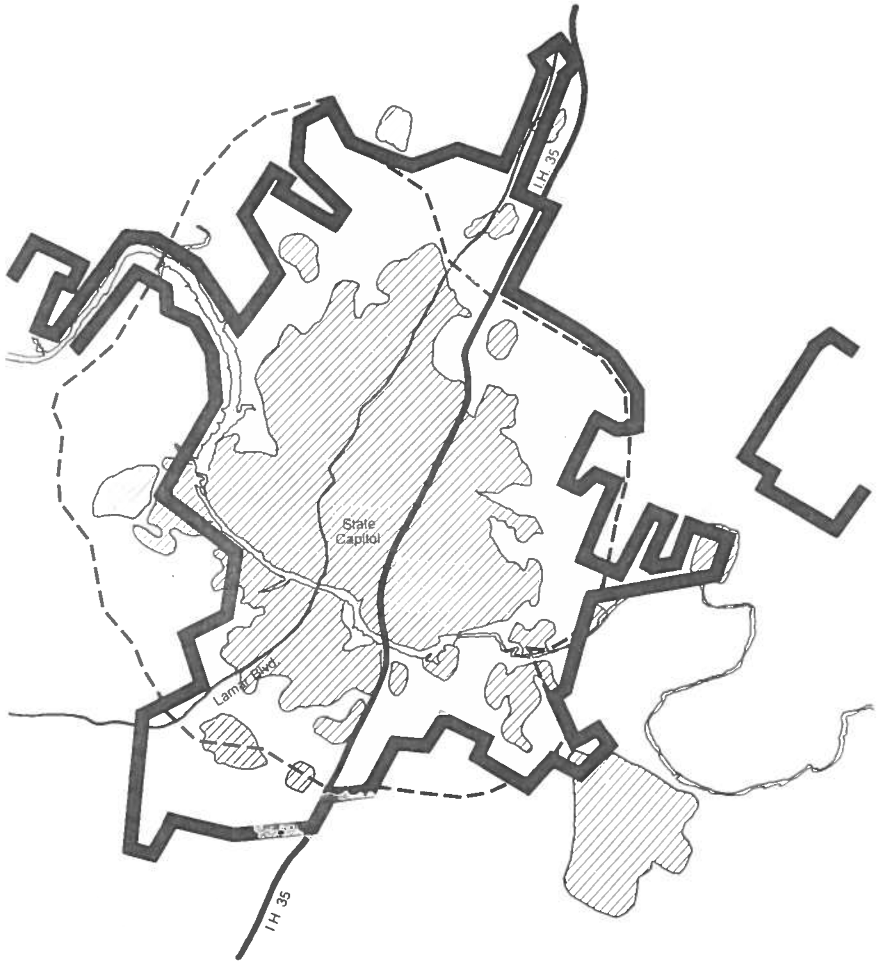
Source: Planning Department, City of Austin.

Figure 1-8: Austin size in 1951 map



Source: Planning Department, City of Austin.

Figure 1-9: Austin size in 1956 map



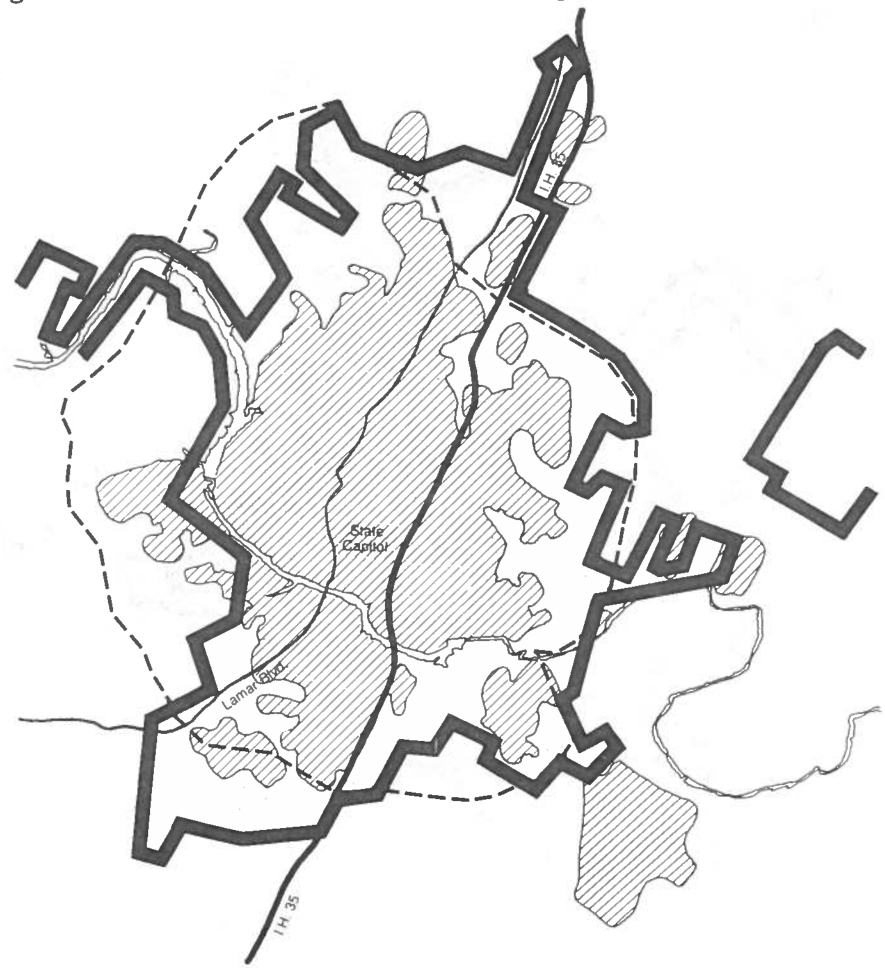
1970 City Limits

Loop 360

Land Use 1956

Source: Planning Department, City of Austin.

Figure 1-10: Austin size in 1962 map



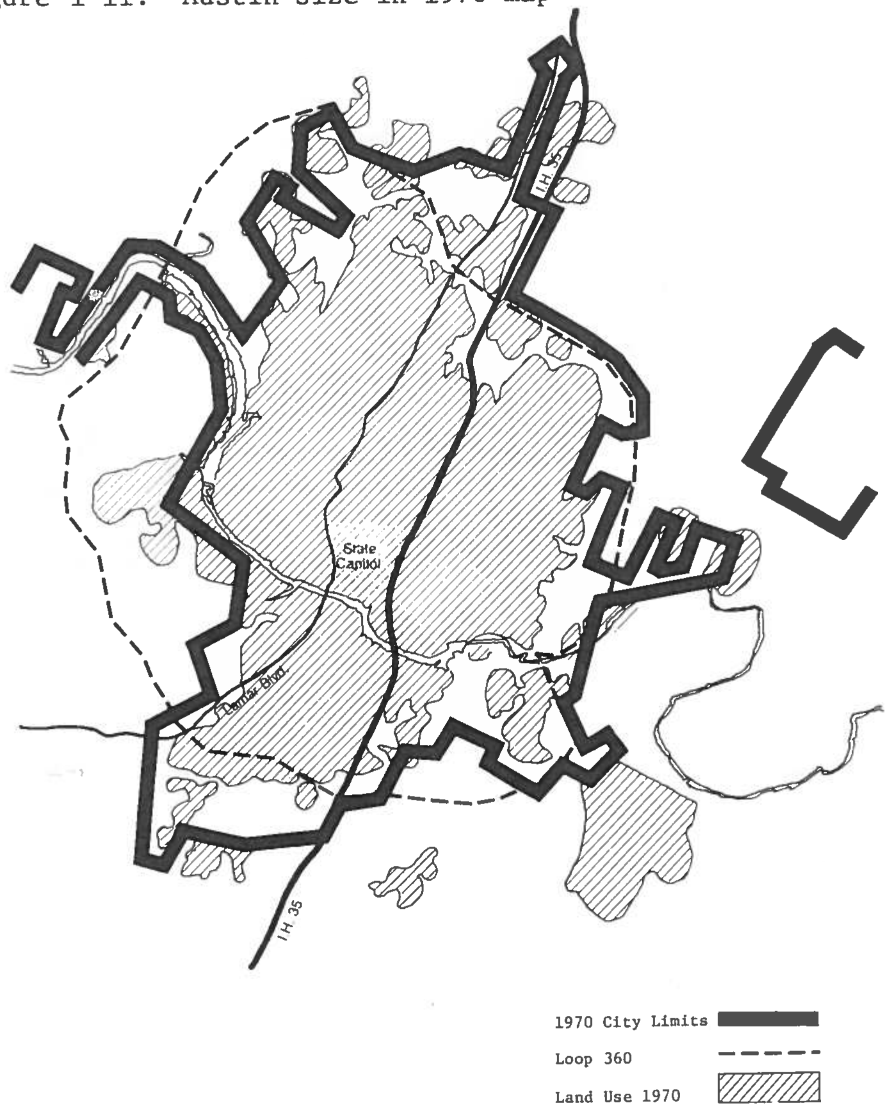
1970 City Limits

Loop 360

Land Use 1962

Source: Planning Department, City of Austin.

Figure 1-11: Austin size in 1970 map



Source: Planning Department, City of Austin.

Conclusion

Austin's physical pattern paralleled ancillary transportation changes. An understanding of this relationship provides the citizen and the planner with a basis for more effectively projecting the future geographic pattern and more effective transportation mixes for the metropolitan area. Traffic congestion and long commuting times for work and shopping trips are beginning to cause significant inconveniences. Present and future land use patterns must be developed in coordination with an effective transportation and utility supply system.

References

The City of Austin Library Archives, specifically:

The Austin Tribune and News, September 9, 1903.

Pitezsch, Louis R., et al, The Austin Electric Railway System Bulletin of the University of Texas No. 81. Seventyfifth Series No. 9 Austin, Texas November 1, 1906.

Sunday American Statesman, July 19, 1936.

Sunday American Statesman, February 4, 1940.

A.T. Jackson Austin's Streetcar Era South Western Historical Quarterly, October, 1954. Vol. LVIII No. 2, pp. 235-248.

The Texas Division Electric Rail Roader's Association Short Circuit Bulletin Milam Building, San Antonio, April 10, 1968.

Sunday American Statesman, March 29, 1969.

A Study of Transportation in Austin, League of Women Voters, 1972.

CHAPTER I

1. The Austin Tomorrow Program, City Planning Department, Austin, Texas, Spring, 1975.

2. Moses, Leon and Williamson, Harold W., "Location of Economic Activities in Cities," The American Economic Review, LVII (1967), pp. 211-22.

3. Meyer, John R., Kain, John K., and Wohl, Martin, The Urban Transportation Problem, Chapter II and III, Harvard University Press, Cambridge, Massachusetts, 1968; and John F. Kain, "The Distribution and Movements of Jobs and Industry," The Metropolitan Enigma, U.S. Chamber of Commerce, Washington, D.C., 1967, pp. 1-34.

4. Meyer, John R., "Urban Transportation", The Metropolitan Enigma, U.S. Chamber of Commerce, Washington, D.C., 1967, pp. 34-58.

Regional Linkages

Chapter 2

Introduction

Texas portrays a distinctive settlement pattern consisting of clusters of densely populated metropolitan areas and sparsely populated rural peripheries. Some of these rural areas are characterized by low incomes, severe unemployment problems, low growth and declining industries. The rural-urban movement accelerated their long-run decline and selective migration has generally left an older, poorly educated populace in its wake.

The traditional concept of a city as CBD or core-dominated has changed. The Austin metropolitan area has expanded outward producing a large urban field or commuting area. Advances in surface transportation and other travel modes accelerated the expansion into areas lying between local townships making it increasingly difficult to identify the urban-rural fringe. As a result, the resources of the rural areas are better utilized and are ceasing to reflect depressed characteristics. The ability to travel considerable distances in a few hours whether for work or weekend recreational activity links cities and their rural hinterlands through the flow of people, goods, and ideas. The increasing demand for these hinterland areas, as exemplified by the area between

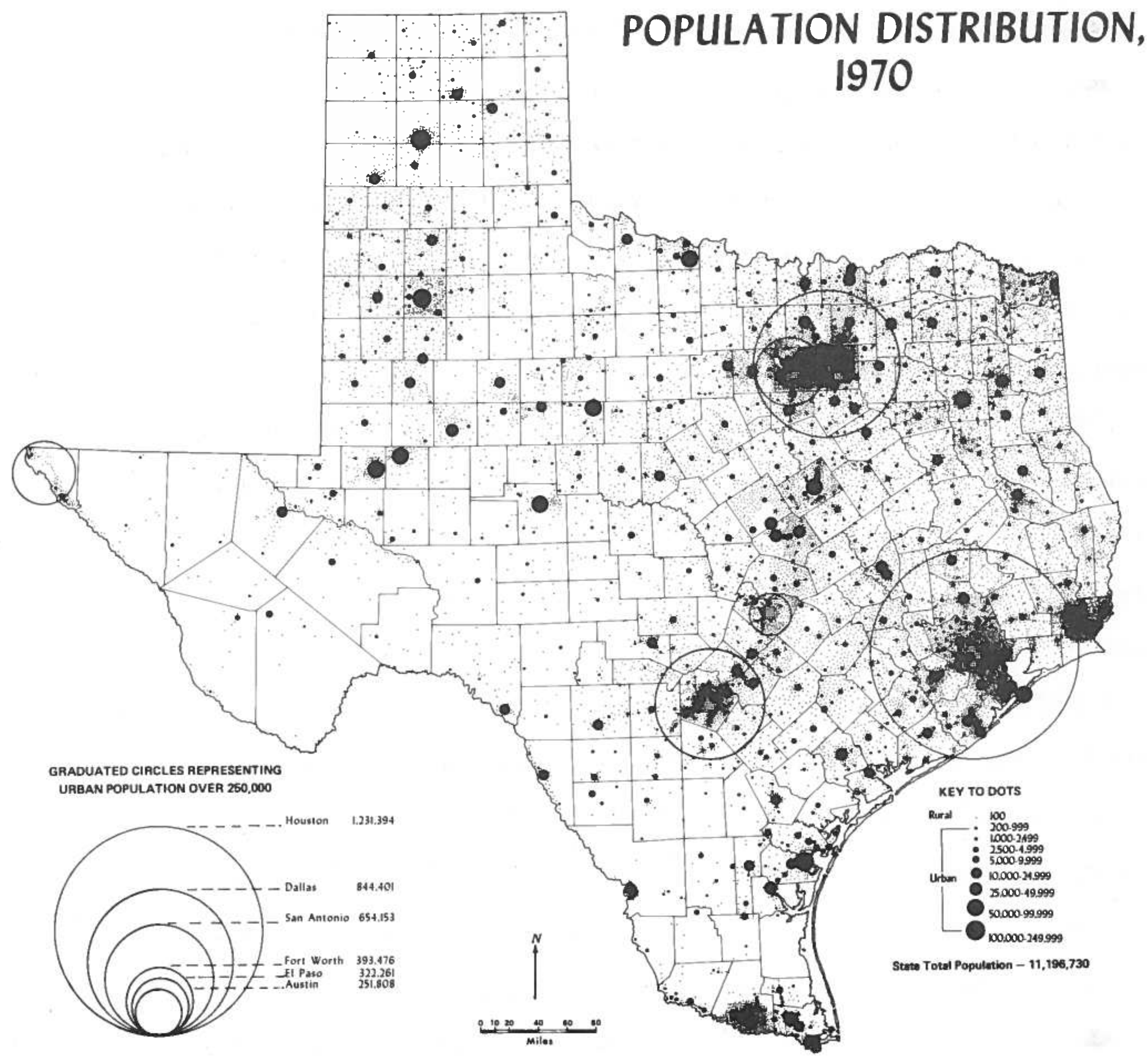
Austin, San Marcos and San Antonio, along with concomitant improvements in surface transportation has accelerated their development.

Increasing real income, leisure, and improved mobility has accelerated this trend. Accessibility and the resulting contraction of space through reduced travel time at lower costs has produced large urban areas. Even considering the impact of the fuel crisis, a wider choice of life style, living environments, and community of interest is accompanying this change. The following section assesses, albeit on a limited scale, Austin's transportation linkage and relationship with its hinterlands. It considers air, auto, rail and bus passenger travel movements and linkages.

Air Passenger Travel Patterns

PASSENGER MOVEMENT. Thirty-one cities in Texas have scheduled air carrier service by one or more carriers[1]. The Texas population map indicates that the location and availability of airport facilities is directly related to demand generated by population concentrations (Figure 2-1)[2]. In 1970, there were approximately 10 million passenger enplanements, defined as a passenger boarding an airline regardless of departure point on scheduled commercial airlines at 31 certified Texas Airports. Approximately 51 percent of all passenger enplanements

Figure 2-1: Population Distribution in Texas, 1970



Source: Robert K. Holz, 'Population Distribution in Texas: Patterns of Population Distribution,' *Texas Business Review*, June 1973.

occurred at the Dallas Love Field, 21 percent at Houston, nine percent at San Antonio, and five percent at El Paso[3]. Austin ranked fifth in importance with some four percent of total enplanements.

ACCESSIBILITY. The ability of an air transportation network to satisfy passenger demand can be assessed by measuring its nodal accessibility. The air network can be abstracted as a set of nodes, or cities with a set of links, or air routes, and its properties and accessibility measured[4].

Table 2-1 presents the direct and indirect airline connections for cities on the Texas air transportation network. Austin ranks tenth in this hierarchy of cities which is again supportive of its ability to retain efficient air facilities and a suitable range of service connections.

AIR TRAFFIC SHADOW CITIES. An examination or the counties in the air traffic shadows of various Texas airports reveals some interesting properties of these traffic shadows. The traffic shadow effect refers to the channeling of air traffic to the largest city of any cluster at the expense of smaller cities. The shadow is not a fixed area, but varies in proportion to the air center's attractive power, which is generally measured in terms of accessibility, scheduling flexibility,

Table 2-1
Hierarchy of Cities On Texas Air Transportation Network: Accessibility

	Hierarchy	
City	Rank	Accessibility Value
Dallas	1	23.04
Houston	2	16.26
San Antonio	3	14.40
Harlingen	4	12.99
McAllen	4	12.99
El Paso	6	12.54
Lubbock	7	12.21
Temple	8	12.00
Corpus Christi	9	11.67
Austin	10	11.49
Midland/Odessa	11	11.31
Amarillo	12	10.98
Wichita Falls	13	8.64
Laredo	14	7.08
College Station	15	6.51
Big Spring	16	6.45
Waco	17	6.00
Brownwood	18	5.43
San Angelo	19	5.43
Beaumont	20	5.13
Brownsville	21	4.56
Longview	22	4.32
Lufkin	23	3.87
Tyler	23	3.87
Abilene	25	3.63
Kileen	26	2.86
Texarkana	27	2.73
Paris	28	2.73
Victoria	29	1.83
Galveston	30	1.83
Del Rio	31	1.38

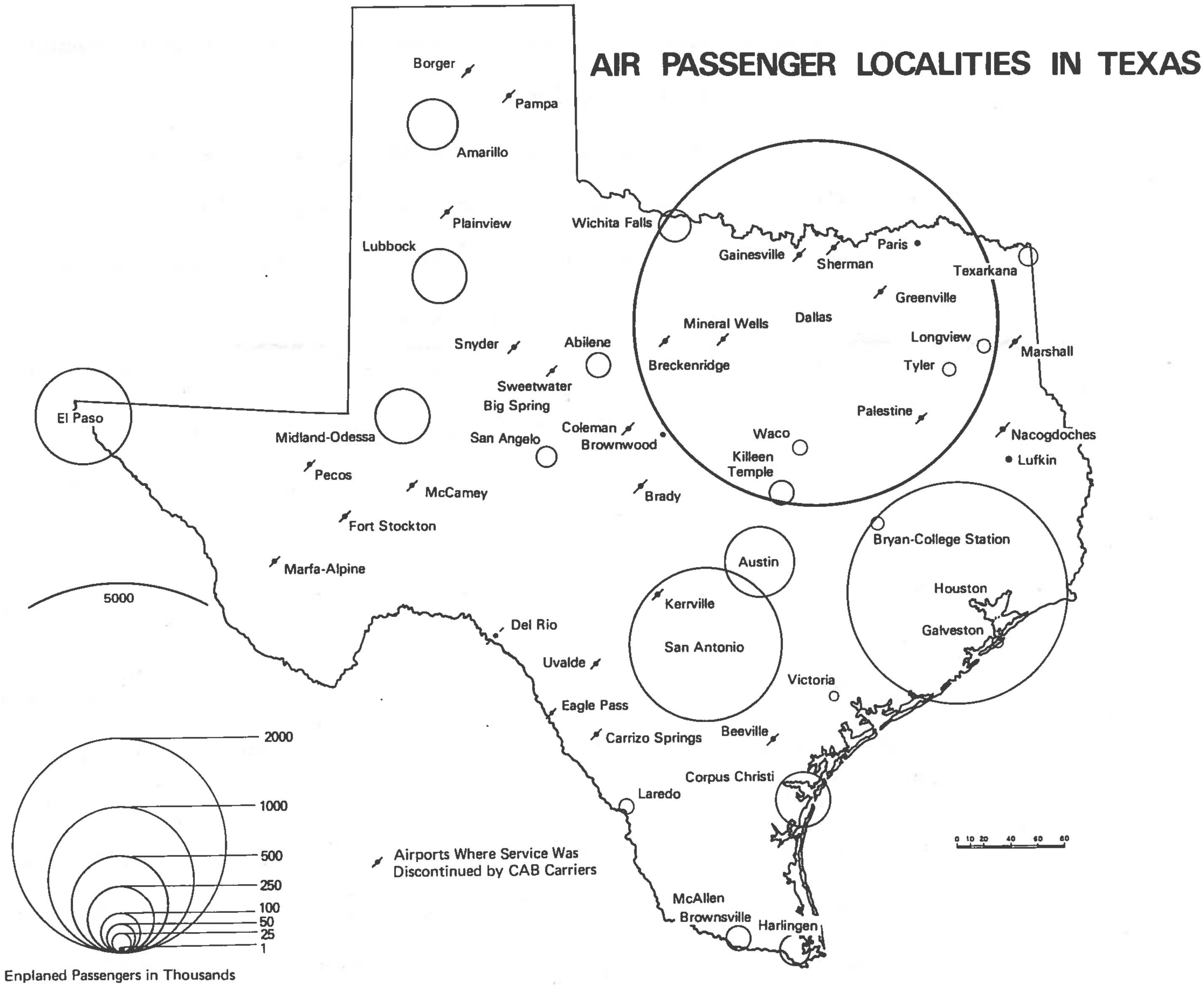
Source: Shane Davies et.al., Passenger Travel Patterns and Mode Selection in Texas: An Evaluation Research Memo 5. October 1973, Council for Advanced Transportation Studies, The University of Texas, Austin p. 44.

and route selections (Figure 2-2). For example, the Dallas/Ft. Worth airport attracts passengers from 180 counties, Houston from 61 counties, and San Antonio from 83 counties.

The air traffic shadow cast by these major centers varies over time. With improvements in surface transportation and extensions of the highway system, the traffic shadows of these centers will tend to expand. The probable result will be an even greater dominance of Texas air traffic by Dallas/Ft. Worth, Houston and San Antonio. Although Austin may fall more heavily within the airport dominance of the San Antonio facility, its present growth rate is promising. The possible institution of a rapid mass transit system between Austin and San Antonio could affect Austin's airport growth making Austinites considerably more dependent on the larger San Antonio facility (Figure 2-2).

IMPACT OF ENERGY CRISIS. In early October, 1973 it appeared that airline passenger service in Texas would experience curtailments due to the fuel shortage. Contingency plans to save fuel which included flight reductions, slower speeds and longer gate holds were outlined. Airlines were to be limited in any one month to the same amount of fuel they had used in the corresponding month in 1972. As of December 1, the Civil Aeronautics Board airlines were to be allocated five percent less than

Figure 2-2: Air Passenger Localities in Texas



Source: Texas Airport System Plan: Part A, Texas Transportation Institute, College Station, Texas, (1973).

Table 2-2
Air Passenger Boardings For Period of Nov-Feb 1971/72, 1972/73, 1973/74

	1971/2	1972/3	1973/4	1971/2	1972/3	1973/4
Total T I System:	Average % In Constant Boardings			Average Boardings		
	100	88	94	715175	626354	674960
Cities 50,000						
Big Spring	100	82	68	323	264	220
Brownwood	100	114	127	214	243	271
Longview	100	92	104	868	799	902
Lufkin	100	78	86	166	129	142
Temple	100	76	41	1118	853	463
50,000-100,000						
Laredo	100	96	98	1343	1287	1313
Midland	100	109	184	1688	1847	3106
San Angelo	100	98	99	1889	1853	1876
Tyler	100	90	90	813	729	734
100,000-150,000						
Abilene	100	92	[illegible]	[illegible]	[illegible]	[illegible]
Amarillo	100	123	115	2273	2806	2604
Harlingen	100	107	105	3073	3279	3234
Texarkana	100	93	101	2204	2046	2215
Waco	100	96	83	1503	1438	1243
Wichita Falls	100	90	79	4511	4051	3544
150,000-300,000						
Lubbock	100	102	106	1731	1763	1837
McAllen	100	109	120	4237	4614	5065
Austin	100	136	155	7257	9869	11273
Corpus Christi	100	95	88	2798	2656	2472
300,000-1,000,000						
San Antonio	100	77	83	3579	2766	2975
El Paso	100	64	83	103	66	85
Beaumont	100	67	73	3863	2599	2829
1,000,000						
Houston	100	81	91	26292	21196	23808
Dallas/Fort Worth	100	88	91	43352	38006	39316

Source: Data derived from Texas International Boarding Figures, 1974.

their 1972 usage and effective January 7, they were to be allocated 15 percent less than their 1972 usage[5].

Little change in service occurred as a result of the fuel allocation program upon airlines serving Texas. Looking at cities by size class gives an indication of the service changes that occurred. The peak year for passenger enplanements of 1971 was selected as the base year and data from Texas International Airlines, (the major CAB carrier in the state) were used. It must be pointed out that Texas International figures may not accurately reflect the air passenger market between points like Dallas/Ft. Worth and Houston. As Table 2-2 indicates, enplanements generally dropped in cities below 150,000 and increased in cities above 150,000. Cities with less than 50,000 population lost on average some three percent of their boardings. Austin, however, falling within the 150,000 - 300,000 population range, experienced an increase in total enplanements.

The energy crisis had no significant effect on airline passenger service within Texas. For most Texas cities, passenger boardings were higher for the November-February, 1973 period than for 1972 and in many cases above the peak year for 1971. This was especially true for the Austin SMSA with an increase from 7,257 to 11,273.

FUTURE PASSENGER DISCONTINUANCES. An examination of the present number of passengers per scheduled departure reveals cases in which the demand for air transportation is insufficient to warrant continuation of air service (Table 2-3). While there was an average of 14 passengers per scheduled departure in 1970, 13 cities were below average, and 11 of these had five fewer passengers per scheduled departure. The Austin SMSA appears to have a healthy passenger per scheduled departure rating of 21.

Summary

Changes in population growth and distribution are important to the restructuring of air travel facilities. The population of Texas is expected to increase from 11.2 million in 1970 to 15.5 million by 1990[6]. Future air service demand will be affected by where this population increase occurs. Passenger air travel in Texas will probably show a marked increase in the next two decades. It is estimated to double between 1970 and 1980, and re-double between 1980 and 1990. Airport facility improvements will occur primarily in expanding urban areas such as Austin[7].

Increases in short inter-city flights will be relatively lower than increases in total inter-city movements due to improvements in surface

Table 2-3
Passengers Per Scheduled Departure, 1970

City	Number of Scheculed Departures Performed*	Number of Enplanements	Passengers Per Scheduled Departure
Abilene	2.5	39.1	16
Amarillo	7.9	165.5	21
Austin	12.5	261.5	21
Beaumont	6.6	76.3	12
Big Spring	1.4	1.1	1
Brownsville	.9	25.2	27
Brownwood	1.3	3.5	3
College Station/Bryan	1.4	2.0	4
Corpus Christi	6.6	169.2	26
Dallas/Fort Worth	127.0	5,294.2	42
El Paso	18.3	508.0	28
Galveston	1.2	4.9	4
Harlingen	3.1	34.8	11
Houston	64.7	2,209.2	34
Laredo	1.6	17.0	10
Longview	2.8	10.2	4
Lubbock	11.0	186.0	17
Lufkin	1.0	3.4	3
Midland/Odessa	11.7	176.4	15
Paris	.6	1.0	2
San Angelo	2.1	28.0	13
San Antonio	29.0	882.1	30
Temple	2.8	14.1	5
Tyler	2.7	9.5	4
Victoria	1.0	5.5	5
Waco	3.4	19.0	5
Wichita Falls	3.1	65.0	21

*All numbers in 000's.

Source: Airport Activity Statistics, Domestic Carrier Operations (Year ended June 30, 1971).

Table 2-4
Traffic Volume Over 24 Hour Period Within Texas' Major Metropolitan Centers*

	1964	1968	1972
Dallas-Fort Worth	35,640	47,960	88,210
Houston	33,170	59,910	99,370
San Antonio	31,320	52,410	77,070
Austin	16,940	28,190	48,590
El Paso	30,550	38,880	64,170
Corpus Christi	18,620	23,410	30,880

Source: Traffic Map, State of Texas, 1964, 1968, 1972; prepared by the Texas Highway Department in cooperation with Department of Commerce and Bureau of Public Roads Survey. These volumes reflect the single largest traffic moves in each of the respective cities.

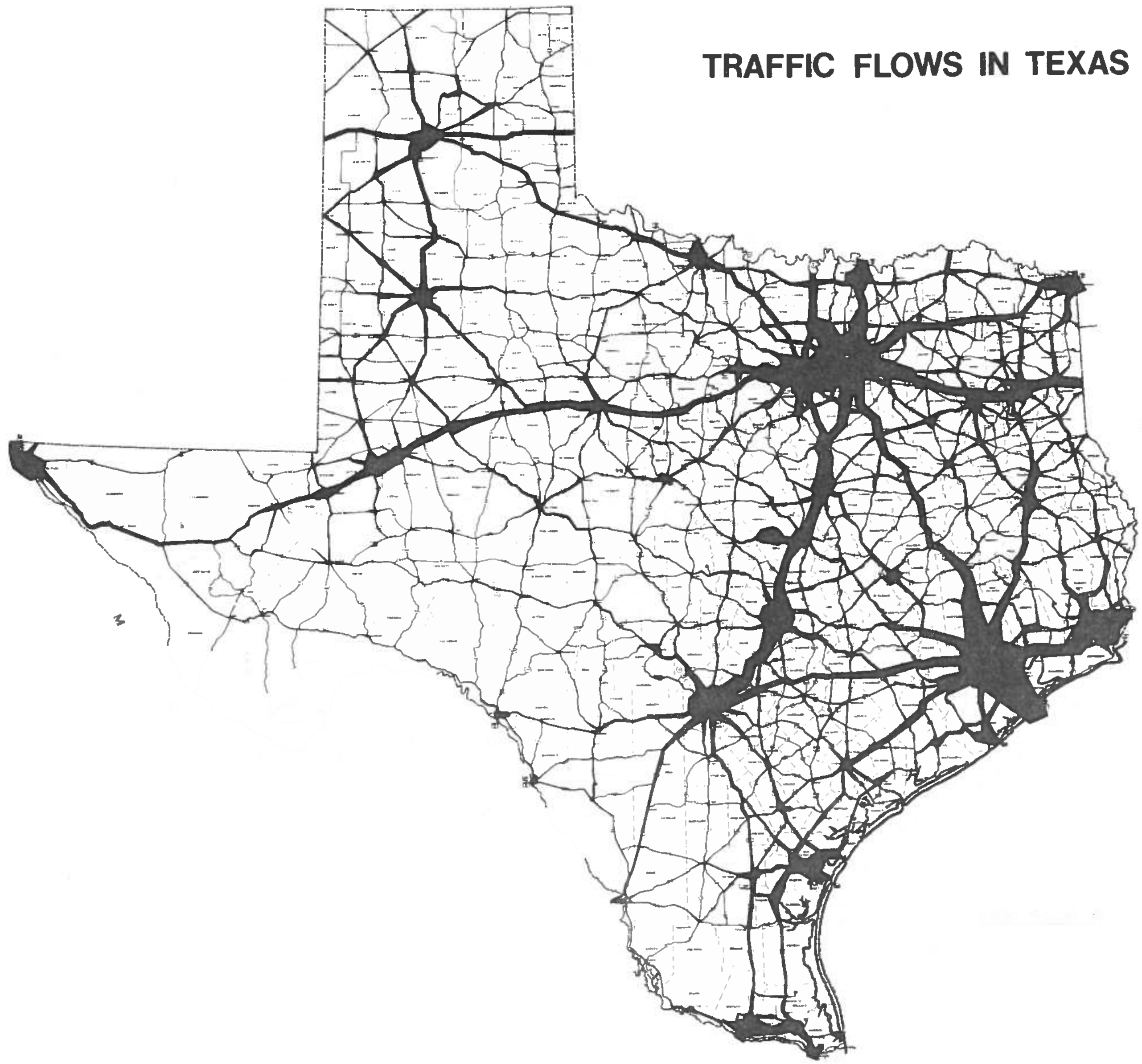
transportation and the closing of some airports that lie within the air traffic shadows of major airport facilities. Given recent improvements in the State's surface transportation, the need to retain passenger flights from cities located within an air traffic shadow will diminish. Cities such as Waco and Temple may find it difficult to support the retention or expansion of their airport facilities. Austin however, should retain its overall position and may not be tangibly affected by the San Antonio facility.

Highway Passenger Travel Patterns

TRAFFIC MOVEMENT. The Dallas/Ft. Worth metroplex and the Houston-Galveston-Beaumont-Orange area account for the greatest traffic flows in the State (Figure 2-3). At one point on Interstate 35 in Dallas, 43 million vehicles, carrying approximately 84 million people, pass every year[8]. The two major centers are followed closely by the San Antonio, Austin, El Paso, Amarillo, and Corpus Christi areas.

In 1972, traffic volumes recorded over a twenty-four hour period at selected sites within the State's largest urban areas indicates traffic volume increases ranging from 100 to 300 percent over the preceding eight years (Table 2-4). Movements in the Austin SMSA increased 289 percent over this period.

Figure 2-3: Traffic Flows in Texas



Source: Texas Highway Department District 14, Austin, Texas, 1974.

Table 2-5
Hierarchy of Cities On The Texas Interstate Highway System

City	No. of Linkages		City	
San Antonio	50	1.	San Antonio	3.36
Dallas	45	2.	Houston	2.95
Houston	43	3.	Dallas	2.94
Hillsboro	34	4.	Hillsboro	2.31
Fort Worth	31	5.	Fort Worth	2.10
Denton	26	6.	Austin	1.64
Austin	24	7.	Denton	1.64
Waco	23	8.	El Paso	1.62
El Paso	22	9.	Waco	1.49
Abilene	18	10.	Abilene	1.35
Pecos	17	11.	Pecos	1.27
Beaumont	16	12.	Midland	1.21
Corpus Christi	16	13.	Corpus Christi	1.04
Laredo	16	14.	Laredo	1.04
Galveston	16	15.	Galveston	.98
Midland	15	16.	Beaumont	.98
Texarkana	15	17.	Texarkana	.94
Amarillo	0	18.	Amarillo	0

Source: Shane Davies et.al., Research Memo 5. Council for Advanced Transportation, University of Texas, Austin p. 55.

ACCESSIBILITY. The nodal accessibility and general dominance of one city relative to other cities on any transportation network can be measured by abstracting the network as a graph. The spatial dominance and relative position of Austin in the highway network's urban hierarchy can be seen in Table 2-5. Austin ranks reasonably high on the network and is well integrated into the interstate system.

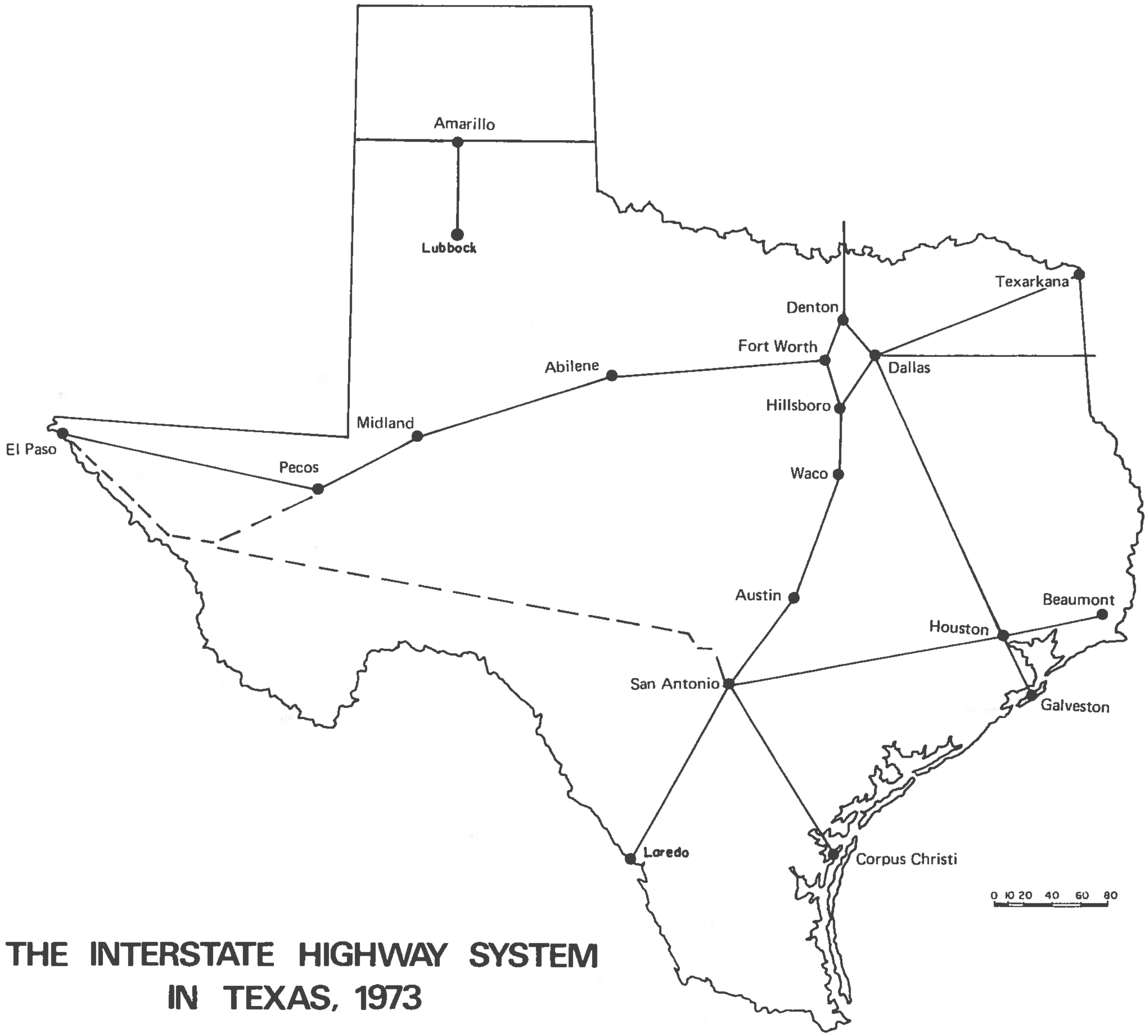
Summary

The Texas Highway Network, consisting of 69,175 miles of roadways, is the most extensive in the Nation[9]. As of January, 1971, it included 3,176 miles of interstate highways, 26,950 miles of primary highways, and 9,786 miles of farm to market and ranch roads, and 29,263 miles of county roads. The Interstate Highway Network links all cities in the State with populations greater than 100,000 except Wichita Falls (Figure 2-4). The Texas Highway System provides some 2,000 smaller rural communities with their primary means of access[10].

Bus Passenger Travel Patterns

THE BUS NETWORK. With the demise of inter-city rail passenger service, bus lines operating on extensive highway networks have become the cominant mode of inter-city fare-passenger travel in Texas. Inter-city

Figure 2-4: Interstate Highway System in Texas, 1973



Source: Texas Highway Department (1973).

bus service is an essential part of the State's transportation system providing approximately 1,000 of the 1,124 places serviced in Texas with their only form of public passenger transportation (Figure 2-5). Since only 31 cities in Texas have regularly scheduled airline service and only 13 cities have rail passenger service, its importance as a public conveyance, particularly for low income groups, is evident[11].

In the Southwest, with its large urban centers separated by vast areas with few people, the express bus fulfills the same function that high speed trains accomplish in the more dense urban corridors of the Northeast. Also, with its low cost city center-to-city center service, it provides a reasonable alternative to air travel on trips of 300 miles or less[12]. A specific example of this is the express bus link between Austin and Dallas. Comfortable, with adequate service over high speed networks, the bus offers formidable competition for the inter-city train, or airline service. With the introduction of hostesses, lounges, and refreshments on major urban linkages, it provides comparative comforts. The limited access highway has allowed the bus to eliminate intermediate stops and thus reduce travel time. Some express buses operate non-stop over distances of up to 300 miles in the State. Twenty-eight bus lines provide regularly scheduled inter-city bus transportation in Texas. The major routes traveled are indicated on Figure 2-5. The two largest carriers, Greyhound and Continental Trailways, serve approximately 20 major population centers. The smaller but equally important bus companies serve predominantly rural areas and small towns.

The quality of the State's bus network is intimately linked to its roads and Interstate Highway System. The main advantage of the bus is its flexibility and ability to adapt to changing patterns of population distribution. While continuing to provide service to non-metropolitan areas in the State, marked increases in express city to city service have occurred.

TIME AND COST COMPARISONS. Two often cited variables used in considering mode attractiveness have been time and cost factors. Table 2-6 shows a comparison of travel times by the most direct route possible for each mode. Travel time is not significantly different for the train or bus. Air travel takes on added importance for those who need to reach their destinations quickly. The automobile is only slightly faster than the bus, but it provides a convenient form of mobility once the traveler reaches his destination. It should also be noted that travel time for bus, train and air do not include door to door times since the area that

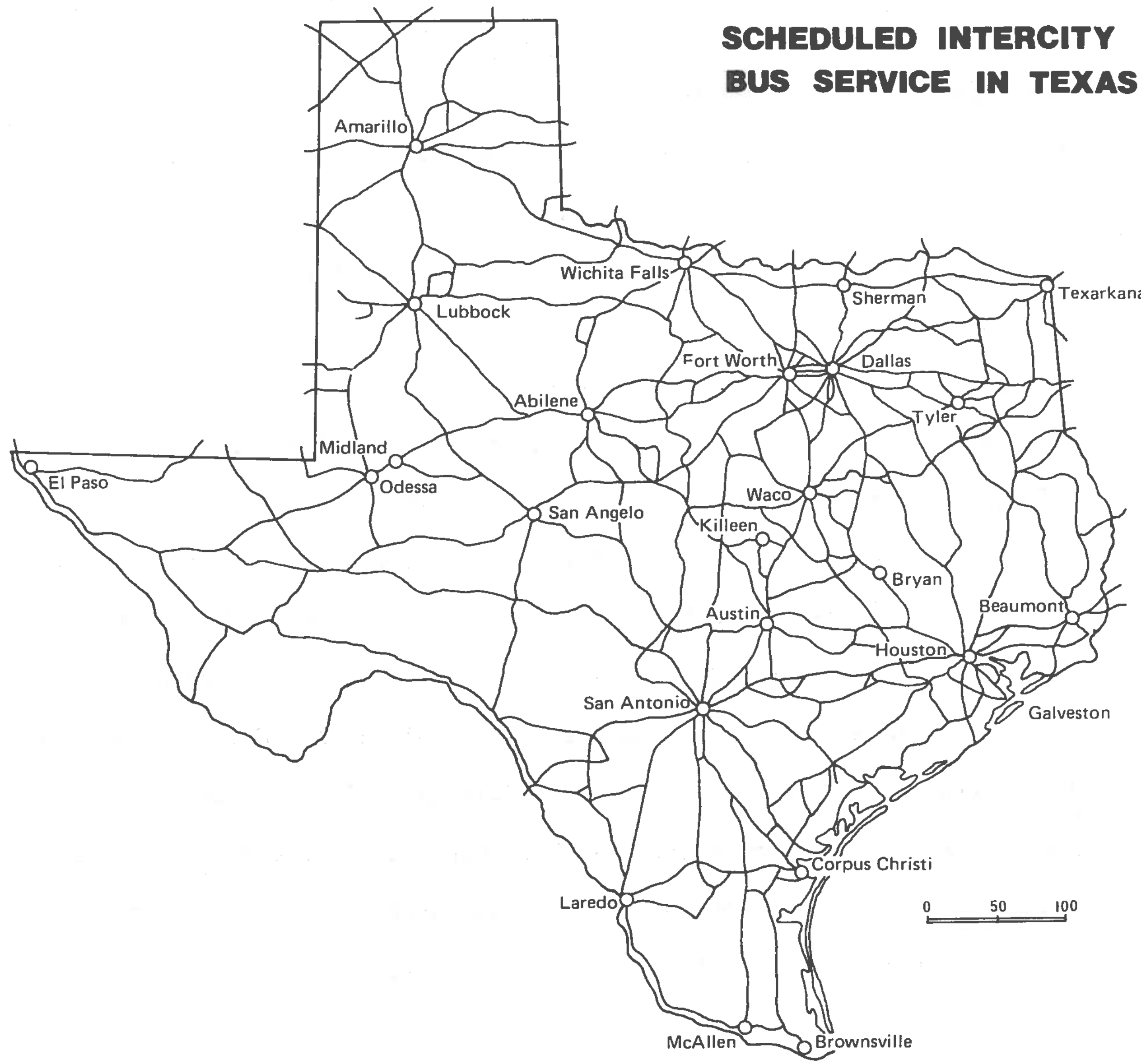
Table 2-6
Travel Time Between Texas' Major Metropolitan Centers

	Travel Times (In Hours)			
	Air	Train	Bus	Auto*
Dallas - Houston	1 1/4	6 1/2	6	4 1/2 - 5
Houston - San Antonio	1 1/2	4 1/2	4 - 5	3 1/2 - 4
Austin - Dallas	1	6 1/2	4 1/2 - 5	4
Dallas - Amarillo	1	NS	13	7 - 7 1/2
Austin - Corpus Christi	NA	NS	5 1/2	3 - 5 - 4

*Assuming 50 MPH Speed.

Source: Compiled by Authors. June 1974.

Figure 2-5: Interstate Bus Service in Texas



Source: Compiled from The Official National Bus Guide and Russell's Official National Motor Coach Guide.

is served by a single mass transportation station e.g. an airport or an Amtrak station, varies so greatly in Texas. Some people have to travel considerable distances to reach air or rail facilities which are often unavailable in their localities. The time range can vary by as much as five hours; thus, actual travelling times are deceiving when transit terminals are not readily accessible to residence or employment.

An attempt was made to compare the cost per passenger mile for railroads, inter-city bus, and air travel between specific destinations. Among mass transportation alternatives, the intercity bus is the most efficient system in terms of cost and the railroad is the least efficient Thus, aside from its other advantages, the intercity bus is capable of providing the least cost per passenger mile of service (Table 2-7). However, this comparison is complicated by perceived differences in the viewing of travel cost. For example, many individuals only perceive the direct travelling costs incurred while driving their cars and do not consider other less direct costs such as depreciation, repair, maintenance, insurance and of course the original purchase price of the automobile. Table 2-7 shows the various cost differences of travel between selected destinations.

Table 2-7
Estimated Travel Cost Between Major Metropolitan Centers

Destination	Air	Train	Bus	Auto*
Dallas - Houston	31.00	14.00	11.00	28.92
Houston - San Antonio	29.00	14.00	9.50	23.88
Austin - Dallas	28.00	12.00	9.00	24.24
Dallas - Amarillo	39.00	NS	18.00	43.56
Austin - Corpus Christi	NA	NS	11.00	23.28

*At 0.12¢ per mile.

Source: Compiled by Authors. June 1974.

Summary

Intercity travel by bus has a healthy future for Austinites. With Amtrak struggling towards a rebirth, air travel becoming increasingly expensive and autos troubled by diminishing fuel supplies and rising fuel costs, buses can capture much of the public passenger travel market between urban areas separated by distances of up to 300 miles. As buses shed their image of being a slow and socially inferior mode, they will become increasingly important to the passenger travel market.

Rail Passenger Travel Patterns

RAIL SERVICE. In the 1960's Texas railroads virtually eliminated passenger service. By 1969 only four passenger trains were in operation on major railroads in the State and attempts were made to discontinue two of these[13]. On May 31, 1969, Dallas became the largest city in the United States, where it was impossible to catch a passenger train[14]. By the time AMTRAK was initiated in May of 1970, passenger service through the Panhandle had been eliminated, as was the route between Laredo and Saint Louis.

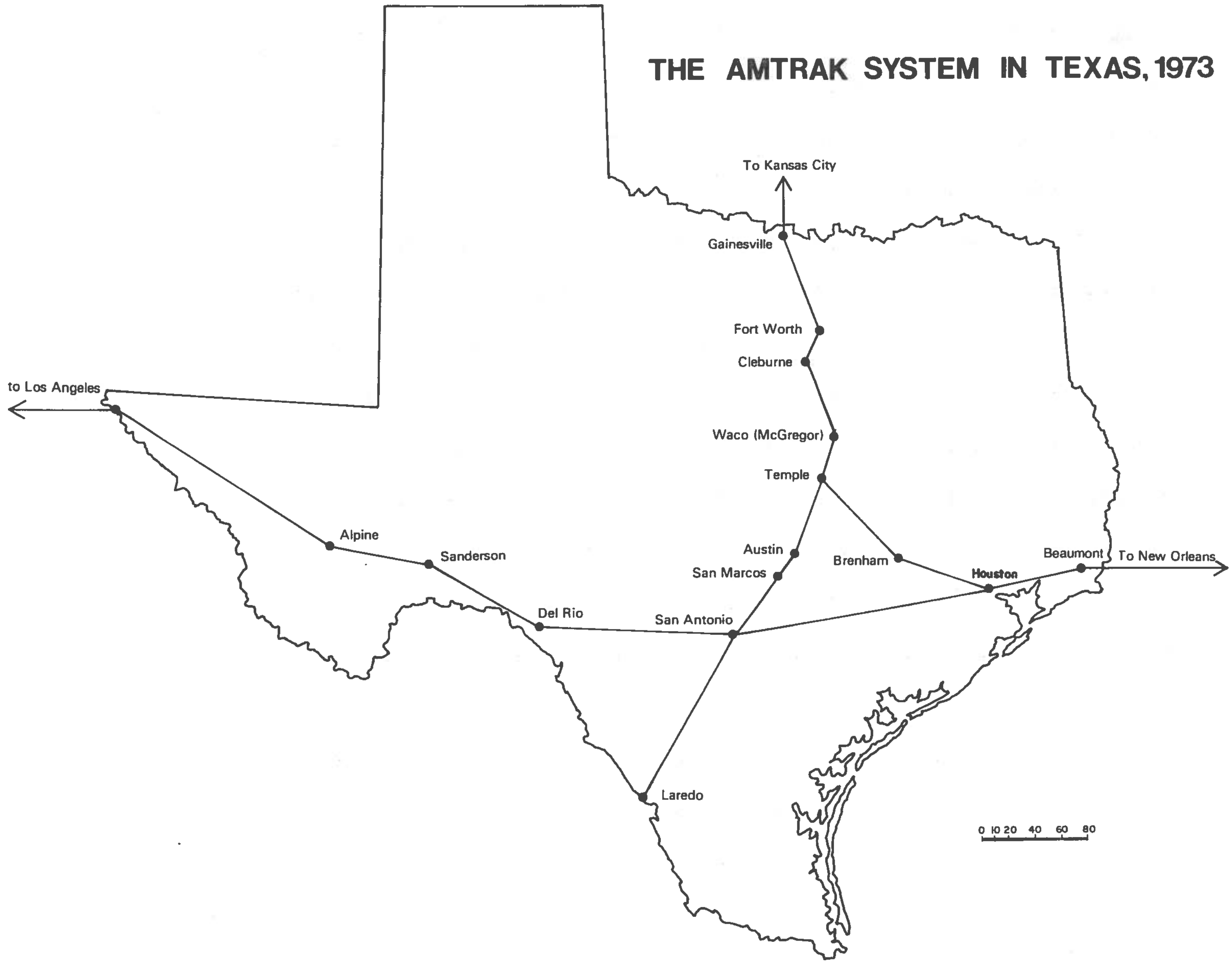
In the 1970's rail passenger usage may increase in Texas, expecially between large urban areas separated by short to medium distances, such as between Dallas-Houston-Austin-San Antonio. Passengers could be attracted from existing modes--airlines, bus service and to some extent, autos by fast, comfortable city-center to city-center service. However, if high-speed intercity passenger service is to be initiated, alternate routes must be provided for freight.

Altogether AMTRAK services 16 cities in Texas[15]. The state is presently served by two North-South trains: The Inter-American, running between St. Louis, Little Rock, Texarkana, Longview, Dallas/Ft. Worth, Austin, San Antonio and Laredo, and the Lone Star, between Chicago and Houston. One East-West line-the Sunset Limited-originating in New Orleans and destined for Los Angeles, passes through Houston, San Antonio and El Paso. Currently, San Antonio is the most accessible city on the rail network with Temple ranked second (Figure 2-6). Plans are presently in abeyance to connect Dallas to Fort Worth and Houston.

The volume of passenger traffic by rail between cities in Texas is difficult to ascertain as passengers disembark and board the train at various points along the scheduled route. The volume of passenger traffic has decreased since the peak years of the 30's. However, since the initiation of AMTRAK in 1971 usage has shown a steady, if not startling increase.

Given the limited railroad network in the State of Texas and the

Figure 2-6: Amtrak System in Texas



Source: Authors.

numerous difficulties which beset passenger trains, it is not surprising that only one percent of intercity travel in Texas is by train. A cursory examination of tickets purchased at the Austin Amtrak station reveals that families that travel by train generally do so for vacations. Many individuals take short trips by train simply to give their children the experience. The elderly and the young are the most frequent users.

The decision to take the train rather than the bus from Austin is not to minimize travel time over short distances. An examination of the travel times between Austin and principal Texas cities reveals that trains are considerably slower than buses and cost more. Trains under their present operating structure in Texas are not attractive to businessmen. Only 10 percent of the total passenger train traffic in Texas is attributable to business trips[16].

AMTRAK[17]. Amtrak's interconnections are beset with inconsistencies--some unavoidable. From Austin to Denver one has to go to Chicago and then due West. The trip from Austin to the West Coast requires a few hours layover in San Antonio. However, the layovers from Austin can be avoided by taking alternative transportation to Temple or San Antonio. The present demand for passenger service in Texas is generated largely by public curiosity and railroad buffs. Unless drastic and unforeseen changes occur, it is doubtful that a large share of the intercity passenger travel will be attracted to the railroads, although the Metroliner between Washington D.C. and Boston and the San Diego-Los Angeles service are attracting passengers.

Summary

Passenger volume is limited by the unavailability of adequate coach cars. Improvements in train scheduling, connections and expansion of the rail network between Houston and Austin, and Fort Worth and Denver would help. The use of the Missouri-Kansas-Texas tracks between Austin, or Austin direct to Dallas, and Fort Worth, would obviate the need for passing through Milano and shorten the trip between the two cities. Alternatively, the Austin-Fort Worth run could be superseded by the institution of a train which would connect with the Temple-Fort Worth run. A fast, efficient train service, similar to that provided by the Washington, D.C. to Boston Metroliner, for San Antonio, Austin, Dallas and Houston might be possible if (with major structural changes) railroad tracks were incorporated within the center median of connecting interstate highways. This is certainly not impossible,--but it would be extremely expensive. Nearly all underpasses would have to be modified to attain legally required vertical clearances and to eliminate the center median supports. A recently completed study on the Dallas-Ft. Worth-San Antonio-Houston triangle for potential rail travel is pessimistic about the success of such a system.

Conclusion

Austin is one of the five major urban areas along with Dallas, Fort Worth, Houston and San Antonio which is well served by bus, air, rail and highway linkages. It is one of the States most accessible cities and has effective links with the resources of its region. This accessibility is an asset to Austin's economic base as witnessed by the city's attraction to secondary and tertiary activities[18].

References

1. Texas Airport System Plan-Preliminary Draft, Part A. Texas Transportation Institute, Texas A&M University, College Station, Texas Chapter IV, p. 6-9. Air carrier service in Texas is handled by trunk airlines providing interstate service; local service airlines (certified by the Civil Aeronautics Board-CAB) provide intrastate service; and commuter airlines (certified by Texas Aeronautics Commission) provide short haul service. The seven trunk airlines which presently serve Texas include American, Braniff, International, Continental, Central, Delta, Eastern and Texas International. Official Airlines Guide, North American Edition (June 1, 1973). Reuben H. Donnelley Publication.

2. Income Distribution of the Populace. The average income per airline passenger in Texas is $13,732.11. Of the air passengers in Texas, some 73.6 percent have incomes of $10,000 or more; 16.6 percent between $6,000-$9,999, and 10 percent under $5,999. Of the 31 Texas airports with certified CAB service, only six of them--Laredo, Del Rio, Harlingen, Brownsville, McAllen, and Beaumont - are located in counties with average median incomes below $6,000.

3. Ibid., Chapter IV, p. 7.

4. Direct Connectivity

The network can be abstracted as a graph and the direct connections recorded in a connectivity matrix where the rows indicate city origins and the columns indicate destinations. A value of 1 or 0 indicates the presence or absence of a direct route. The number of direct linkages from a designated city to all other cities in the network is found by summing all the rows. Finally, by ranking the cities in terms of their direct connections, a hierarchy is established.

Indirect Connectivity

The connectivity matrix is inadequate as a measure of accessibility between nodes involving indirect connections and in discriminating between centers with identical rankings. However, by multiplying the direct connectivity matrix C by itself, a matrix is obtained which records both direct and indirect connections. The multiplication of Matrix C is terminated upon obtaining matrix C^n, where n equals the diameter, that is, the minimum number of linkages necessary to connect the two most distant points in the network. For example, in the analysis of accessibility by airlines, C^n is equal to C^2; and by highways, C^n, is equal to C^3.

The accessibility matrix T is found by summing the direct and indirect connectivity matrices. (ie. $C + C^n$) The problem with the accessibility matrix T is that it gives equal weight to direct and indirect linkages. To decrease the relative importance of indirect linkages, one can weigh the matrix by scalar multiplication. The scalar has a value between 0 and 1 and is used to weigh direct connections; to weigh a two path connection, s^2 is used; and to weigh a three path connection, s^3 is used, and so forth. This introduces a distance decay relationship into the analysis with higher powered matrices having diminishing importance in determining nodal accessibility. The gamma index, which measures the networks connectivity, is the ratio of the number of links in the network to the maximum possible in the network and has a numerical range from 0 to 1.

5. The Texas Aeronautical Commission Bulletin, November-December, 1973.

6. "Preliminary Projections of the Population of States: 1975 to 1990", Current Population Reports, Series P025, No. 477, March, 1972, U.S. Bureau of the Census, Washington, D.C. Poston, D.L. and Bradshaw, B.S., "Population Projections for Texas Counties: 1975-1990", Population Research Center, The University of Texas at Austin, Austin, Texas, May, 1972.

7. Texas Airport System Plan. Texas Transportation Institute, Texas A&M University, College Station, Texas, 1973.

8. Traffic Map, State of Texas, 1964, 1968, 1972; prepared by the Texas Highway Department in cooperation with the Department of Commerce and Bureau of Public Roads Survey.

9. A.H. Belo Corporation, Copyright 1971, p. 350 Texas Almanac (1972-1973).

10. "IH Tie Up Proposed," Texas Highways, Vol. 16, No. 2; and Charles Zlatkovich, "The Interstate Highway System," Texas Business Review, January, 1970, Vol. 44, No. 1.

11. Charles P. Zlatkovich, "Intercity Bus Transportation in Texas," Texas Business Review, Vol. 45, No. 5, The University of Texas at Austin, (May, 1972), pp. 96-102; and Motor Bus Operating Report and Common Carrier Operating Report, Railroad Commission of Texas, Motor Transportation Division.

12. Ibid., Zlatkovich, Texas Business Review, Vol. 45, No. 5

13. Zlatkovich, Charles P., "Texas in the Seventies: 2 Transportation," Texas Business Review, The University of Texas at Austin, Vol. CLIV, No. 4, (April, 1970).

14. Everett De Golyer, Jr., Texas Railroads: The End of an Era, Dallas, Texas (1970), De Golyer Foundation.

15. The objective of Amtrak is to revitalize intercity rail passenger service in the United States as part of a balanced national transportation system. To achieve this goal it has instituted a limited railroad network which is free of duplicate services and uneconomical routes. Few Amtrak trains operate at the breakeven point. Routes are selected on the basis of market size, that is, the population along the rail corridor, physical characteristics of the route and track, and the current demand for passenger service over a particular route as measured in terms of passenger miles per year, passenger miles per train mile and number of trains per week. Other important factors in the selection of routes include mail revenue, current operating costs, adequacy of other travel modes, and service considerations including scenery. U.S. Department of Transportation, Status of Intercity Railroad Passenger Service. Report on the state of rail passenger service and the effectiveness of Rail Passenger Service Act of 1970.

16. Richard Rue, System Energy and Future Transportation Technology Review, January 1972, p. 34-35.

17. Interviews with Mr. John Imburgin, Manager of Amtrak Station, Austin, Texas Summer 1973.

18. The support of the Department of Transportation contract number DOT-OS-30093, administered through the Council for Advanced Transportation Studies, University of Texas at Austin is gratefully acknowledged. See expecially Passenger Travel Patterns and Mode Selection in Texas: An Evaluation by Shane Davies, Mark Alpert, Harry Wolfe and Rebecca Gonzalez. Research Memo #5 October, 1973, Council for Advanced Transportation Studies, The University of Texas at Austin.

Transportation Facilities

Chapter 3

Street System

The City of Austin is generally oriented along a north-south axis between IH-35 and the Mo-Pac freeway. However, despite improvements made by the State, county, city, and property owners, the city's crosstown circulation continues to be a problem. Anderson Lane and Research Boulevard are being constructed to their planned improvement width. Limited capacity on Koenig Lane and Rundberg Lane result in congestion on the streets during peak hours. Traffic is even more constrained closer to the city center. North Loop, 45th, 38th, 29th, 24th, 19th, and 15th streets have numerous traffic signals, and are inadequate for handling peak traffic demand. The other existing major crosstown streets are South of Town Lake and include Riverside Drive, Oltorf Street, Ben White Boulevard and Stassney Lane.

The north-south flow of traffic is also limited. Lamar Boulevard, IH 35, Airport Boulevard, and Ed Bluestein Boulevard are the only existing streets that provide continuous routes for long crosstown trips. MoPac Freeway which will be open in June, 1975, will also carry long, continuous north-south trips as will Loop 360 some 2 1/2 miles farther to the West. Other arterial streets such as Guadalupe, Red River, Jefferson, and South 1st Street provide north-south travel, but because of numerous stops, their capacity potential is not realized. Some 61 percent of travel in the city takes place on about 98 miles of principal arterial streets, or 11 percent of the total street system.

In order to evaluate Austin's street usage and capacity, a comparison with standards proposed in the National Highway Functional Classification Study Manual (NHFCSM) was made (Table 3-1). Austin compares favorably with national standards. For example, on an average, arterial streets are about 5 to 10 percent of the total street system; Austin had 98 miles, or 10 percent of arterial streets in 1969. However, since these national averages take into account major U.S. metropolitan areas, what may be considered congestion in Austin may not be considered as such in Atlanta.

During the last fifteen years, the city significantly expanded its program of street paving to minimize the problems of unpaved streets. Nearly 85 percent of Austin's streets are paved today as compared with 55 percent in 1960.

The 1962 Austin Urban Transportation Study adopted by the City Council and the State Highway Department, resulted in a plan for expressways and major arterial streets to meet the needs of the city by 1982. Over 50 miles of expressways and 350 miles of arterial and collector

Table 3-1
Division of Austin's Street Mileage

Classification of Streets	City of Austin Miles	%	NHFCSM Miles	%
Principal Arterial Streets	98	10	46 - 93	5 - 10
Principal and Minor Arterial Streets	182	18	137 - 278	15 - 25
Collector Streets	102	10	46 - 93	5 - 10
Local Streets	629	62	593 - 730	65 - 80
Total	1,011	100		

Source: City of Austin, Department of Urban Transportation; District 14, Texas Highway Department; Transportation Study Office, 1969.

Table 3-2
Austin's Street Usage - 1969

Type	Mileage	Average Daily Traffic	Vehicle Miles Per Day
Interstate	16	47,181	747,821
Expressways	18	15,488	285,125
Major Arterial	64	15,162	973,695
Minor Arterial	84	7,758	652,687
Collector	102	2,941	300,477
Local	629	500	314,500
Total	913		3,274,305

Source: Present Use of Streets--1969, City of Austin, Department of Urban Transportation and District 14, Texas Highway Department, Transportation Study Office.

streets were recommended. A total of 121 miles have been constructed or reclassified during the previous ten years for an existing total of 200 arterial street miles; thus, the 1982 plan for arterial streets is about 57 percent complete as of this date. Under the Street Improvements Program of the Capital Improvements Program for 1974-1979, a total of $13,255,000 has been set aside for Right-of-Way Acquisition, $14,633,000 for paving and widening, and $1,726,000 for bridges and culverts.

TRAFFIC VOLUME. With over 1,015 miles of expressway, arterial, collector and residential streets in the City of Austin in 1974, the traffic volume range is considerable. Usage rates vary from an estimated 80 vehicles average daily traffic (ADT) on a local street, to over 95,000 vehicles ADT at the 15th street intersection of Interstate Highway 35 (IH 35). Between Riverside Drive and Airport Boulevard, on IH 35, the 60,000 ADT volume is higher than any other segment of the system. This central section, of course, includes the area of the city with the highest daytime concentration of population and employment. Table 3-2 presents an approximate summary, by types, of street usage within Austin.

About 93 percent of the daily trips made by Austin citizens, are made by automobile, reflecting only a slight decrease since the 1962 origin-destination survey. New residential, commercial, and industrial growth, not just within the city but also on the urban fringe, has produced an increased volume of traffic on many of Austin's streets and some shifting of travel patterns while the city bus system and the U.T. Shuttle bus system have had some effect on the changing travel patterns.

Traffic volume inventory comparisons for 1968 and 1972 reflect an average traffic volume increase of 17 percent at locations throughout the city. The largest 24-hour average daily traffic volume-35,530-on a nonaccess controlled facility is on U.S. 183 west of IH 35. In 1968, the largest similar volume was on Lamar at 24th street with 25,285 vehicles. Other streets which reflect considerable increase are shown in Table 3-3. The weekday daily variations of vehicular movements in the CBD, shown in Table 3-4, were determined from traffic counts made at eight control stations. The study revealed a weekday volume variation from five points below the average on Tuesday, to six points above the average on Thursday. This 11 point range may be accounted for in terms of shopping trips and the business hours of commercial establishments in the area. The Central Business District is located in the area north of the Colorado River to 11th Street and between IH-35 on the East and Lamar Boulevard on the West. More than 243,000 vehicles cross the CBD

Table 3-3
Average Daily Traffic Volume Comparison for Austin Arterial Streets 1968 and 1972

Street	1968	1972	% of Increase
Anderson Lane West of Burnet Road	3,118	12,590	303
Ben White Blvd. East of Lamar Blvd.	8,676	18,550	114
Cameron Road north of St. Johns	1,249	6,010	381
Lamar Blvd. south of Oltorf Street	10,656	24,890	134
Live Oak east of Congress Avenue	1,652	3,930	138
Manor Road southwest of North East Dr.	1,991	4,760	139
Montopolis Dr. north of Riverside Dr.	1,442	4,320	200
Oltorf east of Congress Avenue	6,118	15,390	152
U.S. 183 east of IH 35	8,093	16,480	104
11th St. west of Guadalupe	2,568	5,860	128
15th St. east of Nueces	8,830	18,350	108
26th St. east of Speedway	4,593	11,840	158
34th St. west of Lamar Blvd.	2,193	7,480	135

Source: City of Austin, Department of Urban Transportation, 1972.

Table 3-4
Daily Variation for Austin CBD Weekday Vehicular Movements, 1969

Day of Week	Total Movements	% ± from Average
Monday	241,983	-0.5
Tuesday	231,039	-5.0
Wednesday	235,903	-3.0
Thursday	257,791	+6.0
Friday	249,279	+2.5
Average	243,199	- 0

Source: 1969 Cordon Study of the CBD in Austin, Texas. City of Austin--DUT September 1970.

Table 3-5
Traffic Service Deficiency

Street Name	Ratio
Anderson Lane West of Burnet Road	1.2
Ben White Boulevard East of Lamar Boulevard	0.56
Cameron Road North of St. Johns	0.24
Live Oak East of Congress Avenue	0.37
Manor Road Southwest of North East Drive	0.32
Montopolis Drive North of Riverside Drive	0.25
Oltorf East of Congress Avenue	0.90
U.S. 183 East of IH 35	0.41
11th Street West of Guadalupe	0.45
15th Street East of Nueces	1.07
26th Street East of Speedway	0.35
34th Street West of Lamar Boulevard	0.57
IH 35 Between Airport Boulevard and U.S. 290	1.20

Source: City of Austin, Department of Planning, 1975.

Cordon line during an average weekday, and approximately 82 percent of all vehicular movements in the CBD occur between 7:00 am and 7:00 pm. Of the total vehicular movements around the CBD Cordon area 19 percent are in the north, 16 percent in the south, 36 percent in the east, and 29 percent in the west.

VOLUME VS. CAPACITY. When traffic volume exceeds highway capacity, operating conditions are very poor with low speeds, frequent stops and long delays. For a highway to provide an acceptable level of service to the road user, service volume must be lower than roadway capacity. Among the factors considered in evaluating level of service are travel speed and time, traffic restrictions, freedom to maneuver, safety, driving comfort and convenience, and economy. Although all these factors should be incorporated in a level-of-service evaluation, it was not within the scope of this report to determine the irrelative weights.

A comparison of traffic flow and practical capacity of major streets and highways is shown in the Traffic Service Deficiency Table 3-5. A ratio of 1.0 or above indicates that the roadway is operating at or above desirable capacity level. Calculations based on Typical Roadway Practical capacities Table 3-6 as defined by the Highway Research Board, have been made for the section of IH-35 between Airport Boulevard and

U.S. 290. This segment of IH-35 is over-loaded at peak-travel hours, and is inefficient in terms of handling traffic volume. It requires expansion or congestion release through traffic diversion. Removal of curb parking is an effective means of increasing arterial, collector and local street capacity. Reduced parking interference and extra pavement space can increase street capacity by 80 to 100 percent.

There are two methods according to 'An Informational Report on Speed Zoning', for determining the prevailing vehicular speed-the 10 mph Pace method and the 85 percentile Speed method. The City of Austin utilizes both of these methods to determine speed limits. One of the purposes of speed zoning is to determine and post a realistic speed limit. Any speeds above the posted speed limit are normally unsafe and create traffic safety hazards.

Since most city streets were originally constructed for low volume vehicular traffic, some local streets are now serving as collectors and some collectors as arterials as increasing traffic demands get progressively more difficult to handle. In some cases, satisfactory street widening could be accomplished only at high economic and environmental costs.

Table 3-6
Typical Roadway Practical Capacities

Type of Route	24 Hour Two-Direction Volume
8 - lane freeway	100,000 - 120,000
6 - lane freeway	75,000 - 90,000
4 - lane freeway	50,000 - 60,000
6 - lane expressway	45,000 - 55,000
4 - lane expressway	30,000 - 40,000
6 - lane arterial	25,000 - 30,000
6 - lane divided arterial	28,000 - 33,000
4 - lane arterial	18,000 - 22,000
4 - lane divided arterial	20,000 - 25,000
4 - lane major business street	13,000 - 17,000
3 - lane one-way arterial	17,000 - 23,000
2 - lane one-way arterial	12,000 - 17,000
2 - lane arterial	9,000 - 13,000
4 - lane rural road	11,000 - 16,000
2 - lane rural road	5,000 - 7,000

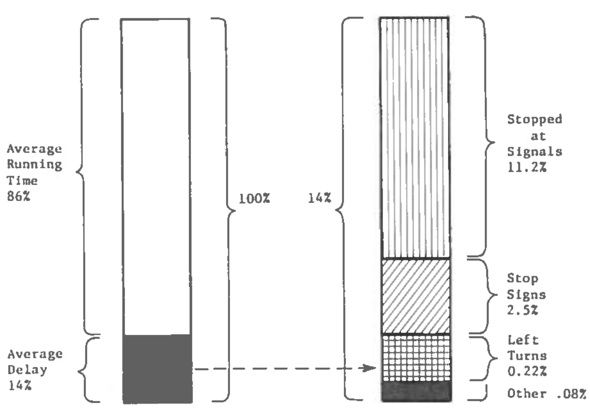
Source: Highway Capacity Manual, Highway Research Board, 1965.

Table 3-7
Desirable Average Operating Speeds In Urban Areas - M.P.H.

Type of Route	Peak Traffic Period	Off-Peak Traffic Period
Freeways and Expressways	35	50
Arterials	25	35
Collectors	20	25
Major Local Streets	10	20

Source: Highway Capacity Manual-1965. Highway Research Board, Special Report 87, National Academy of Sciences, National Research Council Publication 1328.

Figure 3-1: Breakdown of Peak-Hour Travel Time Within Austin



Source: City of Austin, Department of Planning, 1974.

QUALITY OF TRAFFIC FLOW. The traffic service quality of existing street and highway facilities in terms of vehicle travel speeds, accident frequency, and volume and theoretical street capacities have been examined as have peak and off-peak normal weekday traffic flows for 1970, and 1973 on major streets and highways in the Austin SMSA.

The Federal Highway Administration suggests that an urban arterial street system should accomodate overall average speeds of around 35 miles per hour in off-peak and 25 miles per hour in peak periods (Table 3-7).

Figure 3-1 indicates that about 14.5 percent of the overall travel time on major routes in the Austin area is spent in traffic delays where the vehicle is actually stopped. Figure 3-1 also shows that most of the delays are caused at intersections; mid-block delays actually accounted for less than two percent of all delays. An Austinite making a peak time intra-city trip spends about 86 percent of the time moving at normal speed, and the remainder at signals, stop signs and left-turn intersections.

TRAFFIC CONTROL AND REGULATIONS. Many traffic control measures have been applied in the Austin metropolitan area to improve efficiency from existing street facilities. These include 310 traffic control signals and about 4,000 stop and yield signs. About 70 percent of the signalized intersections are located on major thoroughfares and collector streets. Of these, 187 are interconnected to provide progressive movement along certain thoroughfares. The large number of installations where yield signs have materially reduced vehicular collisions illustrates the effectiveness of this type of control. A total of 137 pedestrian activated signals have also been installed, mainly around the University of Texas and in the Downtown area. Funds for traffic signalization programs are derived from Electric Utility current revenues. This part of the CIP is administered by the Department of Urban Transportation and a total of $1,902,000 has been proposed for traffic signalization for the 1974-1979 period.

Between 1960 and 1970 there has been a significant increase in the number of public and private parking spaces in the downtown area. Off-street parking spaces have increased from approximately 10,000 in 1962 to 13,169 in 1972, most of which are privately operated. On-street spaces increased from 1,875 to 2,000 during the same period, and time limit spaces designated by signs which were non-existent in 1960, numbered 686 by 1970. New building programs by major banks, the county, and state agencies have recognized the need

Table 3-8
Austin Intersections with Higher Number of Accidents in 1972

Rank	Intersection	Number of Collisions	Average Daily Traffic
1	Ohlen Rd./Research Blvd.	47	26,440
2	East 19th/East Frontage Rd.	43	21,030
3	West 19th/Guadalupe	38	54,590
4	Ben White Blvd./Manchaca Rd.	37	40,400
5	Ben White Blvd./South 1st	34	43,510
5	North Lamar/Koenig Lane	34	37,200
6	Lamar/West 38th	32	45,690
6	Airport Blvd./Oak Springs Dr.	32	26,680
7	Burnet Dr./North Loop	31	28,970

Source: City of Austin, Departments of Police and Urban Transportation, 1973.

for parking and are providing garage-type facilities to meet the demand.

ACCIDENTS. Over the past ten years, increasing vehicular traffic has resulted in a 23 percent increase in accidents per capita. In 1964, Austin's population was 210,000. There were 9,554 accidents reported or 45.49 accidents/1,000 population. In 1974, Austin's population was 296,000 with 16,588 accidents or 56.04 accidents/1,000 population. Fatalities have risen from 13 in 1962 to 39 in 1972. Street intersections continue to be the location of a high percentage of vehicle accidents, but of the 52 intersections with the highest number of accidents in 1962, only 16 reappear on the 1972 list. Ben White Boulevard at Manchaca Road and also at South 1st Street were not significant problems in 1962, but today they are the fourth and fifth highest ranked intersections in number of accidents. This change in status of higher accident prone intersections is primarily due to increasing urban development in different areas of the city in 1972 as compared to development areas in 1962. Table 3-8 lists the intersections with the highest number of accidents in 1972. Table 3-9 shows accidents in Austin in 1972, broken down by day of week. A further study showed that accidents in Austin, in order of frequency were: 1) rear end, 2) side swipe, 3) right angle, 4) parked vehicle, 5) left turn, 6) existing alley or driveway, 7) collision with fixed object, 8) run off road, and 9) head on. And the most frequent causes were 1) imprudent speed, 2) improper lane change, 3) failure to yield right-of-way, 4) disregard for stop signs, 5) other human error, 6) improper backing, 7) disregard for traffic signal, and 8) following too closely.

Comparing Austin's total traffic accident data with four other major cities in Texas, we find that Austin had the second highest percent increase in fatal accidents between 1962 and 1972. Fort Worth had the highest and San Antonio the lowest percent increase. Table 3-10

Table 3-10
Traffic Accident Data on Major Cities in Texas

City	Fatal Accidents	Fatal-ities	Total Accidents	% of Total Fatal Accidents	Fatal Accidents	Fatal-ities	Total Accidents	% of Total Fatal Accidents	% Increase In Fatal Accidents 1962-1972
Austin	13	13	N/A	5	33	39	17,509	6	154
Dallas	61	63	N/A	22	126	135	43,898	24	107
Fort Worth	29	31	N/A	11	77	86	20,191	15	166
Houston	107	117	N/A	39	189	202	63,586	37	77
San Antonio	64	70	N/A	23	91	93	28,419	18	42
Total	274	294	---	100	516	555	173,603	100	---

Source: State of Texas, Governor's Committee on Traffic Safety, Austin, Texas, July 1, 1974.

Table 3-9
Motor Vehicle Accidents, City of Austin, 1972 Yearly Summary Report

Day of Week	# of Collisions	% of Total Collisions
Sunday	1,477	8.68
Monday	2,292	13.48
Tuesday	2,439	14.34
Wednesday	2,317	13.65
Thursday	2,563	15.08
Friday	3,222	18.95
Saturday	2,690	15.82
Total	17,000	100.00

Source: City of Austin, Department of Urban Transportation, 1973.

Table 3-11
Austin Taxicab Company Revenues ('000 of $) October 1 -- September 30

Company	1966-67	1967-68	1968-70	1969-70	1970-71
Airline	5.6	6.9	6.8	5.6	4.9
Checker	209.2	240.9	234.5	215.6	199.9
Harlem	161.5	233.9	273.6	273.9	340.5
Roy's	185.6	197.3	227.4	211.5	232.5
Yellow	325.1	343.4	375.5	368.7	414.5
Deluxe	90.5	61.7	43.9	42.3	No Report
Total	977.5	1,084.1	1,161.7	1,117.6	1,192.3

Source: City of Austin, Department of Urban Transportation, 1973.

shows comparative 1962-1972 traffic accident data from Austin, Dallas, Fort Worth, Houston, and San Antonio.

Taxicabs

Population increase in Austin over the past 10 years has intensified travel demand within the metropolitan area. Various taxicab companies holding franchises within the corporate limits have eased the burden. There are at present, four companies operating in Austin, 1) Airline, 2) Harlem, 3) Roy's and 4) Yellow/Checker. Table 3-11 indicates the amount of revenue taken in by these companies from 1966-67 through 1970-71 in thousands of dollars. The yearly total of revenue passengers for the 1970-71 year indicates that 796,578 people used taxicabs during this period. The companies combined gross receipts amounted to $1.1 million in 1969-70; $1.2 million in 1970-71; and has grown to $1.3 million per annum in 1971-72 from 1,949,585 paid passenger miles.

Public Bus Mass Transit

Public transportation today, as in the past, provides an essential service to the citizens of the City of Austin. It is a general goal of urban and regional transportation planning to provide mobility for all citizens of the metropolitan area. This mobility permits access to shopping areas, health services, recreational facilities, church, and job opportunities. In order to assure that Austin remains a good place to live and work, mass transit systems must be developed to provide this mobility in a manner which will preserve the city's historic, scenic, cultural, and intrinsic natural environment.

Two transit systems currently operate in the City of Austin. The Austin Transit System is owned by the city but operated by the American Transit Corporation under a management agreement with the city, and the University of Texas Shuttle Bus System is operated under contract by Transportation Enterprises, Inc.

AUSTIN TRANSIT CORPORATION. In an effort to improve bus ridership the Austin Transit System implemented a new route network which provides for expanded and more direct service, simplicity in routing, and elimination of duplicated service. A major improvement is the addition of night and Sunday service. The revised program will produce more frequent bus service and a new fare of 30 cents peak time and 15 cents off-peak time. Bus-stop signs and route markers assist transit users, and shelters and benches provide a degree of comfort for transit patrons.

The transit system acquisition and improvement program through

1973 has a total capital cost of over 8.3 million dollars. Presently 5.7 million dollars, 1.9 million local funds and 3.8 million federal funds, have been designated for improvements to the transit system. Ridership has increased 50 percent in the last 21 months. Approximately 1.7 million additional dollars have been designated to implement the entire program. All but one of the programs should qualify for federal support under programs of the Urban Mass Transportation Administration, U.S. Department of Transportation.

Ridership Trends. Until recently Austin experienced decreasing bus usage. Table 3-12 shows that revenue passengers increased from

Table 3-12
Revenue Passenger Trends, Austin Transit Corporation

Year	Revenue Passengers	Average Revenue Passengers	% Change	Austin Population	Per Capita Riding	% Change in Per Capita Riding
1960	6,086,458	507,205	------	186,545	32.6	-----
1962	5,190,809	432,574	-11.68	199,600	26.0	-14.5
1964	4,826,407	402,201	- 2.35	212,600	22.7	- 5.4
1966	4,385,816	365,485	- 4.33	225,700	19.4	- 7.2
1968	4,558,220	379,852	+ 0.85	238,800	19.1	- 2.1
1969	4,454,012	371,168	- 2.29	245,300	17.7	- 7.3
1973	4,422,500	368,542	- 2.63	296,000	14.9	- 2.8
(As of August)						
1974	3,081,645	256,804	-----	-------	10.4	-----

Source: City of Austin, Department of Urban Transportation, 1973.

6,086,458 in 1960 to 5,588,101 in 1974 but per capita ridership declined from 32.6 in 1960 to 14.9 in 1972, while population grew from 186,545 in 1960 to 273,933 as of April 1972. Figure 3-2 shows the system reaching a low in 1972, and then gradually picking up since.

Transit Service. Austin Transit Corporation operates on 19 routes, Figure 3-3, within the city. All routes, except the Crosstown Route are radial and pass the intersection of 6th Street and Congress Avenue in the CBD. Coverage area is defined as any area within 1/4 mile of a transit line.

Table 3-13 shows that for 5,190,809 revenue passengers in 1962, total annual miles operated were 1,870,322, or 2.78 passengers per mile. Comparatively, for 4,422,500 revenue passengers in 1973, total annual miles operated were 2,463,099, or 1.79 passengers per mile.

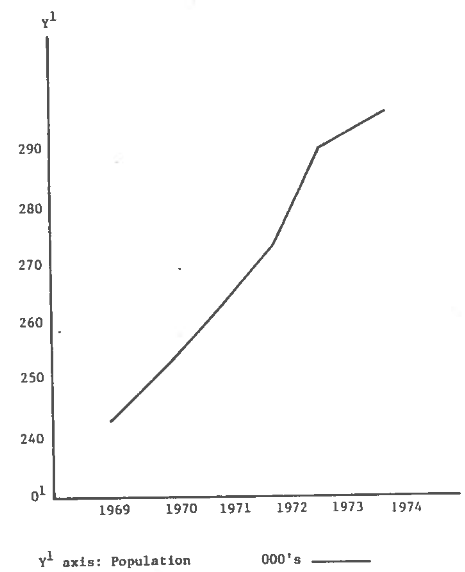
Operating ratios, 0.91 in 1969, were 1.37 passengers per mile in 1973 and estimates show, Table 3-14, that the operating ratio will be 1.27 in 1977. It is also projected that operating revenue of the Austin Transit System in 1977 will be 79 percent of the operating expense.

As far as trip purpose is concerned, travel to and from work accounts for 54 percent of the trips, school trips account for some 18 percent and shopping trips approximate 12 percent of total trips (Table 3-15).

Figure 3-2a: Austin Transit Corporation--Ridership Trends

Source: City of Austin, Department of Urban Transportation, Transportation Services Division, February 1975.

Figure 3-2b: Austin Transit Corporation--Ridership Trends



Source: City of Austin, Department of Urban Transportation, Transportation Services Division, February 1975.

Table 3-13
Transit Service Trends, Austin Transit Corporation

Year	Revenue Passengers	Annual Miles Operated[1]	Passengers Per Mile	Annual Hours of Operation[2]	System Average Speed (mph)
1962	5,190,809	1,870,322	2.78	168,873	11.08
1964	4,826,407	1,843,989	2.62	160,099	11.52
1966	4,385,816	1,656,511	2.65	N/A	
1968	4,558,220	1,668,409	2.73	149,546	11.16
1969	4,454,012	1,658,591	2.69	151,764	10.93
1970	N/A	944,101[3]	N/A	84,377[3]	11.19
1971	N/A	1,033,362[4]	N/A	90,179[4]	11.46

[1]Excludes charter miles but includes school bus miles.
[2]Excludes charter hours but includes school bus hours.
[3]Jan.-July 1970 (7 months), ATC only.
[4]April-December 1971 (9 months), ATC only.

Source: Austin Transit Corporation, 1973.

Figure 3-2c: Austin Transit Corporation--Ridership Trends

Source: City of Austin, Department of Urban Transportation, Transportation Services Division, February 1975.

Table 3-14
Austin Transit Corporation Operating Ratios

Year	Operating Revenues	Operating Expenses	Operating[1] Ratio	Average Operating Speed (mph)
1969	996,186	907,289	0.91	12.2
1970	537,058	578,757	1.07	N/A
1971	580,987[2]	683,722	1.17	N/A
1972	710,937[3]	683,722	0.96	12.8
1973	985,000	1,352,000[4]	1.37	N/A
1974	1,794,000	2,318,000[4]	1.29	N/A
1975	1,887,000	2,504,000[4]	1.33	N/A
1976	2,015,000	2,625,000[4]	1.30	N/A
1977	2,130,000	2,710,000[4]	1.27	N/A

[1]Operating expenses divided by operating revenue.
[2]Excluding payments from City of Austin.
[3]Including payments from City of Austin.
[4]Excludes management fee.

Source: City of Austin, Department of Urban Transportation and Austin Transit Corporation, 1973.

Table 3-15
Transit Trip Purpose Weekdays 1972, Austin Transit System

Trip Purpose	Number	Percent
Work	4,309	54.1
Shopping	978	12.3
School	1,404	17.6
Personal Business	664	8.3
Social/Recreational	77	1.0
Other	530	6.7
Subtotal	7,962	100.0
No Response	54	
Total	8,016	

Source: City of Austin, Department of Urban Transportation, 1972.

The Transit Systems', 1974-1979 CIP budget totals $8.3 million exclusively for this purpose and allows for the expansion of the system to meet the growing transportation needs of the citizens and the increase in ridership caused by improved service, lower fares, and the current shortage of gasoline for private automobiles. An estimated $99,000 will be spent in the five year period of the CIP for bus shelters in the Community Development Districts.

TRANSPORTATION ENTERPRISES, INC. Transportation Enterprises, Inc., (TEI) operates the University of Texas Shuttle Bus System, which is prepaid transit since users are not required to pay each time they board the bus. The cost is paid for by fees from students, on an involuntary basis at registration each semester. Effective November 1, 1971, the Austin City Council authorized dependents of University students, faculty, or staff to purchase shuttle bus passes. The revenue from dependent passes goes to the City of Austin to offset fares lost to the City Transit System.

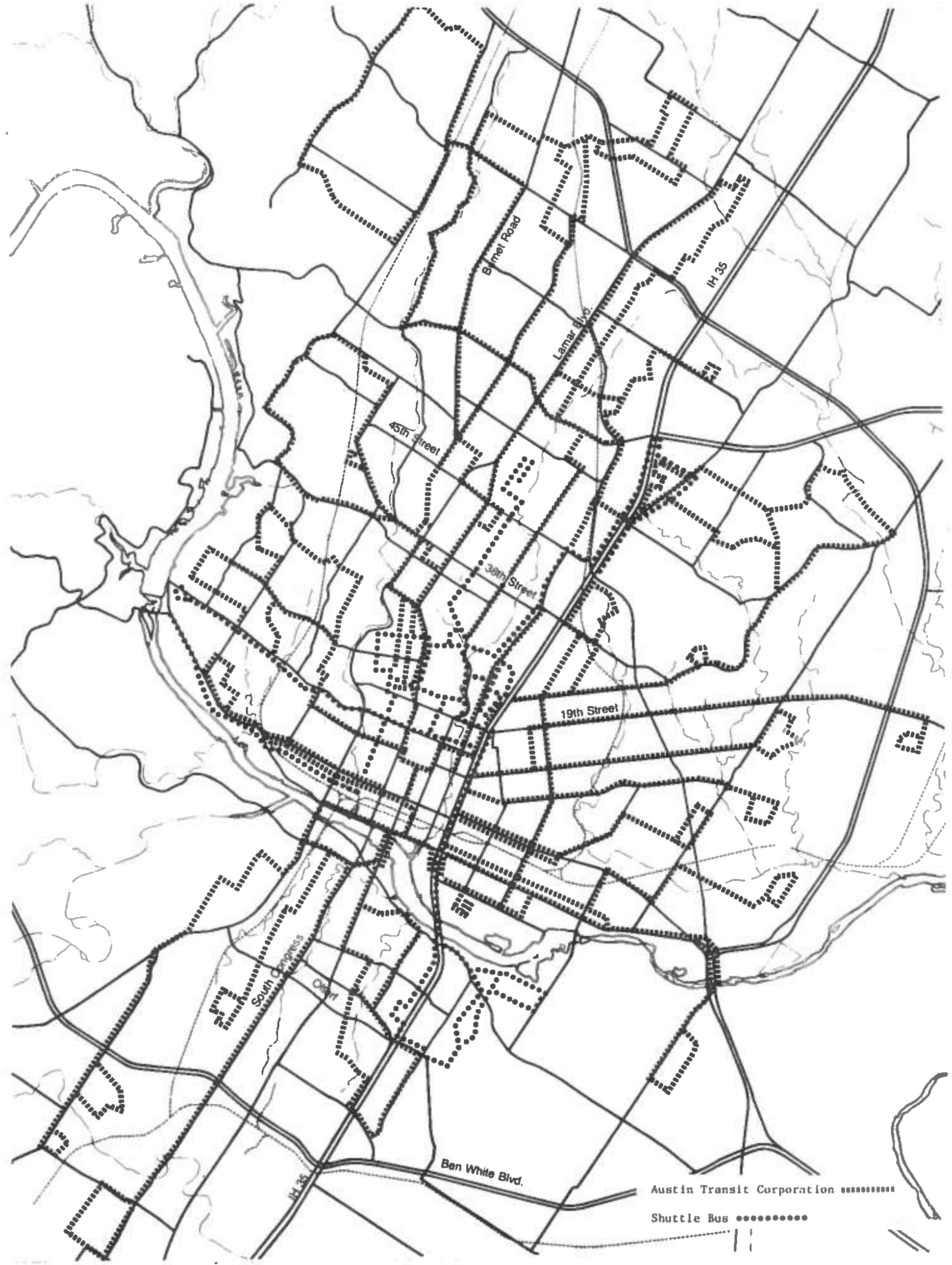
The Shuttle Bus System is not financially supported by the City of Austin, and since TEI is not required to furnish financial records, no current information was available regarding operating expenses incurred by TEI. Table 3-16 lists the trip purposes apropos the U.T.

Table 3-16
Trip Purpose, UT Shuttle Bus System

Trip Purpose	Number	Percent
Work	1,334	5.9
Shopping	388	1.7
School	19,402	86.4
Personal Business	661	3.0
Social/Recreation	458	2.0
Other	231	1.0
Subtotal	22,474	100.0
No Response	25	
Total	22,499	

Source: City of Austin, Department of Urban Transportation, 1972.

Figure 3-3: Austin Transit Corporation and University of Texas Shuttle Bus System Routes



Source: Department of Urban Transportation City of Austin.

Shuttle Bus System. As is expected, the highest percentage, 86.4 percent, is that of school trips, followed by the work trip category, 5.9 percent.

The System operates nine routes in the city, and is only for University students, faculty, staff and their immediate families. Total operational hours per day are 526. Trips during the University workday reaches a peak during the middle of the day. About 36.4 percent of the trips are made in the morning from 6:30 am to 11:00 am; 32.1 percent between 11:00 am and 2:00 pm; 25 percent between 2:00 pm and 6:30 pm; and 6.5 percent between 6:30 pm and 11:30 pm.

Walking was the most popular mode for students, faculty and staff on campus. This was followed by the automobile. Faculty and staff rarely used the Shuttle Bus.

The combined route structure for the two transit systems is shown in Figure 3-3. The central destinations of these routes are separated by a little over a mile. The City Transit System routes converge on the intersection of 6th and Congress Avenue, while the U.T. Shuttle Bus routes converge on the University of Texas campus. However, since no procedure exists to permit transfer between the two transit systems, they operate independently, and the mobility of the riders of each of

Table 3-17
Transit Trips on the Two Systems

System	Transit Trips[1]	Percent
Weekdays		
City Transit System	8,016	26.9
UT Shuttle Bus System	22,499	73.1
Total	30,515	100.0
Saturdays		
City Transit System	6,117	100.0
Total	6,117	100.0

[1]Revenue passengers for the City Transit System and total boarding passengers for the other system.

Source: City of Austin, Department of Urban Transportation, 1972.

Table 3-18
Comparative Unit Operating Costs, Austin Transit Study, 1972

System	Cost/Bus Mile	Cost/Bus Hour	Cost/Passenger
City Transit System[1]	0.62	7.58	0.35
UT Shuttle Bus System[2]	0.55	5.70	0.12

[1]April through December, 1971.
[2]Cost to the University of Texas, Fall Semester, 1971.

Source: City of Austin, Department of Urban Transportation, 1972.

Table 3-19
Central Freight Tonnage, Austin, 1972

Number of Truck Trips Into City	Number of Truck Trips Going Out	Number of Tons Coming In	Number of Tons Going Out	Miles Travelled
12,000	12,000	1,500,000	360,000	600,000

Source: City of Austin, Department of Urban Transportation, 1973.

the systems is limited to the areas covered by their respective system.

Table 3-17 lists the transit trips on the two systems. On weekdays, the U.T. Shuttle Bus System had the higher number of transit trips, while on weekends, the City Transit System was higher because there is not Shuttle Bus System service on those days. Looking at the Comparative Unit Operating Costs (Table 3-18) we find that the City Transit System had the higher cost per bus-mile; one of the reasons being that it provides transit coaches with year-round air-conditioning.

Inter-City Bus and Motor Freight Service

Bus passenger facilities consist of four lines: Continental Trailways, Greyhound, Kerrville, and Arrow, and operate out of two terminals. Continental Trailways maintains its own facility and moves approximately 2,000 tones of freight and 30,000 passengers annually. The other three operate out of the Greyhound Bus Terminal. Greyhound carries 480,000 passengers annually, while Kerrville carries 184,000 and Arrow transports 144,000 passengers annually. As for freight tonnage, these three together transport approximately 12,000 tons annually to Austin (Table 3-19).

The City of Austin is served by twelve motor freight companies which operate both inter-state, and intra-state routes. In 1972, 700 trucks belonging to these 12 companies were driven over seven million miles, from different parts of the U.S., to deliver more than three billion tons of freight in Austin. In addition, approximately 110 of their inter-state trucks were driven over 11 million miles delivering 22 billion tons of freight into neighborhing states. Central Freight Company carries as much tonnage as all other companies located within Austin. Other freight companies in Austin are 1) Brown Express, 2) Curry Express, 3) ETMF System, 4) Lee Way, 5) MoPac Truck Line, 6) Red Arrow, 7) Roadway Express, 8) Southern Pacific, 9) Southwestern, 10) Texas-Film--Texas TexPac, and 11) Yellow Freight.

Railroads

FREIGHT. There are three freight railroad companies currently providing service to Austin. These are the Missouri-Pacific, the Southern-Pacific, and the Missouri-Kansas-Texas. These companies serve Austin from four separate rail lines, all being used for both incoming and outgoing traffic. Total track mileage, as of September, 1972, was approximately 66 miles of which Missouri-Pacific owned 31 miles, Southern-Pacific owned 22 miles, and the Missouri-Kansas-Texas owned 13 miles.

Table 3-20
Railroad Freight Tonnage in Austin - 1972

Company	Inter-City Tonnage	Intra-City Tonnage	Average Cars Per Day	Number of Trains
Southern Pacific	10,000	10,000	150	3
Missouri Pacific	N/A	N/A	840 (110 per avg. train)	8
Missouri Kansas Texas	440	440	8	2

Source: City of Austin, Department of Urban Transportation, 1973.

Freight volumes have increased approximately 25 percent between 1962 and 1972, and a listing of 1972 totals are shown in Table 3-20. Austin in an average week, has 37 scheduled freight trains operating within the city limits. It should be noted here that the Missouri-Kansas-Texas has no separate branch and operates in Austin by a Rights Agreement with other companies.

The Southern-Pacific operates daily, on the Austin Branch, three scheduled trains inbound, and three scheduled trains outbound. Each train carries an average of 65 cars. The Missouri-Kansas-Texas operates on this Southern-Pacific branch, two trains every weekday, one inbound and one outbound. On Saturday, two are outbound, and on Sunday only one inbound train is scheduled. The Southern-Pacific operates one scheduled train inbound and one train outbound daily, except Sunday, on the Llano Branch. It also operates an extra train in each direction on Tuesday and Thursday. The Missouri-Pacific on the South Austin Branch operates 4 trains inbound per day on a flexible schedule. It also operates extras in peak periods and 1 local of undetermined trip length. Each train averages 75 cars. The MKT also operates on this track, two scheduled trains inbound and two outbound per day. Each train averages 100 cars. The Missouri-Pacific operates the Austin

Local on the Bergstrom Spur track. It has no set schedule and runs only when needed. Though only one train, it is considered two trains outbound and inbound, and each averages 10 cars.

AMTRAK. Until recently the rail lines through Austin carried only freight, but with the advent of the Amtrak system rail service has once again become a potentially viable form of passenger travel. Amtrak initiated service through Austin in January, 1973, as a result of the federal government's national program of expansion of rail services. Present scheduling includes north-bound trains to Fort Worth and Chicago and south-bound trains to Laredo, three times per week. Amtrak beginning January 27, 1973 utilizes the Missouri-Pacific rail system on a tri-weekly basis.

RAILROAD CROSSINGS. Although the number of train trips is small, these trains do create some hazards or delays for the average motorist, expecially during morning and evening rush hour traffic periods. Increasing the number of grade separations at major street intersections would facilitate the safe movement of both modes of transportation.

For a relative comparison of at-grade railroad crossings in Austin, two different equations were selected for a priority assignment of improvements. One method involved the use of the State of Oregon

"Accident Prediction" equation while the other method was based on the State of New Hampshire formula. On these bases, an effective railroad crossing protection device program was developed and will be completed in 1976. More detailed information is included in Appendix I.

Air Transportation

Austin is important to trade in the Central Texas area. Of some 12,700 airports in the U.S., only about 500 have scheduled airline service, and Austin's Robert Mueller Municipal Airport is one of these extending over 1,000 acres of land.

Austin Municipal Airport is centrally located approximately 3.5 miles from CBD with good access from IH 35. Private automobile, taxi-cab, rent-a-car, bus and airport limousines are the main access modes.

Besides the Austin Municipal Airport, two other airports are in the Austin vicinity, Tims private Airport and Bergstrom Air Force Base. Both the Municipal and Bergstrom Airports are designed to accomodate instrument approach, departure holding and transition flight maneuvers. Austin is in a radar controlled environment and instrument flight ruled flights out of the Austin Control Zone are monitored by the Houston Center.

Airport operational and maintenance costs are financed by funds from landing fees, office space rentals, parking, hanger space rentals and concessions. Air carriers are charged a landing fee whereas private planes are not. Instead of paying landing fees, private aircraft owners contribute by purchasing aviation fuel from which the airport receives four cents per gallon. New construction or improvements on existing airport facilities, including runways, are financed through municipal bonds; however, federal financial aid up to 50 percent is provided for runway construction.

84 As has been stated earlier, Austin's population is currently estimated at 296,000, and is projected to be approximately 500,000 in 1990. The forecasts of passenger enplanements as included in the 1970 Master Plan Study for the Robert Mueller Municipal Airport, estimated that passenger movements will grow from 536,087 in 1969 to 2,750,000 in 1990. Total annual public and private aircraft movements are expected to grow from 234,000 in 1968 to 458,000 by 1990.

Cargo volume at the Municipal Airport increased by about 450 percent between 1958 and 1968. Tonnage estimates indicate an increase from 3,809 tons in 1968 to about 84,000 tons in 1990. Similarly, passenger boardings per flight are expected to increase from 15.8 in 1969 to

Table 3-21
Austin Bicycle Facilities 1962 and 1972

Type of Facility	Miles 1962	Miles 1972
Hike & Bike	1.0	4.0
Bike Route	0.0	7.8
Bike Lanes	0.0	4.8
Bike Streets	0.0	0.0
Total	1.0	16.6

Source: City of Austin, Department of Urban Transportation.

53.9 in 1990. Total peak hour plane movements, 207 in 1969, will be about 403 in 1990, which will create problems because by 1980 the existing runway system at the Municipal Airport will have reached its maximum capacity of about 220 aircraft movements per hour. The present terminal building has a total area of 44,000 square feet, which is less than the estimated current requirement of 56,500 square feet. This requirement will increase to 158,600 square feet by 1990.

Non-Motorized Traffic

BICYCLE. Over 60,000 bicycles are currently registered in Austin and this mode of transportation is growing in popularity. As an indication of the growing popularity of the bicycle, during 1971-72 some 7,500 bicycles were sold in Austin, or an average of one new bike per 33 residents.

To relate to increased bicycle usage and the promotion of this type of conveyance by the City of Austin, Table 3-21 indicates the increase in different types of facilities that have been provided between 1962 and 1972. While primarily recreational, the bicycle is presently being used for work trips, attending classes and other non-recreational purposes especially in the area around the University. Almost four miles of hike and bike trails have been constructed in Austin with nearly eight miles of bike routes and 5.5 miles of bike lanes designated and marked by the city. About 3.5 miles of bike lanes are in the University area. Implementation of a comprehensive bicycle plan adopted by the City Council in 1972 and the continuing program of hike and bike trails along all natural creeks and streams in the urban area will provide routes linked with the lakeshore improvements along Town Lake. A new bicycle plan is presently being worked on by the Department of Urban Transportation in conjunction with the School of Architecture at the University of Texas. Under the present bicycle plan, efforts are being made to interconnect the University of Texas area, other neighborhood areas, the Capitol Complex, and Central Business District, as well as connecting neighborhood areas to recreational, commercial and other points of interest.

Apart from bike lanes and paths, bike trails will be instituted within major parks and recreation facilities. Existing recreation areas, and the Shoal Creek Hike and Bike Trail will be interconnected with the bicycle system through the designation of Cross-Town Routes. These routes will be selected on the basis of the shortest, safest, and best way to cycle across the city.

It has become necessary for the city to not only recognize this type of transportation as a means of travel, but to develop means and methods of controlling their use. This has been accomplished by a systematic registration system of the vehicles with the cooperation of the Fire, Police, and Urban Transportation Departments in order that uniform safety and performance standards be maintained.

If the number of bike lanes could be increased and made safer from the hazard of automobile intrusion, a greater number of individuals might be encouraged to utilize this form of transportation. The increase would be significant for students at both the University and public schools levels. In the downtown areas, if traffic and parking were to be further restricted, the bicycle could become an alternate transport mode. Some form of bike storage could be introduced for commuters to the CBD at the periphery and at employment locations.

PEDESTRIAN. The new sidewalk construction program initiated by the city over the past two years, acknowledges the need to facilitate pedestrian movement. Construction projects between 1970 and 1973 produced a total of 40 miles of sidewalks at an approximate cost of $650,000. About 1/3 of the total was located in the Model Cities Areas, while the remaining 2/3 were constructed under the Safe School

Route Program for elementary schools and in some new subdivisions. In addition, increased attention has been given to providing marked crosswalks at most arterial street intersections. Many existing neighborhoods, however, have no sidewalks and most new residential developments do not include sidewalks except as part of the Safe School Route Program or where homes qualify under FHA financing. The sidewalk petition program, which is a joint petition program between property owners and the city, has not been used be property owners. As the city continues to grow and new subdivisions are built, the Planning Commission is requesting that sidewalks be installed along at least one side of the streets in order to promote pedestrian travel. In addition, "wait/walk" signals have aided pedestrian travel in highly concentrated areas. The Safe Sidewalk Program, a program for sidewalk construction around schools, has $100,000 per year programmed for sidewalk construction under the Capital Improvements Program. Also, the Parks and Recreation Department has a Town Lake Hike and Bike Trails Program.

Conclusion

Austin's street system, in general, is good in terms of capacity and volume of traffic, street surface, maintenance, and transportation in terms of level of service. Financially, the time-span for the completion of construction projects is relatively short. Public awareness and efficient governmental planning, has provided a fairly efficient base for the planning of an improved and effective transportation program. With plans now underway like the Joint Transportation Study Office Program and the Austin Tomorrow Program, the City of Austin continues to keep its present position as being justifiably concerned with the quality of life of its residents and future development patterns of the area as a whole.

The city's crosstown circulation continues to be a problem as are some north-south corridors. Efforts are being made to improve this flow. The city has over the last decade significantly expanded its street program. In street usage and capacity Austin compares favorably with the national standard as do desirable average operating speeds for major streets. The majority of the trips (93-95 percent) are made by private automobile, however, an expanding Austin Transit System is providing a feasible alternative to auto travel. Transit operating ratios show a steady increase. A greater emphasis on pedestrian walks and bike trails has also occurred.

References

1. National Highway Functional Classification Study Manual, U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Records, April, 1969.

2. Present Use of Streets - 1969, City of Austin, Department of Urban Transportation, and District 14, Texas Highway Department, Transportation Study Office.

3. 1969 Cordon Study of the CBD in Austin, Texas, City of Austin, Department of Urban Transportation, September, 1970.

4. Highway Capacity Manual, 1965; Highway Research Board of the Division of Engineering and Industrial Research, National Academy of Sciences - National Research Council, Washington, D.C., 1965. Special Report 87, Publication 1328.

5. Railroad At-Grade Crossing Study, City of Austin, Department of Urban Transportation, Austin, Texas, 1969.

6. Austin Transit Study, 1972. (a) Analysis of Existing Transit Systems, (b) Transit Action Program, 1972-1977. City of Austin, Department of Urban Transportation, 1972.

7. Traffic Engineering Handbook, edited by John E. Baerwald, Institute of Traffic Engineers, Washington, D.C., 1965, pp. 539-541.

8. An Informational Report on Speed Zoning, Traffic Engineering, Institute of Traffic Engineers, Vol. 31, No. 10 (July, 1961), pp. 39-44.

9. Austin's 1971 Vehicular Traffic Flow, Department of Urban Transportation, City of Austin and Texas Highway Department, Austin, Texas, 1972.

10. Basic Data, City of Austin and Travis County, 1974, Planning Department, City of Austin, Texas, 1974.

11. Austin Metropolitan Area Transportation Study, Origin Destination Survey, Texas Highway Department, Planning Survey Division, in cooperation with the City of Austin, Texas, and the U.S. Department of Commerce, Bureau of Public Roads, Austin, Texas, 1962.

Traffic Related Problems and Suggestions for Solution

Chapter 4

Physical Considerations

TRAFFIC CONGESTION. Transportation demand is related to the spatial distribution of employment, recreational, retail and other service activities. A more rational control of the location of these activities would reduce congestion and allow the planner to more effectively accomodate traffic flows and minimize bottle necks. The projected peak and off-peak traffic flows generated from the various land use types can be estimated and potential areas of congestion isolated. These generated trip volumes can either be accomodated within the existing transportation facilities or road capacity must be expanded. Traffic congestion can be reduced either through capital solutions - new freeways, wider roads, mass transit systems, or non-capital solutions - staggered working hours, pricing mechanisms, and car pooling[1]. Pricing mechanisms which retain an element of choice for the passenger can be designed to discourage travel in congested areas. Parking, highway toll charges and vehicle occupancy rates are responsive to regulatory and pricing changes.

PARKING. The availability of long period parking facilities encourages commuters to drive to work which increases congestion and discourages off-peak shoppers and travelers[2]. A solution would be to either make off-peak parking inexpensive and peak parking expensive or prohibit all day or long term parking. Central business district perimeter parking lots with efficient central circulation systems for bus and pedestrian movements and adequate home to work mass transit facilities would diminish downtown congestion. This low cost perimeter parking should be located on the outer fringes where traffic congestion usually begins to develop. Some employers now subsidize their employees' centrally located parking spots either by direct payment or by providing a parking space. Present city building codes and zoning ordinances which require that new businesses, banks, offices, provide a certain number of spaces per building unit may encourage congestion since the worker will drive to work knowing that a parking space is reserved for him.

Cars could also be prohibited from using certain areas of the city at specific times of the day as is common in European cities which ban cars on certain days or on certain streets at certain times. To initiate this, it would have to be acceptable to the citizens, and the city would have to possess adequate mass transit and police enforcement.

Because of lower land costs new suburban shopping, medical and employment centers have large parking lots which attract customers and encourages congestion in suburban areas but discourages congestion in the central area. Alternative forms of travel may be necessary to discourage the development of this new suburban congestion.

On the general level, on-street parking aggravates traffic congestion by hindering traffic movement. Entrances and exits from parking lots onto streets increases the possibility of accidents. Parking garage automation could reduce aisle and ramp space and operating time losses. At the slower speeds caused by traffic congestion cars have a much greater pollutant effect. To alleviate this problem, on-street parking could be restricted or banned during peak traffic periods. However, parking bans can be counter-productive for short-term users if extended for example to off-peak travelers.

Changing the parking fee structure also has an effect on congestion. The flat rate per month or per unit of time for central city parking charges could be replaced by a rate more sensitive to congestion which would encourage people to travel at off-peak periods. On-street parking meters could be set at a per unit time rate which is progressive, that is, high initial peak hour and increasing long term costs and free or reduced off-peak parking costs. Since parking is not only provided by public agencies, but also by the private sector, some new local legislative and regulatory policies would be required.

USER CHARGES. Highway tolls provide income for the maintenance and operation of roads, bridges and tunnels. An adjustable toll charge on limited access highways exiting into congested areas could influence travel behavior[3]. This type of device would introduce a sophisticated method or pricing on some highways and toll roads. Further, the traveler should pay immediately and not be billed since the psychological effect of immediate as opposed to a billed cash payment is considerable and enhances the effectiveness of a user charge. The psychological effect of immediate as opposed to prolonged payment of course is debatable.

VEHICLE OCCUPANCY RATES. Higher vehicle occupancy rates in cars can be encouraged if monetary and reduced travel time gains are demonstrated to commuters. Improved marketing campaigns are necessary to propagandize car pooling. Large employment concentrations and non-staggered work hours are conducive to car pooling. Reduced or free trips on toll roads and priority expressway lanes are a few of the ways of rewarding and encouraging higher vehicle occupancy rates which presently stand at only 1.4 passengers per vehicle for the worktrip.

PEAK HOUR TRAVEL. Planners can affect peak hour congestion, through the zoning, subdivision and building codes they have at their disposal[4]. These devices, when combined with traffic volume predictions from social and land use data, allows for an orderly and planned distribution of traffic flows. The location or even banning of urban activities that generate excessive trip flows can be controlled effectively through these codes.

Planners could encourage housing and industrial developers to make public transit systems an integral part of the development. The developers could be encouraged to pay for bus stops, transfer facilities, and rights-of-way. Promotional schemes for advertising the benefits of mass transit travel such as its comfort and economy should also be their concern.

Planned unit developments which combine residential, commercial and industrial land uses reduce the number of auto trips per family. Travel time and congestion is frequently diminished and pedestrian travel replaces auto travel for many activities. Planners, citizens and private developers can work together to introduce pedestrian malls and flexible bus circulation systems. To accomplish this, citizen participation in both privately and publicly financed developments is needed. However, it must be pointed out that policies and regulation that might temporarily ease auto congestion might at the same time hinder the development of densities sufficiently high to promote long term development of mass transit.

OFF PEAK TRAVEL. By varying the time of travel demand during the day some congestion can be alleviated. One way to accomplish this is to move away from the normal 7 am to 9 am and 4 pm to 6 pm work schedule by starting and finishing work earlier or later. Staggered working hours require attitude and life style changes on the part of both the employer and employee[5]. A variation on this scheme is to allow an employee to work his 40 hour week on a more flexible time schedule. For example, a firm could permit an employee to work two 12 and two 8 hour days or ask the employee to work five 4 hour days with the remaining 20 hours worked at the mutual convenience of both employer and employee. This worker independence has not been detrimental to production where it has been introduced. In fact, such benefits as greater family interaction in leisure pursuits, improved worker and employer morale, increased production and reduced traffic congestion results.

Also the trend toward a reduced work week has been found to conserve energy resources, improve productivity and morale, reduce absenteeism and decrease job turnover rate. The effect on energy use may be debatable, particularly in higher income groups, since they may generate greater trip rates for leisure and shopping pursuits. A four day staggered work week would reduce time spent in commuting, lessen peak hour congestion, commuting costs, and restaurant and child care costs. These off-peak travel incentives can be accomplished without additional investment in equipment and facilities. Where these methods have been implemented positive results in the form of reduced congestion have been attained. Peak hour travel demand has been reduced and such ancillary benefits as less crowded elevators, streets and lobbies have been realized[6]. However, certain adverse effects can be incurred by the four day work week. For example, mid-week congestion peaks on Tuesday-Thursday are not necessarily reduced, expensive transit rescheduling and ridership loss could occur, and labor and management disagreements over productivity may result. It could also affect mass transit ridership, hinder car pooling efforts and increase the present difficulties of early or late shift workers. However, the benefits of reduced congestion and increased employer morale could exceed the costs associated with worker-employer disparities and transit system changes. The cost of innovative marketing techniques and off-peak revenue losses generated through reduced fares should not be viewed as a mass transit subsidy but as a necessary city expenditure with the major benefit being reduced congestion. Federal funds are available for an investigation of the relationship between changing hours, congestion and social indicators such as morale[7].

MARKETING INCENTIVES. Increased travel time resulting from congestion and inadequate parking, results in revenue loss for retail and service concerns in congested areas because commuters shy away from these congested zones. These stores could improve their generated revenue by encouraging more off-peak shopping trade as well as assist in reducing congestion by extending store hours, providing child care services, free gifts, store discount coupons, free services, return bus fares, and free or reduced parking in off-peak hours. Marketing these changes is relatively inexpensive and the costs could be borne by the retailer and consumer. Medical centers, large office complexes and recreational centers should also be encouraged to be more flexible in their visiting or opening hours and thus encourage off-peak transit usage. Individual off-peak travel is more cost and amenity sensitive than is peak hour travel which is work-oriented and time and reliability sensitive. For the blue collar worker, access to dentists, doctors and public agencies during the normal eight-hour work day and five-day working week is difficult and can result in ill afforded pay losses.

In the marketing of mass transit, skilled advertising through promotional appeals can be instituted to entice travelers to switch from the car to mass transit and also to travel in off-peak hours. These marketing techniques should be directed toward encouraging peak hour travelers to use mass transit and to induce captive non-working riders of mass transit to travel during off-peak hours. Transit telephone answering services, clearly defined transit route maps, radio and T.V. exposures can improve the public's knowledge and image of mass transit. Since promotional campaigns alone will not suffice they must be combined with such regulatory policies as parking control and increased transit services.

PEDESTRIAN DESIGN OR AUTO CONTROL. Pedestrian confusion in the central city can be reduced by restricting all or some of this area for pedestrian travel, either by changing the land use so that it caters to a pedestrian dominated mode or by easing pedestrian trip movements to work and stores. To ease pedestrian movement, pedestrian malls, bridges and moving sidewalks can be introduced[8]. Moving sidewalks are generally escalators, or belts common to airports, but these people movers are beginning to be introduced into shopping malls. Pedestrian streets or the closing of streets to pedestrians at specific times and pedestrian bridges or tunnels linking streets and stores can be developed. Effective landscaping could improve central city aesthetics and innovative malls could attract mass transit riders and car poolers.

At the onset, pedestrian only streets cause consternation among shopkeepers, however, sales generally increase over time. Pedestrian

malls will usually only shift the traffic volume and problems to other streets unless innovative mass transit changes are made in conjunction with their developments. The enforcement of commercial service delivery at the rear of the premises or only at night would alleviate congestion.

TECHNICAL APPROACHES. Audio-visual communication between people in a government complex, between doctors and patients, between supermarkets and clients, among police and in schools can reduce the need to travel and thus decrease traffic flow. Traffic controls and traffic monitoring devices are additional techniques that facilitate traffic movement[9]. A smooth flowing traffic stream decreases travel time, fuel consumption and environmental pollution.

Freeway access can be controlled through peak period and dynamic ramp control and gap availability metering[10]. Additional technical aids are improved traffic routing and regulation of parking and loading, correctly adjusted signals and markings and improved channelization and design of intersections[11]. Since excessive speed is the main cause of traffic accidents its reduction diminishes accidents. Uniform speed flows and adequate signaling also reduce congestion[12].

MODE CONTROL. Fixed rail rapid transit systems have the disadvantage of being expensive and of questionable value to most cities, especially those of the size and population density distribution of Austin. There are only some seven U.S. cities with sufficient corridor volume density to make fixed rail rapid transit feasible[13]. An exclusive busway with its own grade separated right-of-way is a less costly, more flexible, and more feasible way of serving corridors of demand in Austin which because of size and low population density cannot support rapid rail. Exclusive bus lanes can be introduced into Austin's present bus and highway system at considerably less cost to the public than an investment in a fixed rapid rail system[14].

Buses' because of their higher occupancy rates reduce congestion and should be given access priority in mixed traffic systems by exempting them from certain regulations that apply to normal traffic[15]. This can be achieved by developing reserved bus lanes, exclusive bus rights-of-way, contra-flow bus lanes and far side bus stops. Increased bus speed and service reliability would make the bus an attractive alternative to the automobile and alleviate congestion problems. As side benefits, attractive bus systems would speed up traffic flows, decrease accidents and reduce the heavy pollution caused by low speed traffic.

Since congestion at traffic signals is a major cause of bus delay one could also install special traffic signals or selective traffic detection systems which would alert the signal lights that a bus was approaching and permit buses to cross intersections before other vehicles. Additionally, to improve routing, buses could be allowed to ignore turn prohibitions. Automated traffic controllers are presently being used to analyze traffic flows and to operate signal lights according to travel demand response.

An exclusive right-of-way for buses and car-pools is another way of facilitating movement. These lanes can be reserved on streets and the time of this reservation varied to account for peak or off-peak travel differences. These lanes could also be used for emergency vehicles such as police cars, ambulances and fire trucks. Reserved bus lanes increase bus patronage and decrease auto use. The shape and size of a bus and bus routes can be changed to meet new travel demands whereas a fixed rail system cannot. The cost of introducing an exclusive or reserved bus lane is considerably less than that of a fixed rapid rail system.

Contra-flow bus lanes permit travelers to travel against the flow of traffic through a reserved lane on a city street and expressway. These lanes are difficult to enforce, sign and mark than the normal street system but are very effective.

An additional aid is a farside bus stop where passengers are unloaded past an intersection, on the far side of the cross-street. This relieves congestion since buses are able to rejoin the traffic lane more easily and right turning vehicles are no longer delayed[16].

Until recently, no major functional change had been achieved in bus transit primarily because decreasing revenues and ridership caused little or no expenditures for equipment or service improvements. Boarding, loading and unloading packages, and handling children and goods is still difficult on the bus. Greater convenience, improved travel time, comfort and personal service are needed.

A mini-bus is a low capacity, relatively low cost vehicle that lasts about 12 years and is more flexible than the traditional bus. It can carry 15 to 25 passengers and can transport between 1,000 and 4,500 passengers on an hourly basis, depending on its size, operating speed headways and travel demand. Initial costs range between $15,000 and $20,000 with operating costs between one and five cents per seat mile. Mini-bus circulation systems introduced within the CBD have proved successful in transporting individuals within the central city and thus in reducing congestion.

Park and ride or kiss and ride systems which require switching of modes from car to bus or to fixed rapid rail systems is another way of improving the urban circulation system[17]. Depending on which method is used it may free the car for the wife to use during the day. The demand activated dial-a-bus system is a further adaptation. Similar to the taxi-cab the potential bus rider calls up a central location which notifies the bus driver circulating in the vicinity of the caller. Mini-bus circulation systems within the CBD have proven successful in other cities because they are smaller and more flexible than the conventional bus.

In relation to the full-sized city bus, mini-buses demonstrate a number of advantages. Although their restricted capacity may be viewed as a liability during peak hours, most are demand oriented, and their greater numbers compensate for this low capacity. The regular circulation of the mini-bus fleet reduces passenger waiting time since missing one does not insure a long wait. Mini-buses could be scheduled during peak hours to pick up passengers only between certain points and only drop passengers at their required destination, thus decreasing travel time and increasing customer satisfaction. As to their contribution to congestion in the heavily utilized central business district they are only slightly less maneuverable than autos. They merge into the traffic stream easily and even if bus lanes are not provided, their loading and unloading is less time consuming than large buses and consequently do not hinder traffic flows to the same extent. Thus, not only are customers more easily satisfied, but non-rider complaints are reduced since their inconvenience is held to a minimum. Mini-bus or demand responsive services are adaptable and flexible and show much potential for serving low density areas (2,000 to 3,000 persons per sq. mi.) such as those on the periphery of the City of Austin.

The jitney is a vehicle size that falls between the taxi and mini-bus, has low purchasing and operating costs, and has the flexibility and adaptability common to the taxi. Jitney's are extremely useful in low demand areas.

Traffic control systems can be introduced to move vehicles with regard to the vehicle size and number of persons carried in the vehicles i.e., a bus or jitney would have higher priority for getting through a traffic light than cars. The optical beam in the bus would transmit signals from the bus to the electronic receiver to inform the traffic light of its approach. Computer-assisted bus scheduling for time and route selection would also improve bus availability.

The dual mode bus is adaptable to road and rail use through flanged steel wheels which can be lowered from the bus onto rails to guide and support the bus for faster speeds along fixed rail lines. The bus can then return to its tire base for normal road travel. An articulated bus would carry larger numbers of passengers, achieve lower passenger costs and could be used for express travel operations on freeways; the double-decker bus is also a way of increasing passenger loads. Bus propulsion systems with steam and gas turbines have been developed and are considered better alternatives to the present standard gas and diesel engine powered vehicles.

One solution to congestion is to limit the need for the present

Table 4-1
National Primary and Secondary Ambient Air Quality Standards, 1972

Pollutant	Averaging Time	Concentration by Type of Standard: Primary ug/m3	Primary ppm	Secondary ug/m3	Secondary ppm
Particulate matter					
Annual Geometric Mean	24 hr.	75	--	60	--
Annual Maximum	24 hr.	260	--	150	--
Carbon Monoxide					
Annual 8-hour Maximum	8 hr.	10,000	9	10,000	9
Annual 1-hour Maximum	1 hr.	40,000	35	40,000	35
Hydrocarbons (nonmethane)					
Annual 3-hour Maximum	6 to 9 am.	160	0.24	160	0.24
Nitrogen Dioxide					
Annual Arith. Mean	--	100	0.05	100	0.05
Photochemical Oxidants					
Annual Maximum	1 hr.	160	0.08	160	0.08
Sulfur Dioxide					
Annual Arith. Mean	--	80	0.03	60	0.02
Annual 24-hour Maximum	24 hr.	365	0.14	260	0.10
Annual 3-hour Maximum	3 hr.	--	--	1,300	0.50

Source: Air Pollution Control Services, Texas State Department of Health; and Opiela and Atkins (1972).

number of automobiles on certain sections of city streets by establishing more rental services to operate along with public transportation. Small, low-powered inexpensive rental vehicles could be picked up and returned to the original terminal or to other suitably located terminals within the city. Similar to the rent-a-car this would help to decrease congestion.

Environmental Considerations

AIR POLLUTION. Motor vehicle emissions are the major source of air pollution in the Austin area. The number of motor vehicles registered in Travis County, now around 200,000, has increased more than six times since 1940. From 1960 to 1972, registrations increased at an average annual rate of seven percent. Nevertheless, total automobile emissions have probably decreased, and may continue to decrease due to the Federal emission controls on new cars[18].

Measurement of air pollution in Austin has been conducted by such agencies as the Texas State Department of Health, The City of Austin Health Department and The Travis County Health Department and Tracor. Table 4-1 presents the minimum air quality standards set by the Federal government for certain pollutants. The primary standards represent a level of air quality required to protect public health. The secondary standards represent a level of air quality required to protect public welfare from any known or anticipated adverse effect of air pollutants.

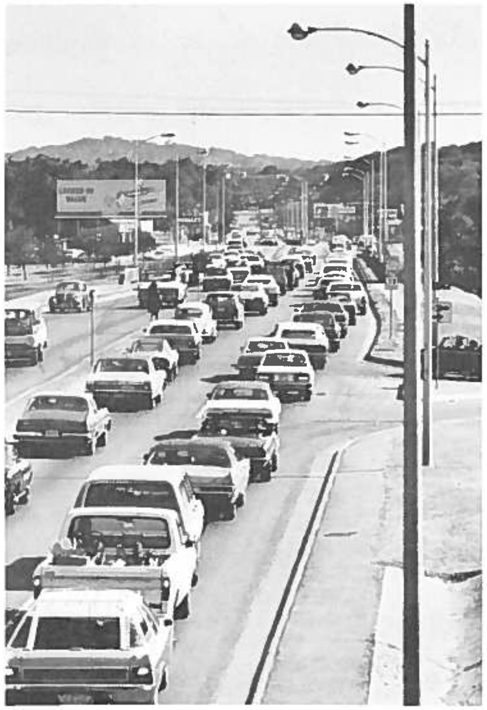
Austin studies indicate that: (1) particulate concentrations in the downtown area narrowly exceed the federal primary standard; (2) there is no evidence that carbon monoxide is found in such concentrations as to produce any perceptible effect on human health; (3) almost all of Austin's airborn lead pollution is associated with the automobile; and (4) The Environmental Protection Agency (EPA) identified Austin as one of nine Texas cities with unacceptable levels of hydrocarbons. The EPA is seeking to reduce hydrocarbon emission in the Austin area by 27 percent and intends to require that all retail gasoline sales outlets retrofix gasoline storage tanks with vapor recovery systems.

Not only emission sources, but also the dispersion abilities of horizontal and vertical air mix cause the concentration of air pollution. Pollution potential is high when wind speeds are less than seven miles per hour. In Austin, September and October are the months when low wind speeds are most frequent. Where the rising warm air begins mixing with the cooler air is the designated upper boundary for air pollution dispersal. Mixing depth for Austin is greatest during summer daylight hours, 6,230 feet in August, and shallowest during winter, 1,570 feet in January. Rainfall acts as a cleansing mechanism by washing out particulate matter from the atmosphere and suppressing ground level dust. Austin's 33.23 mean annual precipitation is well distributed; all twelve months receive long-term averages of at least two inches.

NOISE POLLUTION. One significant source of noise pollution is transportation. Highway vehicles are the greatest source of noise in Austin. Individual passenger cars are the quietest highway vehicles. The typical heavy truck can be expected to produce noise of some 20 dBA's greater, at a distance of 50 feet, than the passenger car. Trucks however, are no louder than many large motorcycles. Incorrectly muffled motorcycles can be twice as loud as the noisiest heavy truck. The automobile, because of sheer numbers, makes the greatest absolute contribution to the total noise level[19].

At truck speeds below 45 mph and automobile speeds below 35 mph, the dominant source of noise is the engine and related parts of the propulsion system. As speeds exceed 50 mph, tire noise becomes dominant. Tire noise increases with speed and is dependent on road surface, axle loading, tread design, and tire wear condition. Air turbulence and mechanical rattles also cause vehicle noise emission.

Figure 4-1 A: Pictorial Essay on Current Traffic Related Problems



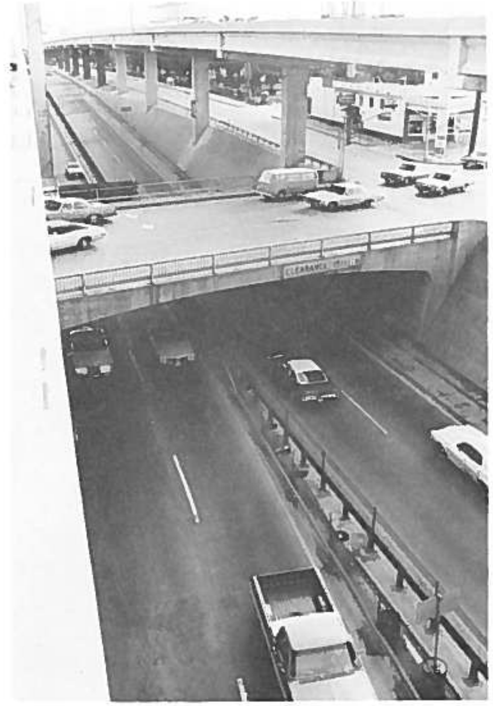
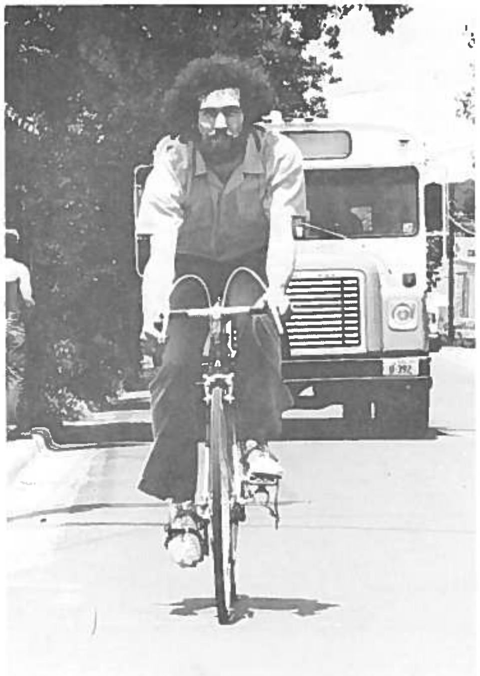


Figure 4-1 B: Pictorial Essay on Current Traffic Related Problems



Trucks powered by diesel engines are louder than gasoline powered trucks. Of the 32,012 commercial trucks and 771 farm trucks registered in Travis County during 1972, only a small percentage were diesel trucks. Buses are quieter than trucks, since they have larger mufflers and an enclosed engine compartment.

Additional noise generators are boats and airplanes. More than 5,500 boats with 10 or more horse power engines were registered in Travis County in 1970. Operator exposure to noise during acceleration is high. The Robert Mueller Municipal Airport is responsible for most of the commercial aircraft noise in Austin. Commercial airline traffic, although not heavy, is on the increase. Almost all jet airplane noise is a combination of low frequency jet thrust roar, and the high frequency fan noise.

Any house built within a half block of most sections of Ben White and Lamar Boulevard would be in unacceptable noise locations, provided there are no barriers between it and the traffic artery. A house along most of Shoal Creek Boulevard, West Avenue, or East Mary Street is within the usually acceptable noise level zone.

AESTHETIC BLIGHT. One of the more obvious examples of this in Austin is Burnet Road with its vast and haphazard array of signs, bill boards and utility poles. They are so poorly arranged that they are of little practical use to the consumer or the retailer. Sign design is important to automobile safety as well as to individual aesthetics. The visual benefit of well-designed expressways and reduced travel time has to be measured against their divisive effect in splitting urban neighborhoods and presenting formidable barriers to construction planning.

Social Equity Considerations

THE MOBILITY IMPAIRED. A basic necessity for an active participation in society is the ability to move about in that society. This ability is presently diminished for many citizens, primarily transportation dependent children, the elderly and the sensory and physically impaired. The Urban Mass Transportation Act as ammended in 1970 specifically states that special efforts must be made in the planning and design of mass transportation facilities and services so that they are available to elderly and handicapped persons and that all Federal Programs offering assistance in the field of mass transportation should contain provisions for the implementation of this policy[20]. The Act further provides for grants or loans for the specific purpose of assisting States and local public bodies and agencies thereof in providing mass transportation services which are planned, designed, and carried out so as to meet the special needs of elderly and handicapped persons. And it allows funding for research, development, and demonstration projects to support these programs. The City of Austin working through the Joint Transportation Study Office is currently developing a total system plan for transportation of the elderly and mobility impaired.

At a recent conference held in Austin, some basic factors regarding the transportation needs of the mobility impaired were discussed. The following points summarize the results: (a) in cases where agencies and organizations have tried to meet the needs of the mobility impaired, it has often meant the diversion of trained personnel from their main activity, teaching, physiotherapy, to that of trying to provide transportation services; (b) those institutions that have tried to provide transportation services on the scale of a minibus system have found that the cost per ride or cost per vehicle mile are usually quite high due to relatively low utilization of the equipment; (c) the paperwork involved with the transportation logistics is lengthy and time consuming and; (d) many people who are eligible for services do not receive them because of a lack of suitable transportation services.

People who have experienced periods of immobility know how demeaning that experience can be, since mobility dependency has a frightening

Table 4-2
Number of Individuals Who Experience Handicap Deficiencies, Travis County

	Travis County
Deaf and Hearing Impaired	183
Orthopedic Impairments	909
Absence and Loss of Extremeties	55
Mental Disorders	796
Alcoholism	434
Drug Addiction	218
Character, Personality and Behavioral Disorders	2,422
Mental Retardation	507
Epilepsy	185
Cardiac and Circulatory Conditions	174
Tuberculosis and Respiratory Diseases	51
Digestive System Disorders	209
Genito-Urinary Disorders	107
Speech Impairments	30
Other Disabilities	603
TOTALS	6,883

Source: Texas Rehabilitation Commission Memo July 24, 1974.

and debilitating affect. Table 4-2 outlines the number of individuals who experience some deficiencies recognized by the State of Texas as producing mobility impairments.

Costs permitting, the following special equipment and services could be included on all public transportation vehicles to aid the mobility impaired: (a) ramps or lifts to help people with walking difficulties or in wheel chairs to get into buses; (b) recordings at bus stops which give verbal information about location, stops, and destinations of buses when buttons are pushed; (c) driver or recorded announcement of stops and destinations as people board; (d) unusual sign systems such as braille signs in street markings, directions, and information related to pedestrian and traffic movement; (e) a "willingness-to-help" attitude on the part of public transportation operators; (f) safe transportation arrangements for wheel-chair-bound persons on public buses, and; (g) sensitivity training for transportation personnel to the general and special problems of the mobility impaired.

Conclusion

A more rational control of the distribution of commercial, industrial and residential development is needed. The present distribution of employment and residential sites, has had a significant impact on passenger travel patterns in Austin. These patterns are characterized by relatively uniform, low volume, cross-town trips making the design and implementation of a satisfactory mass transit system diffcult. Traffic congestion which is beginning to become a problem in certain sections of Austin can be reduced either through capital or non-capital solutions. A mixture of the two solutions is required. Further the trend in urban transportation is expanding from the mere question efficient mobility to include social equity considerations, concerning the mobility of the elderly, the mentally retarded and the physically and sensory impaired. Local agencies are actively addressing these issues and are implementing the necessary solutions.

References

1. Abstracted in part from the study by Rosenbloom, Sandra and Mark J. Miller, Peak Hour Traffic Congestion: Non-Capital Solutions for Texas Cities, the Graduate Program in Community and Regional Planning, August 31, 1973, University of Texas at Austin; Roth, G. J. "An Economic Approach to Traffic Congestion." Town Planning Review, April 1965; Wohl, Martin, "Must something be done about traffic congestion?" Traffic Quarterly, July 1971, 403-418.

2. Rother, G. J. and Thonson, L. "The Relief of Traffic Congestion by Parking Restrictions." Town Planning Review, 34, October, 1963; Rubenstein, Allen M. "Future central area mobility" Nation's Cities, April, 1972, 18-19; Conner, Samuel H. "Downtown Parking: Do you really have a problem?" Public Works, March, 1971, 74-76; Benn, George J. "The Formulation of a Realistic Parking Policy." Traffic Quarterly, 22, July, 1968, 419-432; Hanson, Daniel J. "Parking Restriction and the Curb Lane." Highway Research Board, Special Report 83, 1967, 61-83; Bay, P. N. "Innovation in a Downtown Parking Program." Public Works, 98, January, 1967.

3. Yuan, Li Shin and Kreen, John B. "Adjustment of Freeway Metering Rates to Balance Entrance Ramp Queues." Transportation Research, June, 1971, 127-133; Wohl, Martin, "Congestion Toll Pricing for Public Transport Facilities." Highway Research Record, No. 314, 1970, 20-31.

4. Kanaan, George and Witherford, David K. "Zoning and loading controls." Traffic Quarterly, 25, July, 1971, 447-462.

5. Betz, Matthew, and Supersad, Jankir N. "Traffic and Staggered Working Hours." Traffic Quarterly, 19, April, 1965, 188-203; O'Malley, Brendan. "Staggered Work-Hour Prospect in Lower Manhatten." Highway Research Record, No. 348; Walshe, G. "A Stagger Enquiry." Journal of Transportation Economics and Policy, September 4, 1970, 284-308.

6. Wood, A. A. "Foot Streets--Managing the Environment." Traffic Engineering and Control, February, 1970, 468-469.

7. The Urban Mass Transportation Administration (UMTA) granted Philadelphia $485,000 to establish a staggered work hours program. UMTA, April 17, 1973; U.S. News, August 31, 1972.

8. Stuart, Darwin. "Planning for Pedestrians." American Institute of Planners Journal, 34, January, 1968, 37-41; Older, S. J. "Movement of pedestrians on footways in shopping streets." Traffic Engineering and Control, August, 1968, 160-163; Lovemark, Olaf. "New Approaches to Pedestrian Problems." Journal of Transportation Economics and Policy, 6, January, 1972; Levinson, Herbert S. "Pedestrian way concepts and case studies." Highway Research Record, No. 355, 1971, 69-89; Boston Redevelopment Authority. The feasibility of moving walks in the South Sta-Summer Street area of Boston. Boston: January, 1971 (PB 202015); Hoffman, G. A. "Minimizing Land Used by Automobiles and Buses in Urban Central Core: Underground Highways and Parking Facilities." Highway Research Record, No. 102, 1965.

9. Newman, Leonard, Cunnet, Alex and Meis, Gerald. "Freeway Ramp Control--What it can and cannot do." Traffic Engineering, June, 1969, 14-21; Stockfish, Charles. "Guidelines for Computer Signals System Selection in Urban Areas." Transportation Engineering, December, 1972.

10. Barney, Alan F. "Ramp Metering Traffic Control System." Traffic Engineering and Control, March, 1969, 563-564.

11. Hodgkins, Edmund A. "Effects of Volume Controls on Freeway Traffic Flow--A Theoretical Analysis." Public Roads, February, 1968, 258-266.

12. Davis, M. G. and Hirsch, W. B. "Planning Considerations for Traffic Signal Systems.: Highway Research Record, No. 366, 1971, 29-36; Evans Jemru and Skiles, Gerald W. "Improving public transportation through bus preemtion of traffic signals." Traffic Quarterly, 29, October, 1972, 531-541.

13. Brouwer, P. "Separate traffic lanes for buses; what is the present state of affairs." Revue de l'UITP, 969, No. 3, 209-240; LaPlante, John. "Exclusive Bus Lanes." Highway Research Board, Special Report 93, 1967, 75-83.

15. Young, A. P. "Bus Priorities and Lanes in Great Britain." Transportation Engineering, November, 1971; Van Auerbeke, B. A. "Bus Priorities at Traffic Control Signals." Traffic Engineering and Control, June, 1972, 70-75; Crabtree, Gordon. "Bus Priorities really do cut urban travel delays." Commercial Motors, July 14, 1972, 24.

16. Terry, D. S. and Thomas, G. J. "Farside bus stops are better." Traffic Engineering, March, 1971, 21-29; Thomas, Richard C. "The effecto of one-way traffic operation on retail business." Traffic Engineering, July, 1968, 44-48.

17. Anson, W. J. "Park-and-Ride; an alternative to road pricing." Modern Transportation, January 29, 1966, 14-15.

18. Austin Tomorrow, Technical Report, Environment: An Analysis of Pollution and Natural Features in Austin and Travis County, Department of Planning, October, 1974; Air Pollution Control Services, Texas State Department of Health, and A Methodology for Study of Urban Air Pollution Potential, A. D. Opiela, Jr., and P. R. Atkins, 1972, p. 40; Air Quality Survey of Austin, Texas, June, 1967, Texas State Department of Health, 1969, p. 9; "Report of Ambient Air Pollution Levels in Austin, Texas," Austin - Travis County Health Department, 1973.

19. Connor, William K., Volume 1: Procedures, Results, Analyses, and Recommendations, Tracor Sciences and Systems, Tracor Inc., Austin, Texas, July, 1974; Report to the President and Congress on Noise U.S. Environmental Agency, Washington, D.C., February, 1972.

20. Davies, Shane and Carley, John, The Transportation Problems of the Mentally Retarded, Center of Advanced Transportation Studies, The University of Texas, Austin, January, 1975; Eugene D. Perle, "Urban Mobility Needs of the Handicapped: An Exploration;" F. E. Horton, ed., Geographic Studies of Urban Transportation and Network Analysis, Northwestern University Press, Evanston, Illinois, 1968.

Transportation Preferences

Chapter 5

Introduction

Modal split models are characterized by pre-distribution models where total person trips for a specific trip purpose are allocated to the modes before distributing the trips among the origin and destination zones, and post-distribution models where trips are allocated to the modes after they have been distributed among the zones[1].

Each mode competes for its share of the passenger transportation market, which is the summation of all origin-destination flows within a city. The models estimate the size of travel market and attempt to predict the passenger allocation or split among the competing modes. This allocation is based on such characteristics as the trip cost, the trip maker, auto or non-auto ownership, and the transportation system. The data base used for predicting modal split allocation among the competing modes is obtained from origin-destination surveys, the U.S. census, and attitudinal and behavioral data.

With respect to modal split models, most of the literature has addressed the question of commuter preferences indirectly, by focussing on the decision to use one mode of transportation. These models are generally presented either in regression format, that is, predicting transit usage from characteristics of the transit system and the city's urban structure; or in graphic or tabular form, which shows divergent usage between modes caused by changes in the quality or quantity of various mode characteristics; or as mathematical models. Most of the literature is concerned with the journey to work and falls into three general research areas.

One type of study relates mass transportation usage to such physical and social characteristics of the city as size, density and age, population, income, ethnicity and automobile ownership[2]. These models are only partially satisfactory for predictive purposes, since they generally assume prevailing transit conditions will endure. Unfortunately, the empirical relationships obtained from studies that link usage of public transportation to various characteristics of the urban area embody no convincing causal hypotheses explaining people's actual travel behavior, and without this they are of limited use in policy formation.

In the second general research area, models of modal choice have been developed to explain and predict public transport and private car usage for the work trip between specified geographic zones in urban areas[3]. They use modified "gravity and opportunity" models for replicating and predicting urban travel behavior. They consider trip characteristics--purpose and length; characteristics of the trip user--age, sex and ethnicity; and characteristics of the transportation system--travel time, convenience, and cost. These land use methods are the best presently available for predicting aggregate travel in urban areas. Estimates of future passenger changes on the available modes are predicted on the projected changes in trip, trip user, and transportation characteristics, which control total passenger transportation demand. By extrapolating future increases in household car ownership, mass transit ridership is estimated.

Thirdly, some researchers have developed models to explain and predict individual mode choice by taking account of individual travel and household characteristics[4]. Quarmby, by combining the work of Warner and Beesley developed a model for representing how people make their decisions about using private or public transport to travel to work, and found relative door-to-door travelling time, time spent walking and waiting, and travel cost to be important in affecting their choice. This method enables one to forecast the number of car users who would change to any proposed public transport system.

In today's society where the least-cost approach to transportation planning is not necessarily the most desirable, people's attitudes towards present and future changes in their city's transportation system is important to policy makers since they may be unaware that many non-users of mass transit may be quite willing to support a mass transit system. Why attitudes vary and how they can be satisfied are important inputs to any transportation planning process. Attitude surveys appraise people of their preferences for present and future transportation systems and provide planners with a base of community approval so that implementation of change is considerably eased.

The remaining work to be commented on is less sophisticated statisti-
126 cally and has been concerned primarily with the value of travel time. The choice between two modes of travel frequently involves a trade-off of time against money -- i.e., one mode is cheaper but takes longer than the other. Here the most important work is that of Moses and Williamson, who developed an economic model to predict people's choice of mode based on indifference curves and rate of substitution between working time, travelling time and leisure time[5]. Using the marginal wage rate to represent the value of time spent in travelling to work, they predict the fares needed on public transport to encourage commuters to use it.

From the literature the planner has learned something about why people choose one mode over another. The simple answer is that they prefer one mode to another, but this begs the question why, and again the answer from the literature is "because of things like cost, time used, comfort and convenience." Some of these variables are fairly easily handled, e.g., time and cost, and Quarmby's work in particular does a good job of relating them to the choice of mode. But how do we quantify "comfort and convenience," and how do we know how much weight they have in a final decision?

We need to measure and combine preferences related to different aspects of a transportation mode more accurately, so as to give a better idea of the trade-offs between one good and another[6]. This is important, since it is necessary to devise meausres of transportation satisfaction, which are aggregative in nature if they are to be of use for transportation planning purposes.

Model 1: A Transportation Demand Model[7]

INTRODUCTION. A sample of residents in Austin, Texas were interviewed in their homes regarding their preferences for various transportation systems. A sample was taken of some 149 persons distributed along the dimensions of age, income, race, education and social status. The intent was to investigate the preference differences that might occur between groups along these dimensions.

The dependent variable was the degree of desirability which subjects assigned to trips under differing circumstances. The variation in these circumstances was confined to cost, time, mode of travel, and the amount of waiting time involved when using a bus. The modes were those which were available in Austin: a private car, a bus, and walking.

Each subject was asked a series of questions to ascertain his social background and the mode he usually used in commuting to work and was given a short explanation of how magnitude estimation worked. Thus, data was gathered enabling comparisons to be made for groups of
128 differing backgrounds and mode choices.

The subject was asked to judge the degree of desirability he or she associated with 22 hypothetical commuting situations. In order to provide him with a standard, an arbitrary value of 10 units of desirability was assigned to a work trip made by bus, taking 25 minutes, including three minutes of waiting time, and which cost 35 cents each way. He was then presented with other situations one at a time, asked to compare it to the standard situation, and to give his estimate of its desirability. Another trip might be, for instance, by car, taking 15 minutes, and costing 40 cents. If he thought that this trip would be three times as desirable as the standard bus trip, he would assign it a value of 30, if for some reason he thought it only half as desirable, he would assign it a value of five and so on.

Policy Conclusions

The findings are presented in Table 5-1 and in Figure 5-1, which is a plot of the mean desirability judgements for the entire sample against the total en route travel time of each trip. These modal preference curves give us some interesting information on how preferences, "D-Scores", vary with time for each of the three modes considered. The differences between the curves allow us to see whether the differences in preferences for one mode or another are great or small, and the variations in the points for the bus curves allows us to see the effects of waiting time and of cost on "D-Scores".

It is clear for the whole sample that the auto is preferred to other modes throughout the range of time that we investigated, although for longer trips the auto's advantage is markedly reduced, and for some sub-samples it disappears altogether. Apparently people prefer to drive, but as the trip lengthens, they prefer it less.

The effect of cost on the modal choice can be inferred by imagining a family of curves for the bus mode, each parallel to the curve but higher or lower according to the cost of the trip. We have a single point, at 25 minutes, for one way trip costs of nothing, 15 cents and 60 cents, in addition to the main bus curve, which reflects a cost of 35 cents. It is clear that if the other curves indicated here with

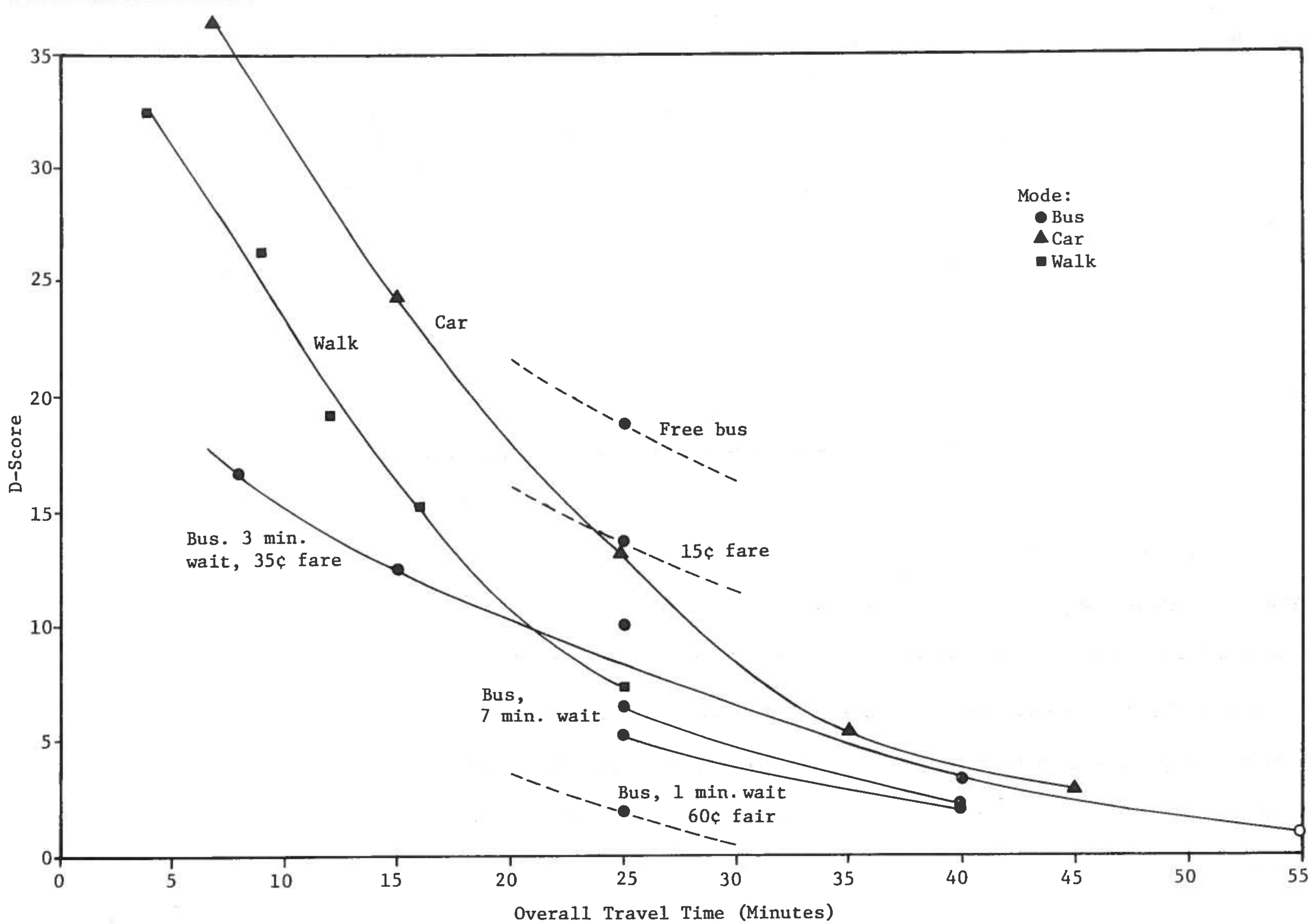
Table 5-1
Geometric Means of Responses, Distribution Factors, and Values to Bracket Approximately 68% of All Cases. (Austin N=149)

Stimulus	D-Score Geometric Mean Response	Corrected Std. Dev.	Dist. Factor	$\overline{X}$geo. x DF	$\overline{X}$geo./DF
Bus, 8 min, 3 min wait, 35¢	16.6	16.0	1.97	32.6	8.4
Bus, 15 min, " " " "	12.5	9.9	1.69	21.2	7.4
[a]Bus, 25 min, " " " "	10.0	0	-	-	-
Bus, 40 min, " " " "	3.4	4.9	2.44	8.3	1.4
Bus, 55 min, " " " "	0.9	1.4	2.56	2.3	.4
Bus, 25 min, 7 min wait 35¢	6.4	7.5	1.86	11.9	3.4
Bus, " " 12 min wait "	5.2	5.8	2.11	11.0	2.5
Bus, 40 min, 7 min wait "	2.2	3.4	2.54	5.6	.9
Bus, " " 12 min wait "	2.1	3.3	2.56	5.4	.8
Bus, 25 min, 3 min wait, free	18.8	16.0	1.85	34.8	10.1
Bus, " " " " " 15¢	13.7	10.6	1.78	24.3	7.7
Bus, " " " " " 60¢	1.8	3.1	2.72	4.9	.7
Car, 7 min, 10¢	36.6	32.4	1.88	69.0	19.4
Car, 15 min, 20¢	24.3	21.4	1.88	45.7	12.9
Car, 25 min, 35¢	13.3	14.3	2.08	27.6	6.4
Car, 35 min, 60¢	5.4	7.8	2.44	13.2	2.2
Car, 45 min, 85¢	2.9	4.6	2.58	7.5	1.1
Walk, 4 min	32.4	31.6	1.98	64.0	16.4
Walk, 8 min	26.3	26.4	2.00	52.7	13.2
Walk, 12 min	19.2	20.3	2.06	39.5	9.3
Walk, 16 min	15.2	16.3	2.07	31.5	7.3
Walk, 25 min	7.3	9.7	2.33	17.0	3.1

[a]Since this was the "standard" trip, the standard deviation is necessarily zero.

Source: Mark I. Alpert and C. Shane Davies, "Segmentation of a Transportation Market by Determinant Attitudes," forthcoming Environment and Behavior, Spring, 1975.

Figure 5-1: Modal Preference Curves, Entire Austin Sample



Source: Allen M. Shinn, "Towards a Policy Oriented Urban Transportation Demand Model: A Psychometric Approach to Modal Split" Paper presented at Urban Regional Information Systems Association, San Francisco, August 1972.

dotted lines, were in fact parallel to the 35 cent curve, then there would be a region in which the auto curve lay below the bus curve, and that the cheaper the bus trip the more this would be the case. If the bus were free, it appears that this sample would be indifferent between the auto and the bus at a trip length of about fifteen minutes, and would prefer the bus at longer times. A bus curve for a cost of more than 35 cents would not appear to intersect the auto curve at all. Thus it is clear that the cost of a trip is an important variable, and obviously one which can be manipulated by subsidy or other policies. Relative cost is a primary consideration. The curve for the auto does not assume constant cost, whereas the bus curve does since it was not considered realistic to present the same cost for auto trips of varying lengths, and thus auto cost was tied to trip length in an arbitrary way. Consequently, the separate effects of time, distance and cost on the auto preference curve are not assessable.

From the policy standpoint there appear two ways to induce people to shift to a bus: cut the fare or increase the costs of driving by parking or toll policy. There is evidence that this Austin sample, at least, would be sensitive to such policy. Further it also appears that buses will not attract many riders unless there is a degree of subsidy in their fares, since rising fares, beyond a certain point, appear to have a sharply negative effect on preferences.

The other variable of obvious importance is time. The curves here compare trips of equal time length by one mode or another, not trips of equal physical distance. The relation between time and distance is primarily a function of the technology employed, but it is also subject to some extent, to regulatory policy. If we assume that buses will always take more time than cars, then buses will be at a further disadvantage in these situations, and the only way to induce ridership will be to make the cost considerations paramount. This will be difficult in most cases, at least from a political point of view. But where we can use new technology or regulatory policy to give buses or another mode of public transportation a time advantage, then we can expect that cost considerations will not be quite so important. In most practical situations some mixture of the two will probably be necessary.

There are existing systems that support this point, the Shirley highway busway in Washington D.C., cut about 30 minutes from the trip time by automobile for the whole length of the busway, and our data suggests that such a time advantage, if it were possible in the context of Austin commuting, would dominate the situation entirely. The same can be said of the Lindenwold rapid transit line southeast of Philadelphia.

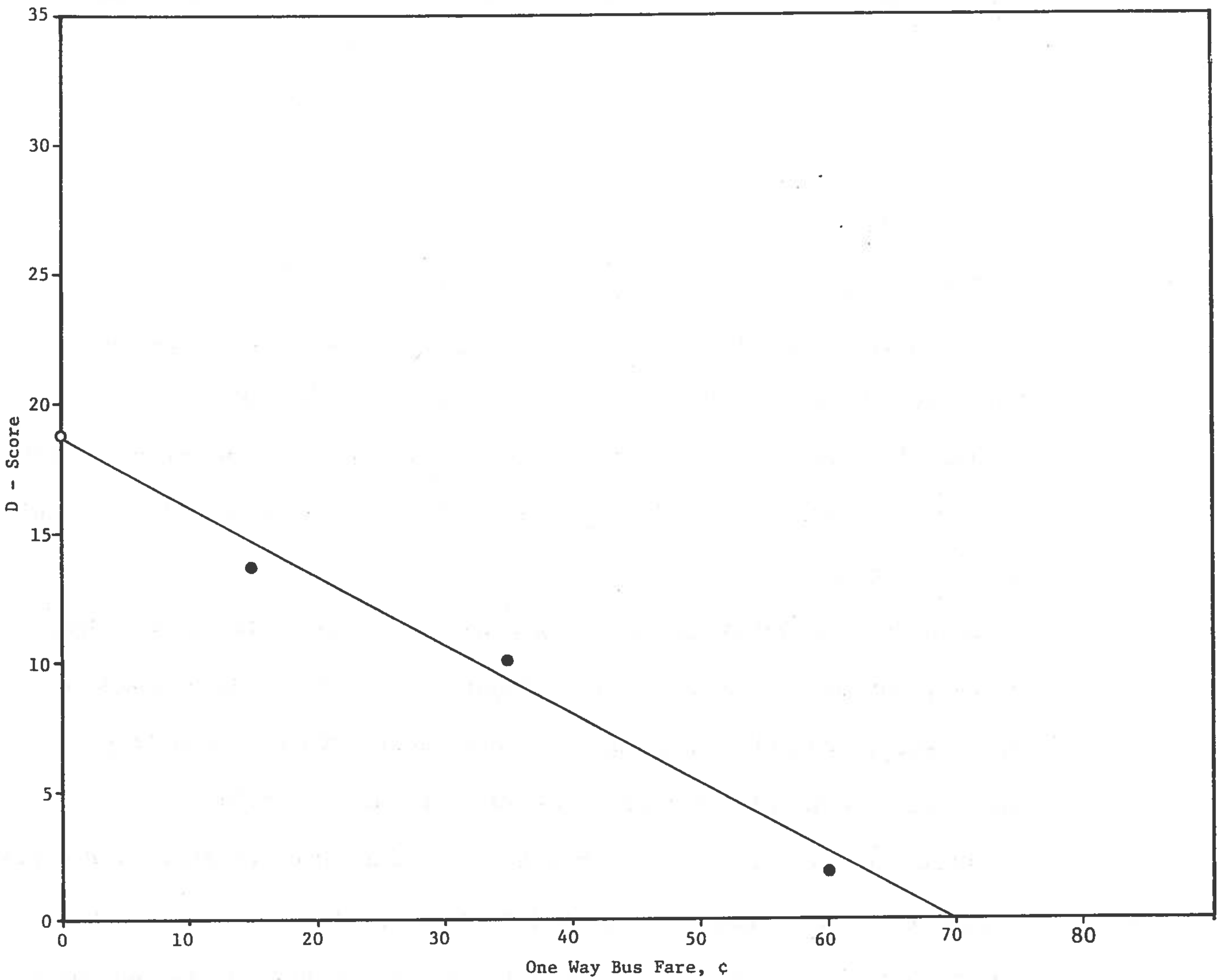
Clearly technology, in the form of rapid transit, is one way to increase ridership. But regulatory policy could do it considerably cheaper. If for instance, certain streets in Austin were restricted during certain hours to cars carrying at least three persons and to buses, the effect would be to considerably reduce traffic on the road, with an attendant increase in speed; but more important, it would shift the single occupant auto to side streets where it would suffer a significant time disadvantage. The result should be a major time advantage for buses and car pool situations and be a persuasive variable in a person's mode selection.

The curves also illustrate convenience and its importance in mode choice selection. Several items were included which hypothesized a bus trip of either 25 or 40 minutes, but which varied the waiting time from three to 12 minutes and with the cost the same in all cases. The results clearly show that people would rather ride than wait. A trip of 25 minutes total time with only a short wait was clearly preferable to one of the same overall time but which included a longer wait. When it is realized that waiting time does not normally substitute for riding time, but rather is in addition to riding time, it is clear that it is important to provide service on as short a headway as possible.

A rough idea of the relation between desirability and cost can be realized by plotting the D-scores obtained for these stimuli against cost, as in Figure 5-2. The points appear to describe a straight line with the true curve somewhat concave upwards. This suggests that desirability will be more sensitive to small fare changes when the fare is low than when it is relatively high, for the curve should be steeper in this region.

Data was collected on the background variables of race, sex, age, income, subjective social class, education, present time of commute, and present mode of commuting, and mean judgements for each trip were computed within each class of each of these variables. An analysis of variance was then run to determine which of these variables seemed to have an important effect on modal preferences, and it was found that the effects were generally not important. On income, age, education, subjective social class and present time of commute the observer differences were negligible and statistically insignificant.

Figure 5-2: Sensitivity to Cost, Entire Austin Sample

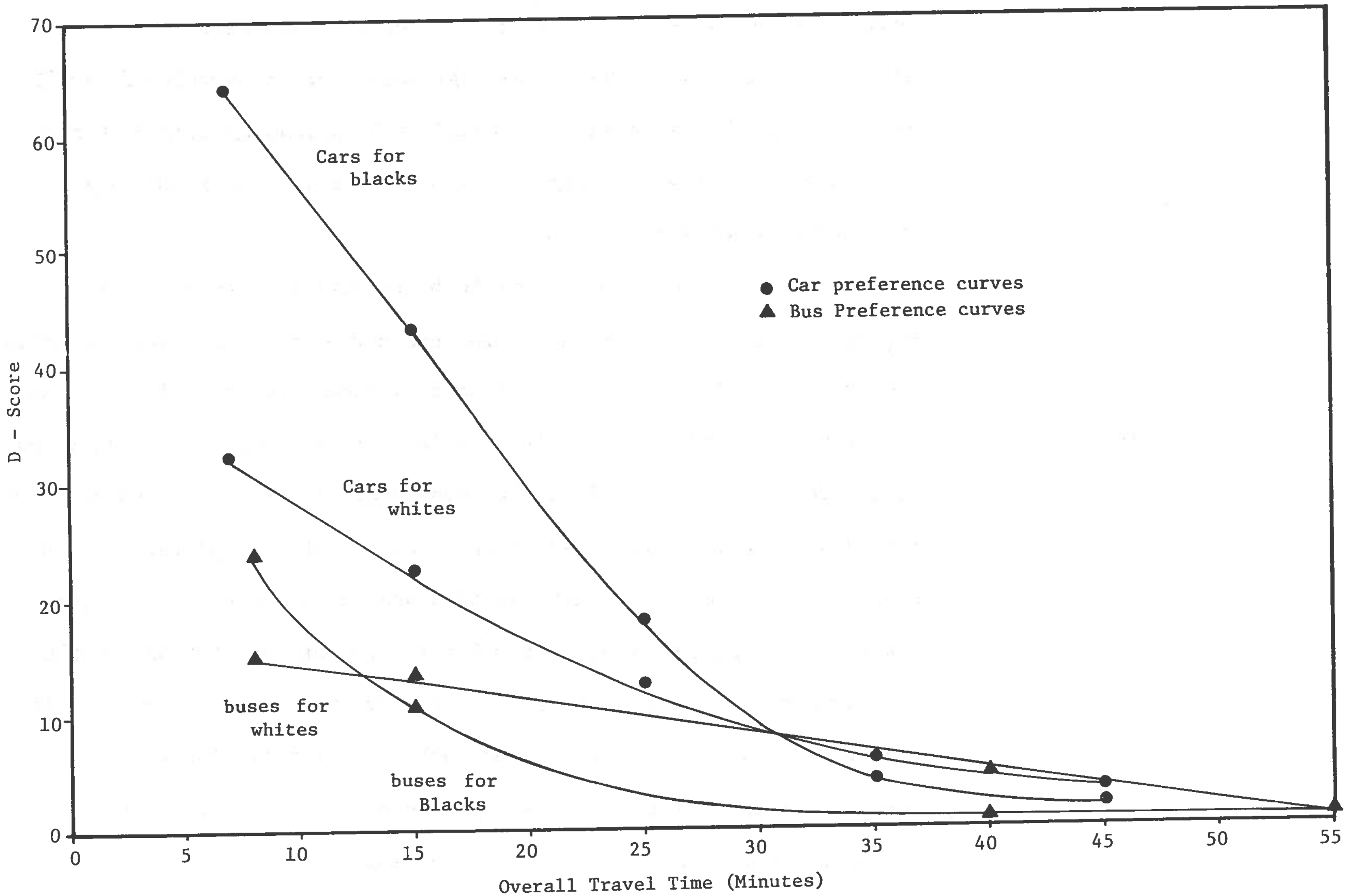


Source: Allen M. Shinn, "Towards a Policy Oriented Urban Transportation Demand Model: A Psychomertirc Approach to Modal Split" Paper presented at Urban Regional Information Systems Association, San Francisco, August 1972.

On the sex variable there were some statistically significant differences, but they were not striking. The only substantial difference occurred in attitudes towards walking; women were less willing to walk than men, and the difference increased with increasing length of the walk. Attitudes towards trips by car or bus did not seem to vary in any consistent or important way.

The ethnic variable turned out to be significant, however, and Figure 5-3 presents two modal preference curves for the Black and Anglo groups. The main effect seems to be an increased sensitivity to time on the part of the Black sample. While neither group found long trips to be desirable, the Black sample found short trips to be considerably more desirable than the Anglo group. The effect is apparent in both the car and bus curves. There is also some difference in the relative positions of the two modal curves for the two groups; for Anglos the bus curve rises slightly above the car curve for longer trips, and it appears that at these trip lengths Anglos are largely indifferent between the two modes. For Blacks, however, the bus curve remains definitely below the car curve over the entire range. A possible interpretation is that Blacks who use the bus are more sensitive to the status implications of riding the bus. This is hardly surprising since

Figure 5-3: Modal Preference Curves by Race



Source: Allen M. Shinn, "Towards a Policy Oriented Urban Transportation Demand Model: A Psychometrics Approach to Modal Split" Paper presented at Urban Regional Information Systems Association, San Francisco, August 1972.

in some parts of town the only users of the bus system appear to be Blacks.

The differences between the attitudes of the bus and car groups is quite apparent. The preference curve for regular bus riders is considerably above the preference curve for cars except for very short trips, while the reverse is true for car users. The car groups show a preference for the auto throughout the range investigated which is an important check on the accuracy of the preference curves in general, for if they did not predict reasonably well the present behavior of the sample would be suspect.

An assessment is needed on how people perceive the dollar cost of operating an automobile and the attributes they consider important in mode selection. In this study the social image attached to a mode is an important attribute. Buses running throughout the affluent western part of Austin carry predominantly domestic help and yardmen but rarely the professional businessman residing in the area.

Another factor considered to be important appears to be citizen participation in the transportation planning process. Reston, Virginia, although not typical of other U.S. urban areas, has a commuter bus system which is organized by a citizens committee, operates without subsidy, and whose tickets are collected by a rider who receives a weeks free pass. It carries over half the commuters from Reston to Washington a distance of some 20 miles. Neighboring communities have inferior bus services and most of their commuters use their cars. It appears that citizen involvement does produce improved service since they feel the service is responsive to their demands. Consequently they make sure the system runs on time, is flexible and costs are kept to a minimum. The Austin Tomorrow Program is soliciting similar citizen input.

The results suggest we need to concentrate on the "social demand structure" of transportation, that is, the way transportation preferences vary based on different characteristics of the transportation system and trip maker. Further, despite rising levels of affluence many people, especially the young, aged, the infirm and the poor do not own a car and make fewer work trips than commuters. Consequently, the transportation system should be structured to consider their needs and by so doing the needs of other commuters will be satisfied.

Model 2: A Public Transportation Market[8]

A sample of over 250 adults, 18 or over, in the Austin Metropolitan

Area were surveyed in a random sample of Austin households, stratified by census-tract area with quotas proportional to population. Personal interviewers contacted each respondent, discussed the purpose of the interview, and assisted in questions concerning the survey forms. Respondents filled them out in the presence of the interviewer.

In addition to the general Austin survey, the same data was gathered from at least 50 random samples of persons identified as "city leaders" made up of financial people, Church leaders, Chamber of Commerce members, frequent bus riders and students. Bus riders were obtained in a two-stage process. A random sample of bus riders were contacted on the bus and they were surveyed later at home in the presence of the interviewer. Routes and times of day were selected in order to provide a representative sample of riders of the city route and time patterns. The data was gathered between April and June of 1974.

This section reports only on the preliminary results of the general adult and the "city leaders" sample. While it is not expected that many from the latter sample will switch to a public transit mode, their views on the development and financing of mass transit systems is considered important to city policy groups. Only the findings of the predominant commuter trip, the work trip, is addressed since the potential positive benefits to the Austin community is considerably greater if mass transit patronage is increased for this trip with the resultant concomitant decrease in congestion, pollution, etc.

The subjects sampled were asked to evaluate the relative importance of 27 modal attributes, e.g. flexibility, dependability, low pollution per passenger, in their travel mode for the work trip and their perception of the differences they perceived among the various competing transportation modes available to them on these attributes for this trip.

The data identified potential switchers to mass transit, that is those people presently not using public transit but who would definitely use it if certain changes in bus features were initiated. Attitudes to the financing of public transportation are highlighted and a cursory description of the T.V., Radio, and Newspaper media most popularly used by the respondents and therefore most useful to transportation planners in the marketing of mass transit is presented. Demographic profiles are described which makes it easier to identify the potential switcher groups.

Policy Conclusions

Approximately one-sixth of the general adult sample surveyed are poten-

Table 5-2
Ranked Attributes for Potential Switchers, Austin

Rank	Attribute	Car or Bus Superior
1	Dependability	Car
2	Low energy use per passenger	Bus
3	Economy	Bus
4	Low pollution per passenger	Bus
5	Convenience	Car
6	Flexibility	Car
7	Freedom from repairs	Bus
8	Freedom from accidents	Bus
9	No parking problems	Bus
10	Brief travel time	Car
11	Safe from dangerous people	Car
12	Relaxing	n.s.d.
13	Ease of travel with packages	Car
14	Avoid traffic congestion	Bus
15	Freedom from weather	Car
16	Uncrowded	Car
17	Privacy	Car
18	Ability to look at scenery	Bus
19	Ease of travel with children	Car
20	Pleasant riding surroundings	n.s.d.
21	Ability to read	Bus
22	Quiet ride	Car
23	Opportunity to socialize	Bus
24	Smooth ride	Car
25	Can listen to radio or tape	Car
26	Fun to drive	Car
27	Socially accepted transportation mode	Car

Source: Mark I. Alpert and C. Shane Davies, "Segmentation of a Transportation Market by Determinant Attitudes," forthcoming Environment and Behavior, Spring, 1975.

tial switchers. These are individuals who presently use a car for the work trip but who would, given feature changes in public transit, change to the bus for this trip. Since the general adult sample was randomly selected these switchers are representative of the potential switcher market presently available among the Austin adult population. Since the present transit system captures some three to five percent of total local trips then the potential for improved patronage is optimistic.

The potential switchers rated in descending order those attributes they considered most important, and whether the bus or car was superior on that attribute. The attributes rated in descending order of rank and the superiority of the bus or car on this attribute are listed in Table 5-2. Naturally, while dependability can be built into a transit system, it is difficult to tailor the travel time and flexibility of the service to meet the spectrum of trip purposes--work, shopping, school, recreation, etc.

These determinant attributes selected by the potential switchers should be emphasized by transportation planners since they offer the greatest potential market for patronage increase. To appeal to potential switchers, city transportation planners need to incorporate desirable levels of the first 11 determinant attributes. The remaining attributes were found not to be statistically significant, that is, they were not important for the work trip. However, some, such as "ease of travel with packages" become important when a shopping trip is involved.

The bus is perceived by the switchers to be superior on several attributes. If mass transit planners can improve on those attributes not perceived as being superior by the potential switcher group such as dependability, convenience, flexibility, travel time and safety from dangerous people and to emphasize the perceived advantages of the bus
144 in terms of environmental gains, economy, parking and less accidents, then the public transit system could conceivably gain increased patronage. The findings are very supportive of city's present Transit System. Their present innovative policy attempts to improve flexibility through park and ride service and dependability through reduced headways.

The demographic profile shows the potential switcher group to be relatively young, with mean age of 30 to 35 years, members of small households and more than likely to be working in the State Capitol, University and Downtown complex. The geographic concentration of this complex, which supplies thousands of jobs, assists the development of viable public transit.

Concerning attitudes towards the financing of public transit, community leaders were more strongly opposed to property tax subsidies of mass transit than the general adult sample but were more supportive of a sales tax subsidy than the general sample. However, most financing solutions were opposed by both groups with slight support by both groups for tapping the "highway trust fund" for support of public transit financing. The study indicated an increasing sensitivity towards the service characteristics of the bus system.

Conclusion

The solicitation of Austinites' preferences for transportation provides the planner with knowledge of what attributes the public transit system should emphasize in order to appeal to citizens and thus increase transit patronage. The evidence presented here suggests that Austinites are appreciative of transit service improvements and are receptive and sensitive to changes which permit them greater mass transit options.

References

1. a) Fertal, Martin J., et al., "Modal Split": Documentation of Nine Methods for Estimating Transit Usage (1966) Government Printing Office, Washington, D.C. b) Voorhees, Alan M. and Associates Inc. Modal Split Model. Erie Area Transportation Study, Staff Report, No. 3, September 4, 1963. c) Quarmby, D.A., Modal Split Review, a report prepared by the Greater London Council Planning and Transportation Department, London, United Kingdom, May 1970.

2. a) Kain, J.F. and M.E. Beesley. "Forecasting Car Ownership and Use," Urban Studies, Vol. 2, No. 2, November 1965, pp. 163-185. b) Adams, W.T. "Factor Enhancing Transit and Automobile Use in Urban Areas," Highway Research Bulletin, No. 230, 1959, pp. 101-111. c) Bevis, Howard W. "Trip Length by Mode of Travel in CATS Area," CATS Research News, Chicago Area Transportation Study, Research News, Vol. 2, No. 11, June 1958. d) Kasoff, M.J. Socioeconomic Factors Underlying Public Transit Use in the Journey to Work, Occasional Paper No. 1, a report prepared for Syracuse University, Syracuse, New York, June 1970.

3. a) Chicago Area Transportation Study (Final Report) Vol. 1, December 1959, Chapter V; Vol. 2, July 1960, Chapters V and VI. Chicago, Illinois, 1960. b) Urban Mass Transit Planning Project--Technical Report 4: Modal Split Simulation Model, for the Department of Transportation, Washington, D.C., August 1967.

4. a) Quarmby, D.A. "Choice of Travel Mode for the Journey to Work," Journal of Transport Economics and Policy, Vol. 1, No. 3, 1967, pp. 273-314. b) Sharpe, G.B., W.G. Hansen and L.B. Hamner. "Factors Affecting Trip Generation of Residential Land-Use Areas," Highway Research Board Bulletin, No. 203, 1958, pp. 20-36; also Public Roads, Vol. 30, No. 4, October 1958. c) Warner, S.L. Stochastic Choice of Mode in Urban Travel: A Study in Binary Choice, Evanston, Illinois, Northwestern University Press, 1962. d) Stopher, P.R. "Predicting Model of Travel Mode Choice for the Journey to Work," Highway Research Record, No. 283, 1969, pp. 57-65. e) Lave, C.A. "A Behavioral Approach to Modal Split Forecasting," Transportation Research, Vol. 3, No. 4, December 1969, pp. 463-480.

5. Moses, Leon N. and Harold F. Williamson, Jr. "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation," Journal of Political Economy, No. 71, June, 1963, pp. 247-264.

6. Shinn, Allen M., Jr. and Shane Davies. Measuring the Utility of Housing and Transportation, a research report supported by the National Science Foundation, University of Texas, Austin, Texas, Summer 1971. Davies, Shane "Value of Travel Time" Council for Planning Librarians #675 supported by National Science Foundation GS-28352.

7. The support of the National Science Foundation contract number GS-28352 is gratefully acknowledged. This section is abstracted from Shinn, A.M. "Toward a Policy Oriented Urban Transportation Demand Model: A Psychometric Approach to Modal Split," paper presented at the Urban Regional Information Systems Association, San Francisco, August 1972.

8. The support of the Department of Transportation contract number DOT-OS-30093, administered through the Council for Advanced Transportation Studies, University of Texas at Austin is gratefully acknowledged. This section is abstracted from Alpert, Mark I., and C. Shane Davies, "Segmentation of Transportation Market By Determinant Attitudes" forthcoming American Association of Decision Sciences, Fall 1974 and an extended version forthcoming in Environment and Behavior. R. Dobson and T.F. Golob (eds.) 1975.

Alternative Modes

Chapter 6

Introduction

This section on the economic aspects of urban public transportation provides a base of comparison for Austin citizens to judge what transportation modes are suitable for adoption in a city with the present and predicted characteristics of Austin. A variety of transportation mode alternatives are presented so that the reader may judge in the light of Austin's characteristics what is most feasible for this city.

Bus Transit

In 1969, 94 percent of bus transit revenue in the U.S. came from passengers using normal city bus service; the remainder came from charter service.[1] Fares increased on a nation wide average from 15 to 25 cents between 1960 and 1969.[2] General transportation expenses, followed by driver's wages, consumed most of this revenue. Expense per passenger rose from 10 to 15 to 20 to 25 cents and was experienced by all revenue size groups.[3]

In spite of tax relief, 54 percent of the firms did not cover total operating expenses in 1969 compared with 22 percent in 1960.[4] The smaller firms, generating under $1 million in annual revenue experienced the greatest deterioration in their ability to cover costs. Of the small firms, 43 percent were unable to cover variable costs--total expenses less depreciation, amortization and taxes, in 1969.[5]

The profit squeeze experienced by bus firms can be detected not only through the revenue-cost ratio, but also by their fleet characteristics. Since there is little incentive to invest in new plants and equipment, the age of the firm's capital stock increases and maintenance is deferred. The median age of fleets, especially for

small firms, has increased from 9.6 years in 1960 to 10.9 years by 1969. The philosophy of replacing, as opposed to repairing buses is somewhat obscure, especially in the face of rising costs and declining revenue. Those owners who invest presume that new buses will attract more riders. Although this is not an altogether false assumption, one could argue that ridership decline results from fare increases primarily, and service decreases, secondarily. One could argue against this since demand elasticity is very high. By providing new buses, the firms may attract some additional riders, but this new patronage is usually lost when fare hikes are initiated to pay for the new buses.[6] One could also argue that the attractiveness of other modes is also a primary factor in mass transit ridership decline.

The impact of increased fares and decreased service level is readily apparent. Failure to attract adequate patronage has resulted in definite declines. There have been significant reductions in annual passengers per mile (generally 50 percent) for all size firms from 1960 to 1970. Large firms, with greater than 5 million dollar annual revenues, experienced greater absolute reductions than small firms.

In 1969, bus firms across the country continued the downward trend begun in the previous decade. Both small and large bus companies retrogressed rapidly due to sharp declines in passenger density and passenger revenue. A general decline in passenger density may favor the smaller firm which has lower unit costs. The large company has a lower operating ratio, but a higher cost per bus mile due to higher wages demanded in major cities. Revenue per passenger and per bus mile was similar for all size firms.

It is doubtful whether new, bigger buses and even slightly increased service will alleviate the problems of the bus transit industry. A combination of public ownership or subsidy, lower fares, increased service, additional scheduling, improved image, and the energy crisis may aid the industry's recovery.

Urban Rail Rapid Transit

Rail rapid transit is a facility operating within urban areas on exclusive right-of-way above or below ground. Although the total annual revenue of the nine U.S. properties in existence in 1960 increased by 75 percent during the 60's as a result of fare increases, operating expenses proved greater than incoming revenue. A gross deficit of $80 million was incurred in 1970 which did not include depreciation or interest charges.

Only five of the U.S. rail rapid transit properties are discussed since they account for 98 percent of the total U.S. revenue.[7] Both the size of the New York system, which accounts for over 75 percent of the total U.S. revenue and 78 percent of revenue passengers, and the few existing U.S. properties suggests that various solutions are required if their individual financial positions are to be improved.

In cases where revenue passengers have not declined, as in the case of the Port Authority Trans-Hudson Corporation (PATH) system, the operating expenses are still more than twice the revenue generated.[8] Only two of the nine U.S. properties had revenue per passenger sufficient to cover cost per passenger.[9] The two Canadian systems, in contrast, both had sufficient revenue per passenger to cover cost per passenger. The difficulties experienced by these firms are offered as an illustration of the complexity of the issue and the problems Austinites would have to face if similar systems were introduced in this city. Evidence indicates that even in those major metropolitan areas which possess the high density corridors considered suitable for rail rapid transit, system losses result.

THE NEW YORK SYSTEM. From 1960 to 1969 this property incurred heavy losses. In 1960, the total operating revenue was approximately $1 million less than operating expenses, widening to $80 million by 1969. The operating ratio, which is defined as operating expenses divided by total revenue, increased from 1.01 to 1.28 during this period; dropping to 1.14 in 1970. Ridership dropped seven percent between 1960 and 1970 due in part to a fare increase of five cents, which suggests that, depending on the elasticity of demand, an increase in already existing charge may not be justified if it results in an under-utilization of resources. In January, 1970, fares again rose from 20 to 30 cents. Passenger car miles, which were constant from 1960 to 1966, increased by 19 percent between 1966 and 1970. The number of active passenger cars increased eight percent between 1960 and 1966 and then remained constant through 1970.

CHICAGO TRANSIT AUTHORITY. Total operating revenue of the CTA increased through fare increases.[10] Operating expenses approximated the revenue generated from 1960 to 1970. The operating ratio, operating expenses divided by total revenue, fluctuated between 0.97 and 1.03 from 1960 to 1967. The operating profit of $1 million in 1969 became a deficit of $5.3 million in 1970 and the corresponding operating ratio increased from 0.98 to 1.11. This sudden drop in profit is attributed to fare increases: 25 to 30 cents in November 1967, rising to 45 cents in July 1970. Passenger car miles, active passenger cars and miles of single track all increased during this period suggesting that passengers want services to be increased and will continue to patronize rail rapid transit provided the costs of increased services are not exhorbitant.

MASSACHUSETTS BAY TRANSIT AUTHORITY. From 1960 to 1969 operating expenses and revenue generated on this property were approximately equal.[11] The operating ratio fluctuated between 0.98 and 1.06. The number of revenue passengers declined from 1960 to 1963, remained constant, and then climbed in 1967 and 1968, dropping again between

1969 and 1970. In 1960 while operating expenses increased, revenue declined, increasing the operating ratio from 1.06 to 1.32. The first fare increase in seven years occurred in December 1968, from 20 to 25 cents. In the service sector the number of passenger cars remained constant until 1970 when some cars were added. The track mileage has remained constant since 1963.

The pattern of decline experienced by these systems is similar to that found in the bus industry. Firms respond to declining passenger revenue and increasing operating costs by increasing fares and then, if possible, increasing service and investment in new capital stock. The MBTA system showed that fare increased on a gradual basis will not alienate revenue passengers. Despite these efforts, passenger revenue continues to decline and costs continue to rise. Eventually, the government steps in and subsidizes the losing operation, thus prolonging the process of natural attrition although maintaining the service. By continually subsidizing transit operations, the government is supporting the view that the only way to "sell" the public on public transit industry is to make its cost negligible relative to the automobile.

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Bus-Rail Rapid Transit Comparison

Rail rapid transit systems have little or no relation between firm size and profitability when contrasted with bus systems. In 1969, the two smallest and two largest rail rapid transit firms showed profits. In 1970, the only U.S. rail rapid transit operations showing a profit were the two smallest firms. Unit cost relationships for rail rapid transit and bus systems are dissimilar. Small bus systems tend to have smaller unit costs, cost per bus mile, than large bus systems; whereas the small rail rapid system have unit costs higher than larger rail rapid systems.

Rail rapid transit experienced a nationwide decrease of 7.3 percent in annual revenue passengers from 1960 to 1970. Although total revenue increased by 75 percent through fare increases, these increases were exceeded by operating expenses resulting in a gross deficit of $80 million in 1970. Annual passenger car miles increased by 15 percent, the number of cars by 5.7 percent, and track mileage by 2.7 percent. In the early 60's revenues of the majority of U.S. properties covered operating expenses.[12] However, by 1970 this gap had narrowed and all but two had deficits, Shaker Heights and Newark, the two smallest properties.

Some obvious similarities and dissimilarities exist between the bus and rail systems. Both have experienced declines in revenue passengers. To compensate for this decline and sharply rising operating costs both modes increased fares and in some instances, service.

Commuter Railroads

Commuter railroads are run by railroad companies as part of their passenger and freight service and haul passengers to and from the city for an average work trip length of 22 miles. An inspection of 14 of the 16 commuter railroads in 1970 revealed that they were losing money with twelve of the fourteen recording a net deficit. The overall net deficit amounted to $36 million and the aggregate operating deficit amounted to $41 million. Revenues per passenger and per passenger mile are more uniform than the operating cost per passenger.[13] These indices are influenced by operating size as was the case for buses and rail rapid transit.

Total commuter rail patronage dropped six percent from 1960 to 1965 in New York City returning by 1968 to its 1960 level and then remaining constant.[14] New York patronage has remained steady at 126 to 128

million passengers annually since 1965. Chicago and Philadelphia experienced an increase in patronage, with Chicago moving from 62 to 68 million between 1960 and 1970 and Philadelphia moving from 24 to 25 million during this same period. Both Boston and San Francisco experienced a patronage decline from 13 to 11 million and from seven to six million, respectively, during this same period. Nearly all of the railroads examined experienced an increase in average fare or revenue per passenger. Between 1964 and 1970 the average fare increase and the increase per passenger mile for some of the railroads was
158 twenty percent.

The number of revenue passengers increased six percent on commuter railroads from 1967 to 1970; passenger revenue increased 29 percent and passenger miles increased nine percent. Revenue per passenger increased from $.69 in 1964 to $1.23 in 1970 and revenue per passenger mile increased from $3.24 in 1964 to $3.74 in 1970.

The commuter railroad is the only transit sector that did not experience a significant decline in patronage between 1960 and 1970. Although passenger miles and passenger revenue increased, practically all of the commuter railroads had a net deficit because of increasing operating expenses. Other financial support, possibly government subsidies, is needed since the increase in expenses cannot be absorbed purely by patronage.

Taxicab

In aggregate terms, taxis in urban areas transport more people than rail rapid transit and over half as many as bus transit. More revenue is generated by taxis than the combined total of other mass transit operations and in some cities the taxi is the only means of "public" transportation and the only form of "public" transit that resembles private transit in that the service is demand activated, not scheduled. Taxis are used mainly by housewives and white collar workers.[15] The majority of riders are white and of working age, and most trips are from home or work.[16] However, a significant number of riders fall outside of these categories with service and household workers constituting a significant percentage of riders to non-central city destinations. Twenty-six percent of the ridership is generated by students, the unemployed, the retired, and the incapacitated.

The taxi industry is dominated by small fleets of two or more taxis per owner and there are approximately 7,200 companies operating in 3,300 communities.[17] The large ratio of 11.1 licenses per 1,000 population in Washington, D.C. is due to the almost unrestricted entry in this area. The median number of licenses per 1,000 population in 0.57 or a little over one taxi for 2,000 persons and the mean number of 0.93 indicates the influence of large metropolitan areas.

In addition to being demand activated, taxis are also similar to private automobiles in the number of passengers carried. A sample of 194 communities in 1969 indicated that taxis carry about 1.6 passengers per trip for an average trip length of 4.5 miles.[18] Typically, they carry 14,000 passengers per year some 40,000 miles for an average of 0.35 passengers per vehicle mile.

160 The taxi industry, by providing demand-activated systems, via radio-dispatch or cruising, operates about three times as many vehicles for two times as many revenue vehicle miles. Despite this heavy underutilization the passenger revenue in 1970 was 2.2 billion dollars or $600 million more than the combined total revenues of the bus and rail industries. These high returns can be attributed in part to fare increases.

It is apparent that taxis are not experiencing as great a profit squeeze or decline in operating ratios.[19] They are able to cover all variable costs and interest, depreciation and taxes and still retain a profit margin. In comparison with the previous evidence presented from other transit industries, it is obvious that transit patrons prefer a demand activated as opposed to a scheduled operation. Furthermore, they are willing to pay higher costs per mile for this service, thirty to thirty two cents per mile.[20] Although it can be argued that each transit industry serves a specific need, for an average trip of 4.5 miles the taxi should realize more competition from the bus, especially when the latter has a considerably lower fare. Yet, taxis continue to show profits and buses continue to experience deficits.

Energy and Vehicle Operating Characteristics[21]

Electrically powered vehicles are no more energy efficient than gasoline or diesel powered vehicles in terms of propulsions per unit of energy consumed. For the automobile, energy losses occur within the engine of the automobile; for electrically powered vehicles, most of the energy losses take place at the generating plant and along the distribution lines.

For a public transportation system to be efficient, it must not only have efficient vehicles but they must be heavily utilized. Vehicle usage is measured on the basis of passenger miles of travel divided by vehicle miles required to provide the service, including vehicle recirculation requirements. The recirculation, or deadheading, means that average transit occupancy on bus or rail, is only about one-fourth of what it appears to be at its peak usage. In spite of this, mass transit is most efficient, that is, has its maximum capacity during its busiest hours with an adverse effect on terminal facilities. Conversely, a characteristic of automobile use is that occupancy reaches its lowest levels during peak hour periods.

In a recent major report by Alan M. Voorhees and Associates the diesel powered local bus was found to be as energy efficient as rapid rail systems. Local buses competing with rail systems in the suburbs get two to three times as many passenger miles per gallon as rail systems. Further, buses are less expensive to purchase and operate and more flexible in adjusting to schedule and route changes than fixed rapid rail systems.

With the exception of suburban rail and express bus systems which are calculated on the basis of passengers having to ride or drive to the transit station, all modes of intra-city transportation are compared on the basis of passengers who first have to walk to the transit stop. The energy efficiencies of typical work trips is measured in passenger miles per gallon. Passenger miles per gallon or gasoline

Table 6-1
Energy Efficiencies (Passenger Miles Per Gallon)

Mode	Pass. Miles/Gal.
Walk-in Rapid Rail (N.Y.C.)	109.0
Local Bus (3 mil. pop.)	93.1
Small Auto (4 occupants)	71.8
Van Pool	70.0
Walk-in/CTA Rail (Chicago)	70.0
Small Auto (3 occupants)	55.1
Local Bus (300,000 pop.)	46.6
Standard Auto (5 occupants)	44.9
Park-Ride/Rail Rapid (N.Y.C.)	41.7
Dial-a-Bus/Express Bus	39.8
Park-Ride/BART (San Francisco)	38.8
Small Auto (2 occupants)	37.8
Standard Auto (4 occupants)	36.7
Park-Ride/CTA Rail (Chicago)	35.6
Park-Ride/Express Bus	34.6
Park-Ride/Commuter Rail	30.6
Standard Auto (3 occupants)	28.2
Kiss-Ride/Rapid Rail (N.Y.C.)	24.6
Kiss-Ride/BART (San Francisco)	23.6
Kiss-Ride/CTA Rail (Chicago)	22.3
Kiss-Ride/Commuter Rail	20.3
Kiss-Ride/Express Bus	21.9
Small Auto (1 occupant)	19.3
Standard Auto (2 occupants)	19.3
Standard Auto (1 occupant)	9.9

Source: Background, Highway Users Federation, Washington, D.C., 1974.

for various modes of urban transportation is derived from an energy efficient measure, miles per gallon of gasoline per vehicle, and a measure of the efficiency of actual use of a system, passenger miles per vehicle. Table 6-1 is a comparison ranked according to energy efficiency of a typical work trip of 10 miles over rapid rail, commuter rail, bus and other urban transportation modes.

The findings pertinent to this study are as follows. Cars get fewer miles per gallon today than in the past. The 1973 average for urban driving was 11.7 miles per gallon (mpg); in 1958 it was 14.07 mpg. The increasing weight of automobiles is the main factor causing this decrease. A 2,000 lb car gets almost twice the gas mileage achieved by a 4,000 lb car. This inverse relationship also holds true for mass transit vehicles. Other factors affecting auto fuel economy are engine design, emission controls, air conditioning, automatic transmissions, tire inflation and design and driving habits. Rapid fuel consumption increases over 50 mph, are attributed to both aerodynamic drag and inefficient gear ratio.

Two other factors are roadway and traffic conditions. A major city street with badly broken or patched pavement can increase fuel consumption 20 percent for 30 mph traffic. Heavy, slow-down-speed-up traffic on a freeway can increase fuel consumption by as much as 50 percent. And if the traffic has to stop, even more gas is wasted. This is particularly crucial for bus travel within cities which carry 70 percent of America's mass transit passengers.

Highway construction projects can assist in the effort to improve fuel economy. For example, the limited access Interstate system, when completed, will result in a 20 percent fuel savings when compared with major arterials passing through intersections. Improved traffic flow and reduced delay through low-cost operational improvements can achieve substantial fuel savings. In a study of signal timing in California it was observed that a 19 percent fuel saving could be achieved by simply re-timing traffic control signals in a 60 intersection system.

However, when changing from one mode of transportation to another, for example from cars to rail, one will only achieve a limited improvement in efficiency in the near future. The capacity of current transit systems to absorb additional passengers is small and even if its maximum capacity were achieved, the fuel savings would be less than four percent. The success of mass transit in reducing automobile travel is directly related to its attractiveness. Even if the number of mass transit vehicles were doubled, its portion of urban work trips would increase less than five percent, from 13.7 percent to 18.4 percent.

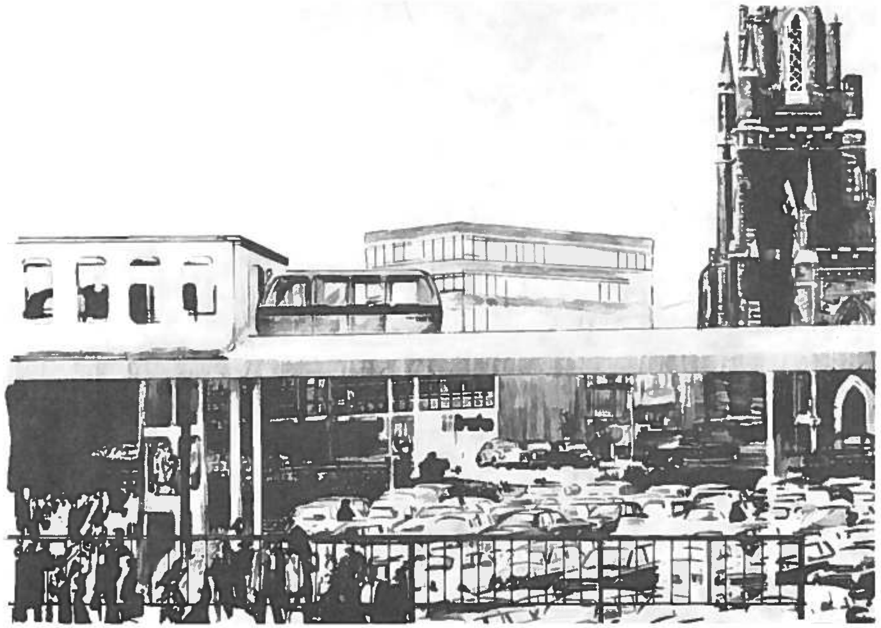
Furthermore, mass transit's portion of all urban trips including trips to movies, shopping centers, schools, as well as jobs would increase only from six to eight percent. Now and probably in the future, the greatest potential for work trip efficiency lies in boosting automobile occupancy through carpools and other ride-sharing plans. If increases in these informal methods of mass transit are not attainable, then the next best, most cost-effective method, is bus mass transit.[22]

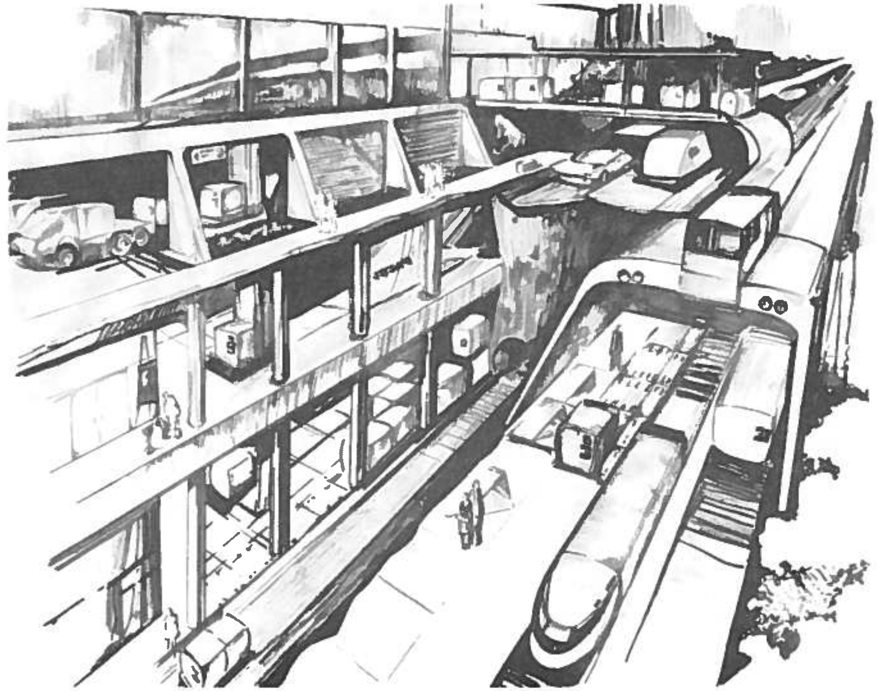
FUTURE SYSTEMS. The following systems are in use in U.S. cities or are under consideration for adoption. Although some have trappings of science fiction they are viable alternative systems for urban areas.

Dial-A-Bus. Mini-buses can carry 10 to 25 passengers, make front door pickups and transport the rider to a desired destination on telephone request. These "mini-buses" have easy exit and entrance, are not crowded and are luxurious. These buses are sometimes operated by computer, location-timing programs. The dispatcher verifies the location of the caller and feeds this information to the computer which analyzes the present bus locations relative to the potential rider and dispatches the nearest bus to the caller based on the shortest travel-time path. The benefits of such a system are: 1) fare decrease through greater vehicle ridership; 2) handling door-to-door travel demand at the time of the demand; and 3) reduction of automobile dependence. The dial-a-bus can average some 100 trips per hour per square mile. This monitoring system also serves city police, ambulance and other city utility vehicles.

Personal Rapid Transit (PRT). The PRT carries people non-stop in small cars between stations along a network of fixed guideways. It can serve major activity centers such as airports, shopping malls and the C.B.D. The PRT provides fast, almost non-stop transportation for travelers, similar to the automobile freeway systems. The PRT reduces travel time, minimizes on frustration and maximizes on passenger comfort. Vehicles could wait for passengers and not passengers having to wait for vehicles on by-pass tracks off the main line. The advantages of the PRT include 1) operation on an exclusive right-of-way; 2) inconspicuous guideways; 3) full automatic computer control and vehicle management; 4) fast efficient service; 5) an atmosphere similar to an automobile interior for privacy and personal intimacy; and 6) improved passenger accommodations and safety with reduced

Figure 6-1 A: Future Systems





air pollution. PRT cost per passenger seat is less than half that of dual rail systems and only a fraction higher than current bus costs. PRT guideway costs are one half the cost of an elevated rail system but requires several times as much cost to give the same area coverage. In tunnels, PRT guideways are about two thirds cheaper than rail. However, the PRT is still very expensive and the latest experiment at Morgantown, West Virginia proved to be an abject failure.

The following are some of the PRT developments presently available. 1) a track-guided system called "Cabinentaxi", consists of three-passenger vehicles, automatically controlled, driven by two-sided linear induction motors with variable voltage speed control, run on solid-rubber tires, managed asynchronously, and run both above and below a single guideway. The system is free from high noise and harmful emissions; fits into the structure of the built-up area and offers a good transport service. It is presently undergoing field trials for vehicle, guideway, station, and system control; 2) the "Aramis" attains high capacity by running vehicles with four to ten passengers on electronic guideways. This system has been in full-scale experimentation at Orly International Airport, Paris, since March, 1973. It is considered adaptable to cities of 200,000 to 1,500,000 people.

It offers the passenger the choice of a preassigned destination or assignment on request; 3) computer-Controlled Vehicle System (CVS) is intended for short-distance transportation in cities, as an alternative to the taxis. Two to four seater cars move driverless on exclusive guideways. They are powered by electricity and are centrally controlled and managed. They are suitable for conveying freight, newspapers, and mail. It is particularly adaptable to city-center areas and is reasonably low cost, estimated guideway cost is $770,000, per single km-land. A full-scale experiment, known as the Higashimurayama Project, is presently operating under the auspices of the Japanese Ministry of International Trade and Industry and Tokyo University; 4) the Ford Automatically Controlled Transportation System (ACT) utilize driverless, rubber-tired, electronically propelled vehicles which operate under computer control on a guideway. The control system routes and schedules vehicles in response to demand-responsive travel or scheduled service. A test track for the Fort ACT system is in operation west of Dearborn, Michigan. The Ford Company is now installing an ACT System at the Fairlane Town Center in Dearborn and at Bradley International Airport in Connecticut; 5) the Airtrans system (installed at the Dallas/Ft. Worth International Airport) is automated and is designed to carry people as well as cargo, and is supported by rubber foam filled tires to avoid punctures. This system has all the trappings of advanced technologies such as the air cushion and linear-induction propulsion. It is also equally adaptable as an elevated or at-grade installation; and 6) finally, Monocale is a transportation system of small automatic six-passenger vehicles operating on unobstrusive aerial guideways, using parallel over/under stations which allow direct origin-destination travel without the need for turn arounds or grade changes for access to the main line. The system is designed for applications in which trip times are normally less than 10 minutes, and complements rather than competes with traditional mass transit. It can be installed above existing right-of-ways without interferring with existing ground traffic. The typical cost, including vehicles, guideways and stations, is $4 million per mile.

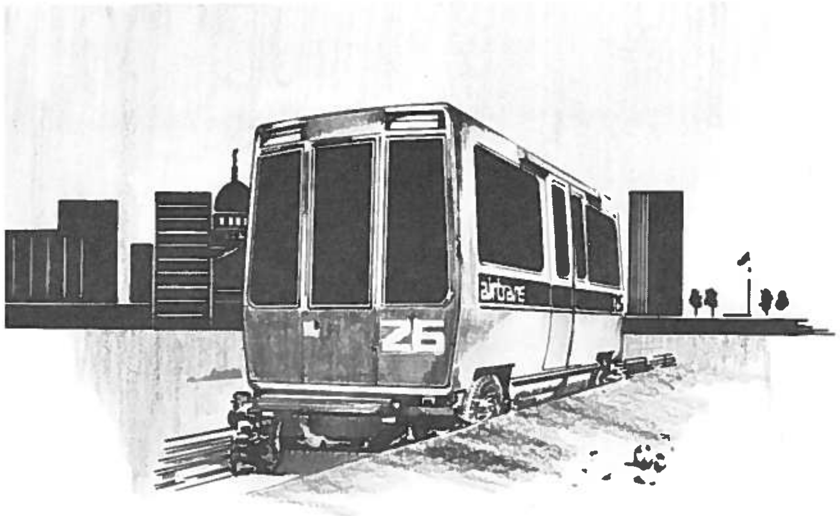
Conveyor System. This system can carry up to 22,000 persons per hour in wheelless cars that move on a conveyor belt track at speeds of up to 15 mph. Passengers board from parallel moving platforms synchronized to the station speed of the cars which is approximately 1 1/2 mph. As the cars leave the station they move over a group of accelerator wheels which increase car movement to cruising speed with decelerator wheels reversing the process at the next station. The difference between the cruising and station speed causes the cars to arrive at the station bumper to bumper which assures the continuous availability of cars. Costs are very expensive ranging from five to seven million dollars per track mile. This system can be used as intermediate transportation linking shopping malls and C.B.D. perimeter areas to alternative transport.

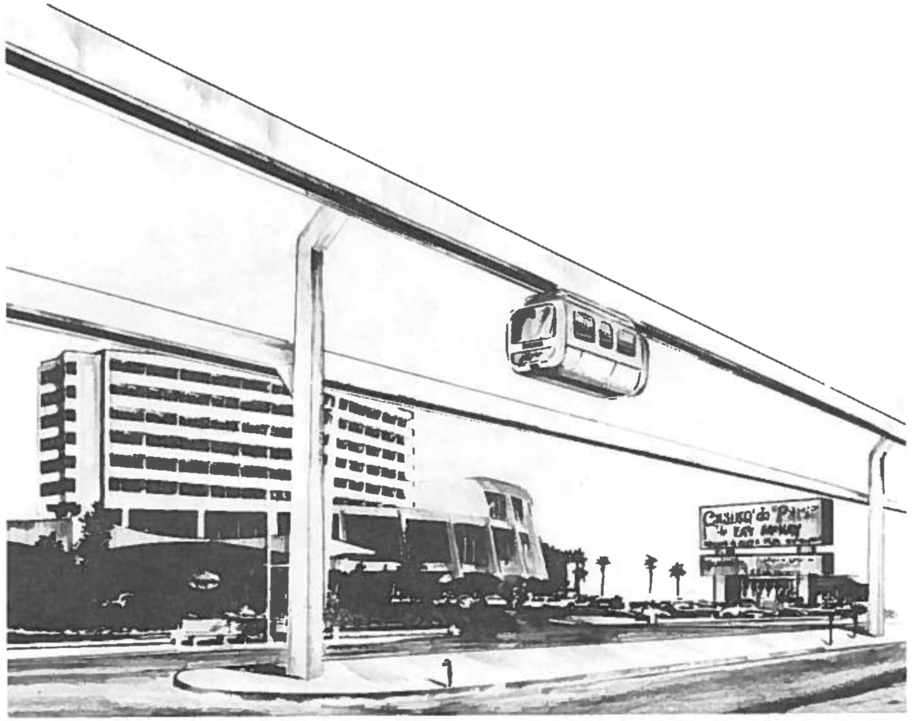
Horizontal Elevators. The horizontal elevator is an automated train of small cars which has the mechanical ability to couple and uncouple. At peak hours the individual cars are connected to form long trains and during off-peak periods the cars are disconnected to serve smaller passenger loads.

Mini-Electric Cars. This car is similar to a golf cart. It is small, low-powered, battery-operated, and reduces pollution and noise and takes up less than half the space taken by a conventional automobile.

Hovercraft. Hovercars, are a viable alternative to wheeled vehicles. They are powered by the reaction between current carrying windings and imbedded metal in the track. Air resistance is the main impediment to movement. A hovertrain could be used on central city-to-airport routes with almost "no-wait" two minute intervals between vehicles

Figure 6-1 B: Future Systems





at speeds of up to 250 mph, provided rights-of-way could be acquired.

High Speed Tube Transportation. The tube system is similar to a large pipe through which vehicles travel at high speeds. The necessity for straightness makes route construction very expensive, $4 to $5 million dollars per route mile. The theory of the tube system involves 1) a pumping out of air inside the tube to minimize air resistance to the projectiles; 2) creation of a pneumatic vacuum; and 3) re-entry of air into the tube behind the passenger modules, with sufficient force to push and accelerate the module. Water in the bottom of the tube acts as a shock-absorber and deadens the sound. The vehicular modules are thin-walled cylinders approximately 65 feet long by 9 feet in diameter which move by wheels on rails within the tube. One could make a trip of 85 miles in 13 minutes at an average speed of 390 mph. An urban network of tubes radiating in six directions from metropolitan New York City with headways of 10 minutes, has a single tube capacity of 36,000 passengers per hour. This capacity is doubled for pairs of tubes running side by side. Sub-level tube systems reduce surface-level environmental problems by 1) reducing automobile traffic and pollution; 2) accidents; and 3) abuse of the landscape.

Conclusion

These exotic systems are costly and dubious in effect. The Morgantown, West Virginia PRT system has been a costly abject failure. Instead of searching for exotic transportation solutions, improving presently available systems by remedying their difficulties and increasing their performance level should be given the highest priority. This means operating the available street and highway network more equitably and efficiently by upgrading present transit systems.

References

1. Congressional Quarterly Weekly Report February 1970.

2. Wilfred Owen, The Accessible City, Washington, Brookings Institute 1972 pp. 1-150.

3. Wells, John D., ed., Economic Characteristics of the Urban Public Transportation Industry, Institute for Defense Analyses, February, 1972, pp. 3-24. Ibid., Table 3B 4 - Revenue Per Passenger, By Revenue Size Group, 1960 and 1969.

4. Ibid., Table 3B. 9 - Expenses Less Depreciation and Amortization Per Passenger, By Revenue Size Group, 1960 and 1969.

5. Tables 3B. 1, 3B. 2 and 3B. 3.

6. Table 3B. 14.

7. Figs. 6.1, 6.2, 6.3, 6.5 and 6.7.

8. Ibid.,

9. Ibid.,

10. Ibid.,

11. Table 6.17.

12. Ibid.,

13. Table 2.18 and 2.19.

14. Table 2.22.

15. Table 2.25.

16. Table 8.4.

17. Table 2.27.

18. Tables 8C. 3, 8C. 11, 8C. 13, 8C. 15 and 8C. 17.

19. Table 2.29.

20. Table 8.14.

21. Alan M. Voorhees and Associates, Energy Study Shows Advanteges of the Bus, Highway Users Federation, Washington, D.C., July 9, 1974 (memo).

22. Ibid.

Federal State and Local Transportation Legislation and Financing

Chapter 7

Public Transportation Legislation

In transportation legislation, the 1973 Federal Aid Highway Act, signed by President Nixon on August 13, 1973, provides 18.7 billion dollars to The Highway Trust Fund over the three year period 1974-1976. Currently, this fund is used for highway construction only, but with the passage of this recent bill money can now be spent on mass transit if the cities, States and the Secretary of Transportation all agree that a specific stretch of highway need not be built. However, the trust fund will be held inviolate through fiscal 1974. In fiscal 1975, $200 million will be made available to metropolitan transit systems for the exclusive purchase of buses. In 1976, cities will have the option of spending $800 million on mass transit, including rail systems. Although these appropriations are relatively small in comparison with total appropriations for highways, this is a step forward in changing the national transportation spending priorities.

A concern with the federal assistance or grant-in-aid programs is that the response of state and local governments to the needs of their citizens is being determined by federal policies and funding levels.

Federal assistance may constrain smaller governmental bodies to policies that fail to achieve satisfactory results. The argument is for a national grant policy that is more amenable to local experimentation. One way of insuring both federal assistance and local experimentation is to broaden the range of programs elegible for federal assistance. The use of part of the Highway Trust Fund for mass transit is an example. The idea, simply is to increase the options for the city or state without decreasing funding.

The first direct national legislative action dealing with urban
178 transportation problems came in the form of the Housing Act of 1961. This Act consisted of three amendments to existing legislation. The first section which amended the Housing Act of 1949, authorized $25 million in federal aid for the Demonstration Grant Program. Two-thirds of the cost of the transit Demonstration Grant Program went to the operational aspects of the program. Funds were not intended for long-term capital improvements but for the development of informational and operational techniques applicable throughout the nation. Forty-eight percent of the $25 million allocation aided suburban commuter railroads, a mode serving only six percent of public transportation passengers. The second provision of the Housing Act of 1961 amended the Housing Act

of 1954 to require mass transit to be an integral part of comprehensive urban planning. The third provision, amending the Housing Act of 1955, initially authorized $50 million for the capital investment needs of mass transit through low interest rate loans.

President Kennedy's transportation message of 1962 re-emphasized urban transportation needs. The address emphasized the necessity for continuing demonstration grants and comprehensive planning in urban areas. During that same year additional emphasis was placed on the coordination of transportation planning in the form of the Federal Aid Highway Act which recognized the need for coordinating all aspects of urban transportation.

These transportation policy changes gave impetus to the Urban Mass Transportation Act of 1964. This Act has served as the primary instrument for federal transit assistance to public transportation. The Act initially authorized $375 million in matching funds to local public transit agencies over a three year period. The purposes of the Act were: (1) to coordinate assistance between the federal government and public and private companies to help develop mass transit; (2) to plan and establish regional transit systems and (3) to assist states and cities in financing their transit systems and needs. The Act which continued the demonstration program begun in 1961 also authorized a new program of grants for capital equipment not to exceed two-thirds of the net cost of the project. Finally, the act of 1964 called for coordination of planning in the development of urban transportation.

The Urban Mass Transportation Act of 1964 which was amended in 1966 authorized continued grant expenditures through fiscal 1969 at the rate of $150 million per year. Section 9 of the 1966 Act called for a Technical Studies Program and provided aid for functional planning. Grants up to two-thirds of the project cost were authorized to public agencies to determine the type of location of a transportation system needed in a specific area and to assess its impact on the community.

Until the inception of the Department of Transportation in 1966, transportation came under the realm of Interstate Commerce, principally, the Housing and Home Financing Agency, and Housing and Urban Development. Therefore, legislation such as the High Speed Ground Transportation Act of 1965 was implemented by different agencies and for different purposes.

The above mentioned High Speed Ground Transportation Act authorized the Secretary of Commerce to undertake research and development in high speed intercity mass transit. The legislation provided for a series of demonstration projects with a total authorization of $90 million through fiscal year 1968. The Act stated, that the establishment of a Department of Transportation is necessary to the public interest and to the effective administration of federal transportation programs.[1]

Further diffusion of authority and policy-making is evident in the indirect impact of transportation planning. Various federal agencies not dealing directly with transportation may develop programs having an indirect impact on transportation. For this reason, agreements, such as the Technical Services Agreement between the Department of Transportation and Housing and Urban Development beginning in September of 1968, were formulated to assist the Department of Transportation to fulfill their objectives.

Policy coordination is a less difficult task than the coordination of finances. The Department of Transportation has been largely underfinanced, and annual appropriations, as opposed to long-term financing, are endemic to the successful development of programs and policies. The Urban Mass Transportation Assistance Act of 1970 sought to confront some of these problems by providing long-term financing or expanded urban mass transportation programs.

This Act appropriated $10 billion for twelve years to continue local planning and provide greater flexibility in program administration.

In line with the current administration's policy of decentralized decision-making, this Act sought to permit local communities to exercise the initiative necessary to satisfy urban transportation requirements via federal financial assistance.

Public transportation legislation has basically been of three kinds: (1) demonstration and development, (2) capital assistance grants and (3) policy assistance. The five most prominent pieces of legislation are: (1) The Housing Act of 1961; (2) The Urban Mass Transportation Act of 1964 (amended in 1966); (3) The Department of Transportation Act of
182 1966; (4) The Urban Mass Transportation Assistance Act of 1970 and (5) The 1973 Highway Act. These pieces of legislation have had the most direct impact on public transportation. The National Land Use Policy Act, which would have had considerable impact on transportation was recently defeated. The main focus of the bill was environmental protection. It called upon states to identify and control the use of land in areas of critical environmental concern; and to control all large-scale development around major public facilities such as airports.

DEMONSTRATION AND DEVELOPMENT ASSISTANCE. The research and demonstration program is disappointing since capital is not generally available for the testing of the ideas generated by the program.[2] Also, the program has been preoccupied with exotic hardware when it should have addressed more ordinary operational characteristics such as making sure the bus ran on schedule. In the short run technological improvements are less important than upgrading the system and increasing managerial competence.[3]

However, research and development activity conducted under Section 6 of the Urban Mass Transportation Assistance Act of 1970 was not oriented to the pursuit of mundane activities. The program involves the development, testing, and demonstration of new equipment facilities, and techniques. It assists in reducing urban transportation problems and in improving mass transportation services or in meeting total urban transportation needs at an effective cost level.

More money is being spent on these projects. In 1974 the activity level will be $80 million spread over an estimated 160 projects. This compares with $73.2 million in 1973 over an estimated 160 projects and $61.4 million in 1972 on 105 projects. It is estimated that there will be 300 applications in 1974 totaling $105 million in value. This compares with a 1973 estimate of 259 applications and amendments with a dollar value of $70 million and a 1972 amount of 95 applications and amendments with a dollar value of $30.3 million.[4]

President Nixon signed into law the Emergency Highway Energy Conservation Act which authorized the Secretary of Transportation to approve demonstration projects designed to encourage the use of car pools in urban areas with the federal share of car pool projects rising as high as 90 percent of the project cost but not exceeding an absolute figure of $1 million for any single planned project.

This Act specifies that funded projects may include, but not be limited to, methods for locating and matching potential riders, designating highway lanes as preferential to car pools and buses or both; providing related traffic control devices, and designating certain publicly owned facilities as preferential to car pool parking. Cut-off for approval of these projects is December 31, 1974.

However, what may appear to be quick, free and easily obtained Federal funds for innovative programs, are in the long-run, usually going to cost the city in some other programs. The purpose of the funding must receive careful consideration by the city prior to acceptance. It should be noted that any Federal Funds obligated or expended would be deducted from the local Urban System funds.

CAPITAL ASSISTANCE. In 1961 the Congress included mass transit capital improvements in the Public Facilities Loan Program. Not until the 1964 Urban Mass Transportation Act, however, did outright federal grants for capital facilities and research gain congressional approval. In 1966, the authority for planning grants, managerial training grants and support of university research was added. By fiscal year 1971 appropriations under the 1964 Act totalled $197 million of which $80.0 million was committed to capital grants. In 1970, the capital assistance program on a financial basis, paralleled in importance the highway program. Contract authority was made available for obligation without prior congressional appropriations. Although, increased funds were available, federal assistance was still limited to assisting public agencies in financing the acquisition, construction, reconstruction and improvement of facilities and equipment for use in mass transportation service.[5]

In addition to the federal assistance programs there are state and local assistance programs. The State assistance programs are usually in the form of emergency relief and consist of the following: operating cost subsidies; reduced fare subsidies; tax relief and rebate; and state authority for local taxation. The operating cost subsidies are payments for the upcoming year and are not to exceed losses from the previous calendar year. Reduced fare subsidies are primarily applied to school children. Tax relief allows exemption in federal tax on per gallon gas and diesel fuel. It also permits exemptions from the federal excise taxes on buses and maintenance parts. State authority for local taxation allows local government authorities to impose taxes, especially property taxes, to assist in paying the transit operating costs.

Local assistance programs are similar to state relief programs in that they are designed to preserve existing transit systems. Generally, the transit services are required to submit a justified budget for all transit costs. The provision of transit service is then placed in competition with other municipal services for local funds. This latter approach is a more realistic funding mechanism and is more directly related to needs.

The most reassuring result of federal mass transit programs is that mass transit systems are now a reasonable alternative to highways. The most important result of the federal program is the generated awareness of the value of mass transportation. This is especially true at the federal, legislative and agency level. Few cities, however, have a comprehensive transit system that efficiently serves the public and is well integrated with the other transportation modes. Those who operationalize federal legislation are considerably removed from the local scene where the decision on what mode of public transit is a reasonable alternative and how to convince the citizen of this fact and encourage their use of it as well as the implementation and operationalization of it presents innumerable problems.

POLICY ASSISTANCE. Policy implications of the transportation programs are far-reaching. There are complaints that there either are no national transportation policies or that there are too many uncoordinated policies. Both are correct because there hasn't been any national transportation policy until recently and what does exist is uncoordinated. This ad hoc pattern of national transportation policy formulation may be attributed to: (1) the mixed transportation enterprise designed to serve both public and private sectors; (2) the individual characteristics of each of the modes; (3) the standard practice of developing policy on an ad hoc basis; (4) the influence of "crisis" on policy; (5) the previously limited efforts at federal and state levels to integrate transportation policy; (6) transportation lobbyists and labor unions; and (7) the differing needs of various parts of the country.[6]

There exist avenues through which transportation policy can be coordinated and made influential. The greatest opportunity for influence will probably occur with respect to incremental projects since there tends to be more policy latitude with these projects than new projects that draw heavily from existing resources and services. The second avenue of influence is through the coordination of planning requirements. Comprehensive and overall systems planning establishes broad community goals and objectives that must be met in the undertaking of public and/ or private projects included. Project planning is concerned with detailed plans for specific projects. These planning requirements serve as a conduit for national transportation policy. The Transportation Department has made efforts to make increasing federal assistance contingent upon the institution of comprehensive, coordinated, and continuing planning.

The Housing Act of 1961 called for federal assistance on a continuing basis to state and local governments to facilitate comprehensive planning for urban development, including coordinated transportation systems.[7] A responsibility inherent in the Transportation Act of 1966 was the withholding of project approvals that required use of park, recreational or other public lands unless no other feasible alternative existed.[8] The Urban Mass Transportation Assistance Act of 1970 declared that special efforts should be made to preserve the environment in planning, designing and constructing transportation facilities.[9]

Another step undertaken by the Department of Transportation (DOT) was the establishment of a set of common criteria for a DOT Planning Certification Process. This process clarifies the standards, reduces the time factor involved and makes a significant step towards intermodal planning. The final avenue of influence will be the state Department of Transportation. Primarily the State DOT is designed to better serve the needs of the people, who cannot be adequately served by a single federal Department of Transportation. State DOT's emulate the same goals and objectives as the Federal DOT, but apply them in a smaller area. Improved policy coordination and planning is made possible through a state DOT which the State of Texas is considering. In 1972, 16 states authorized the creation of multi-modal State Departments of Transportation.

The Federal Role

For those who oppose federal financing because it is attached to federal policy guidelines, there is little consolation. Small governments or private industry are not financially secure enough to permit experimentation or undertake imaginative transportation programs. Federal aid in the planning and financing of transportation experiments is indispensable. Additionally, the power of the purse is a highly effective way and often the only way to foster cooperation between local, state, and federal governments. A high degree of coordination in planning is essential for the successful implementation of a multi-modal transportation system within the urban areas. This is presently being achieved through the Austin Urban Transportation Study Office. To achieve success some degree of local initiative will have to be expended.

REVENUE-SHARING. The purpose of revenue-sharing is to provide a compromise, by allowing for local initiative and federal financing.
190 President Nixon proposed a revenue-sharing program that would consolidate the major federal transportation assistance grants into two areas: for general transportation activities and for mass transit capital investment. The funds in the general transportation activities would be allocated to the states with the provision that a substantial percentage would be passed onto the cities. Ten percent of this grant would be retained for direct allocation by the Secretary of Transportation.

The proponents of revenue-sharing see this as a measure that insures local initiative and fosters more orderly growth at the state and community level. Opponents view this with less optimism. They feel that less money would be available because of administrative costs involved for transportation considerations.

IMPOUNDMENT OF FUNDS. Underfinancing of budget appropriations is a problem as is the impoundment of funds already appropriated. In fiscal 1971 Congress authorized the Urban Mass Transit Administration (UTMA) to obligate $600 million, the Office of Management and Budgeting (OMB) limited it to $400 million, of this only $283.7 million was ultimately designated for capital grants. In fiscal 1972 Congress authorized a limit of $900 million. The OMB limited this to $600 million and $510 million was eventually spent.

The financing of urban mass transportation has not been adequate. Revenue-sharing has possibilities for alleviating this situation. Federal financial assistance is essential to the successful implementation of an urban mass transportation program. The federal government is establishing new priorities and appropriating more money to accomplish the task, and is desisting from the impoundment of needed funds. Court decisions have effectively negated impoundment.

Transportation Program Financing

The three main types of transportation programs; operations, capital improvements, and research, are funded in several ways. The financing of operations is carried on via grants-in-aid, direct subsidies, leasing arrangements, or gas tax rebates or exemptions. The financing of research and development is undertaken with the aid of demonstration grants, technical-studies grants and poverty-agency contracts.

OPERATIONS FINANCING. The financing of operations has not been met favorably in all situations. Criticisms have been directed at such financing on the grounds that it only seeks to save existing transit systems from bankruptcy. This also applies to airlines and indirectly to highways. Furthermore, a disproportionate amount of this money goes to the suburban commuter railroad which carries the least amount of riders. With deficits increasing throughout the transit industry, to continue financing these operations seems questionable.[10] Over 80 percent of all funds made available have gone into capital grants for operating systems which have played little part in encouraging technological advances of either the gradual or revolutionary type.[11] However, the somewhat fatal transportation "innovation" introduced at the University of West Virginia attests to the need that considerable thought be given to revolutionary systems.

CAPITAL FINANCING. Financial assistance to capital improvements has not kept pace with needs.[12] By April 15, 1971, UMTA had a backlog of

89 applications requesting federal aid in excess of $2.6 billion, and by mid-1972 this was $4 billion. From 1965-1972 the federal funding provided through UMTA totaled only a little over $1 billion for 279 projects. UMTA has had continuing problems in allocating authorized funds due mainly to impoundment of funds. However, the absence of an effective transportation lobby until recently, and the wariness of Congress in committing substantial resources, have compounded the problem. For most transportation programs, funding has been so small as to be ineffective. Unfortunately, as of late the federal policy response continues to be one of distributing relatively small sums, completely out of proportion to the size of the mass transportation problems faced across the nation.[13]

RESEARCH AND DEVELOPMENT FINANCING. Research and development expenditures are no exception. A more critical problem in research is the dependence of researchers upon federal support prior to commencement of the investigation.[14]

Regular Policies

Regulatory policies as applied to taxis', address the rate of fare, the number of taxis' allowable per area, the insurance requirements, the licensing of drivers and the mode of operation. Other transit industries have similar regulations including the regulation of route schedules. The three important elements of regulation are monopoly rights, entry conditions and fare control. Early regulatory policy was based on the concept of monopoly. In return for the franchise to a monopolistic position the firm was regulated in the public interest. Entry conditions applied to specific factors of production and generally raised the cost of entry. Fare control consists of managing the level and structure of the fares charged.

Regulation is an inexpedient economic policy since it demands an extreme form of entry control that results in a reinforcement of one form of product differentiation. The cumulative effect is to raise the price while hopefully insuring a higher quality of service. Regulation inflates the total transport bill to society by causing prices to diverge from cost inefficiently and by causing costs to be higher than they would be if all adjustments in output and capacity were permitted.[15] Furthermore, these increased prices are not consistent. Fare control forces underpricing in the peak and overpricing in off-peak travel.[16]

The assumption that higher costs produce a higher quality service is erroneous. The transit industries are not permitted additional traffic through pursuing rate competition, and, when there is no competition high quality service is not that essential to the attraction of customers. This is not necessarily the case of a public owned system. Regulation was not created to secure a profitable position for the transit industry. The National Transportation Policy enacted in 1940 specified that the Interstate Commerce Act shall be administered so as to recognize and preserve the inherent advantage of each of the modes of transportation covered by the Act. What exactly, is meant by the inherent advantage is unclear. This seems to have been interpreted as the necessity for supplying subsidies to transit industries experiencing difficulties.

The railroad was the first industry to be covered by regulation. It's economies of scale made it monopolistic in form and regulation was considered necessary. At this time regulation was the preferred alternative to public ownership. By the early 1930's the monopoly pattern of regulation was fully developed as an integral part of a national transportation policy.

Unfortunately, the regulatory policy was very static. The transportation network was expanding, and the highway system was replacing the monopolistic pattern set by the railroads. Regulatory policy was unresponsive to these changing fares and similar regulations were imposed on these new industries despite the fact that they did not possess the same economic characteristics as the railroads. Regulation was imposed upon the tracklines in 1935, the air carriers in 1938, the inland water carriers in 1940, and the freight forwarders in 1942.

Regulation is outmoded. It was implemented as an alternative to public ownership. This alternative has dissipated over the years and most transportation systems are now publicly owned and operated. Also, the emphasis of regulation on transportation has shifted from freight to passenger orientation. Regulation has allocated resources in two ways: to produce the consequences of a monopoly or a cartel, and then to perpetuate a service which is failing the market test.[17] However, revealed demand indicates that automobile/highways meet the "market test". Regulation should be updated or discarded to prevent further deterioration of the transportation systems.

The Subsidy Issue

The Urban Mass Transportation Act of 1964 specifically prohibited the use of federal funds to defray operating expenses.[18] However, capital grants of up to two-thirds of the cost of equipment, buildings, etc.

may be obtained with the applicant financing the additional one-third. From 1964 to 1970 approximately $735 million was committed by the federal government under this program. With the passage of the Urban Mass Transportation Act of 1970 an additional $10 billion over a 12 year period was made available. Section 5 of the NMTAA now allows a 50 percent operating subsidy.

The arguments for restricting subsidies to capital grants are: (1) local governments do not have sufficient capital to maintain adequate service; (2) capital grants limit the Federal Government's liability and avoids a "permanent" subsidy, such as the operating subsidy; and (3) a capital grant has tangible results in the form of new equipment.

It has been argued that the capital grant may be just as inefficient as the operating subsidy.[19] An alternative proposal would be the allocation of federal grants on a transportation revenue-sharing basis without a restriction to capital expenses. Thus, the recipient is not required to become inefficient in order to maximize his share of grant funds. Transit industries that are no longer profitable are allowed to exist for the sake of preserving each distinct mode of transportation. Transit industries are forced to compete for federal funding as a matter of survival. The few profitable firms that exist must make a choice between unsubsidized operating costs or subsidized capital costs. Finally, cities and the state have no choice. They need federal funding for urgent needs and they must accept the federal policy guidelines attached to the money.[20]

A federal operating subsidy to save mass transit systems could provide several benefits: improved energy use, increased mobility for those persons without a car, improved land use, decreased air pollution and reduced inflation. The out of pocket cost of driving a car is 13.5 cents a mile but when such externalities as congestion, pollution
198 and parking is brought into the calculation it rises to a dollar a mile.

Many cities, states and interstate bodies have shown willingness to provide extra operating subsidies for urban mass transit. Profits from bridge and tunnel tolls have been used for this purpose in New York, Philadelphia and the San Francisco Bay area. Voter referendums have approved support of mass transit in Atlanta, Chicago, Cincinnati, Dayton, Denver, Miami, Seattle and in the states of California and New Jersey.

Experiments on fare manipulation to increase patronage have been fairly successful in some cities. Atlanta, for example, cut bus fares to 15 cents from 40 cents. In a few months 20,000 automobiles disappeared from the city's streets; more than half of them during peak commuting periods. In September, Seattle began a "Magic Carpet" no fare zone that in two months increased ridership by 56 percent. This innovative program, operating on all downtown routes, although costing the city some $64,000 a year reduced air pollution, etc. Tulsa reduced bus fares to 25 cents, ridership improved by almost 50 percent and total revenues increased. Boston and New York who are experimenting with reduced fare periods on their transit lines indicate good initial results.

Local Transportation Legislation and Financing

Austin SMSA Federal, State and City governments all participate in the planning, construction, and maintenance of transportation facilities in the Austin area. Taxi, trucking, and intercity bus services are privately sponsored while parking facilities are provided both by public and private agencies.

Federal Funds for major street and highway construction in Austin are administered via the Texas Highway Department and the Public Works and Urban Transportation Departments of the City of Austin. Except for the Interstate system, which is a 90 percent Federal and 10 percent local split, all other highways are on 70 percent Federal and 30 percent local funds split.

Table 7-1 indicates the presently approved federal-aid for Texas for fiscal years 1974 and 1975. Texas received substantial funds for road construction from the federal government for the two fiscal years shown. The bulk of federal-aid funds available for construction has been apportioned to the federal-aid non-interstate system. Aid for rural and urban systems development remains substantially the same over the two time periods. However, in the case of Priority Primary, apportionment for 1975 compared with 1974, will more than double. The interstate system will get a higher apportionment in 1975, as compared to 1974, mainly because of increased letting of bids for expansion of the system. Most construction jobs allocated earlier have been completed and few new projects were begun in Travis County. Further, the major projects that were let and completed furing this period, have not been paid for as yet by the Federal Government. This being the case, the possibility of 1973-74 figures going up to approximately $15,000,000 is quite positive.

In order to qualify for federal-aid apportionments, the State must provide some funds and conform with standards of construction approved by the Federal Highway Administration (FHWA). The necessary state funds

Table 7-1
Annual Federal Aid Apportionments to the State of Texas
1974 and 1975

	Federal Fiscal Year 1974	Federal Fiscal Year 1975
Rural	$ 59,183,796	$ 61,470,401
Urban	59,260,528	60,986,033
*1-1/2% Planning	1,283,323	1,466,568
*Priority Primary	5,891,744	11,904,968
Sub-Total	125,619,389	135,807,970
Interstate	114,930,062	133,978,740
Total	$240,549,451	$269,786,710

*One and one-half percent planning apportionments are for systems planning purposes. Priority Primary means that the highways of primary importance, have priority financing status.

Source: District 14, Texas Highway Department, Austin, Texas, 1974.

Table 7-2
Statewide Road-User Taxes and Their Distribution, 1972-1973

	Diesel and Motor Fuel Taxes	License Fees	Totals
Schools	$ 95,095,790	Not Applicable	$ 95,095,790
County Road Bond	7,300,000	$ 33,573,660	40,873,660
State Highway Fund	275,189,769	179,189,682	454,379,451
Total	$377,585,559	$212,763,342	$590,348,901

Note: Enforcement Costs are omitted.

Source: District 14, Texas Highway Department, Austin, Texas, 1974.

Table 7-3
Annual Highway Expenditures-Travis County: 1969-1973

	Federal	State		Total
		Construction & Engineering	Maintenance	
1968-69	$9,350,000	$9,438,078	$1,038,227	$19,826,305
1969-70	6,966,000	7,799,530	902,476	15,668,006
1970-71	4,056,000	4,460,133	852,020	9,368,153
1971-72	2,233,000	5,235,027	789,131	8,257,226
1972-73	1,191,000	3,314,527	666,699	5,172,226

Source: District 14, Texas Highway Department, Austin, Texas, 1974.

are received from various state road-user taxes. These include Diesel and Motor Fuel taxes and License fees. Table 7-2 shows the statewide road-user taxes and their distribution over various entities.

Table 7-3 lists the expenditures on Highways in Travis County between 1968-'69 and 1972-'73. It should be noted here that total figures have been decreasing regularly, primarily because most of the major work has been accomplished and some of the monies have not been received from the Federal Government yet.

The Federal Highway Administration (FHWA) may allow a state to make publicly acquired rights-of-way available without charge for publicly owned mass transit facilities, under certain conditions. Moreover, capital grant funds have been increased to $6.1 billion through fiscal year 1975, and the federal share of an Urban Mass Transportation Administration grant program may now be as high as 80 percent. Nevertheless, Texas cities do not receive state highway funds for Transit Systems. Nor do they receive financial assistance from highway monies for (a) Capital Improvements, (b) Subsidies for Operating Expenses, (c) School Fare and Senior Citizen Reimbursement in terms of Mass Transportation. On the other hand, the 18 states that do allocate funds for transit purposes have been giving increasing amounts every year from $75,280,988 in 1971, to $176,724,109 in 1972 to $244,431,654 in 1973. It should also be noted here that Operating Expenses Subsidies category received the largest share of the monies in each of the three years.

Recently, President Ford signed an $11.8 billion mass transit bill, now the National Mass Transportation Assistance Act, that is designed to foster continued operation of urban mass transportation systems and help build new ones. The bill marks the first time that federal funds have been used to finance transit operations. A total of $3.9 billion in operating subsidies is authorized over the period 1975-80. The other $7.9 billion in the bill continues the present capital grant program for the construction of new transit systems and the purchase of subway cars, track, buses and other items needed to upgrade or expand old systems. For the first time the capital grant programs includes $500 million for public transportation in rural areas. Cities will have to match the funds for operating subsidies on a 50-50 basis while localities seeking capital grants must put up at least 20 percent of the cost. The subsidies will be distributed on a formula based on total population density. Cities where transit systems are not running deficits would be eligible to use the subsidy funds for capital improvements.

Table 7-4
Topics and Metropolitan Highway Project in Austin, 1972-1973

Road Signalization Projects	$ 207,850
Construction Projects	2,261,720
Total	$2,469,570

Source: Texas Highway Department, 1974.

Table 7-4 shows TOPICS (Traffic Operations Program to Increase Capacity and Safety) and Metropolitan Highway projects in Austin, 1972-73. It should be noted that the City of Austin contributed $536,450 as its share of the overall cost of construction projects. The additional funding was provided by the FHWA. The city does not have to contribute to the capital cost of Highway Signalization Projects.

The expenses relating to transportation facilities in the city are supported by revenue from local taxes, charges for current services, bond sales, revenue from use of money and property, fines and penalties, federal aid provided under the TOPICS program, Model Cities fund and the Capital Improvement Project (CIP) fund. For example, the 1973 expenses on Traffic Signal and Signs, which totaled $1,420,000 was covered by finances from the Model Cities Fund ($70,000), the CIP Fund ($588,000) and Federal Aid under Topics Program (now Urban Systems projects).

Major arterials and highways in urban areas which are not in the state system are the responsibility of the City and the County. The Capital Improvements Program has apportioned the following revenues for the next five years.

The Williams-Minish bill would provide $11.8 billion for mass transit projects over six years. The bill would provide $7.9 billion for capital projects and another $3.9 billion for operating subsidies. Money would be allotted to individual cities on the basis of population and population density. Part of the money provided in the bills can be used for operating costs, which is a departure from present practice. Until now, cities have been able to use federal mass transit funds only for capital costs. Without operating subsidies, transit authorities must raise fares to cover deficits, and fare increases chase away riders.

Between 1965 and 1974, UMTA gave cities $3.2 billion for capital costs of mass transit; but, for each dollar given, six more were requested. Two years ago, the U.S. Department of Transportation, of which UMTA is a part, reported that capital investments for mass transit would cost $3 billion annually through 1990. UMTA has less than half of $3 billion to allot this year. Meanwhile, increasing labor costs and lost riders have created mammoth operating deficits.

Conclusion

The pressing need for comprehensive transportation planning at the metropolitan level can only be achieved if present fragmented and uncoordinated efforts at the federal, state and local levels are coordinated. On interpretation federal legislation often appears less than amenable to the many of transportation related problems affecting urban areas. For example, funding levels are completely out of proportion to the gravity of the urban mass transit problem. Transportation policies and funding levels should become more sensitive to local metropolitan transportation needs. Less emphasis should be placed on "exotic hardware", such as personal rapid transit systems and more emphasis placed on improving the every day operations of the bus system. In the short run, technical improvements are less important than upgrading the system and improving managerial efficiency.

References

1. Mertins, Herman, "The New Federalism and Federal Transportation Policy," Public Administration Review, Vol. 33, No. 3, June 1973.

2. Smerk, George M., "An Evaluation of Ten Years of Federal Policy in Urban Mass Transportation," Transportation Journal, Vol. 11, No. 2, Winter 1971 pp. 45-58.

3. Department of Transportation and Related Agencies, Appropriations for 1973, Hearings before the Subcommittee of the Committee on Appropriations, House of Representatives, Washington, 1972.

4. Ibid.,

5. U.S. Department of Transportation, Feasibility of Federal Assistance for Urban Mass Transportation Costs, November 1971, p. 36.

6. Mertins, op.cit., p. 173.

7. Barsness, Richard W., "Policy Changes and Objectives of the Department of Transportation," The Quarterly Review of Economics and Business, Vol. 9, Spring 1969, p. 63.

8. Ibid.,

9. Ibid., see also CQW Report, February 6, 1970.

10. Rosenbloom, Sandra, The Impact of Federal Urban Transportation Programs on the Development of Metropolitan Transportation Systems forthcoming Phd disertation UCLA.

11. Mertins, op.cit., p. 173.

12. Mertins, op.cit., p. 171.

13. Mertins, op.cit., pp. 171-173; see also Wells, John D., ed., Economic Characteristics of the Urban Public Transportation Industry, Institute of Defense Analysis, February 1972, pp. 3-24.

14. Mertins, op.cit., p. 173.

15. Smerk, op.cit., pp. 45-58.

16. Beesley, M.E., "Regulation of Taxis," The Economic Journal, No. 38, March 1973, p. 154.

17. Hilton, George W., "The Basic Behavior of Regulatory Commissions," American Economic Review, Vol. 62, No. 1, March 1972.

18. U.S. Department of Transportation, op.cit., p. 36.

19. U.S. Department of Transportation, op.cit., pp. 34-36.

20. U.S. Department of Transportation, op.cit., pp. 35-37. The research assistance of Tina Garner on this section is appreciated.

Conclusion

In the most general terms, Austin's metropolitan transportation problem can be viewed as the dilemma of moving people to and from work; the specific problem areas being mass transit decline, congestion and parking.

To make mass transit more attractive one needs to remove the societal impositions that affect mass transit users. Present pricing, taxation, and highway planning practices involve subsidies to the car user which are generally larger than those given to mass transit users. It is generally recognized that this imbalance should be corrected based on the need for desirable service; the benefits of economies of scale; social equity considerations as related to the poor and physically impaired; the need to satisfy latent travel demand; and the need to reduce the social costs of air pollution and congestion.

There are two conceivable ways of improving public transit: 1) by allocating transport costs through toll and parking fee charges in order to divert people from auto use to mass transit usage; and 2) by providing the same subsidy to public transit that is presently being given to auto users who use the highways. Improved pricing practices are also required for peak off-peak travel and for pricing between modes. Mass transit is often underpriced for peak and overpriced for off-peak travel. It is important to try to encourage auto users to use mass transit in place of their cars whenever possible since the revival of a good public transit system has many side effects, such as the arrest of urban blight and pollution, the maintenance of downtown property values and the creation of higher property values along existing and new routes.

Traditionally the urban transportation problem has been perceived of largely in terms of congestion. The attempted remedy was to build additional roads to accomodate increased automobile usage. Political and financing institutions were created in the 30's, 40's, and 50's to initiate this accomodation and as a result, almost universal personal mobility by the private auto on safe public roads became a reality. Unfortunately, automobile usage exceeded all road building capacity and metropolitan congestion intensified. More money for more highways was considered to be the panacea. It was not. Slowly these institutional structures are changing and new, more flexible and innovative programs are being substituted in their place. The highway engineer who provided our excellent highways and interstate systems is aware of the need for institutional change. The political protectionism created to support the finances and organizational structure of highway building is changing since the trend toward urban transportation is itself shifting from the question of personal mobility to an expanded view of transportation as a city shaper, as an influence on access to parks and employment, and as a major determinant of air quality and energy use. Public opinion over the negative effects of increased automobile use such as noise and air pollution, the divisive effect of highways on neighborhoods and the increasing isolation of the aged and the poor has encouraged reassessment of the transport modes required for city dwellers.

While the traditional public transportation system has to focus on concentrated travel demand, cities continue to develop through low density growth. Because of this paradox, bus systems experience operating difficulties. The remedy appears to lie in a balanced transportation mix. More small capacity vehicles are needed to serve dispersed residential and employment locations. Dual mode systems would include buses, demand responsive jitneys and mini-buses, park and ride operations, taxis and cars--all of which should effectively intermesh. A transportation mix is required which takes advantage of several modes for the trip purpose but does not utilize a mode which has technical, economical, or operational disadvantages.

Urban transportation is a conceptual and institutional problem as well as a technical one. If there is a fuel crisis of long-term standing; the continued insensitive use of land; continuing reduction in air quality; and a desired reduction in automobile traffic; then more freeways and the exotic hardware of fixed rail rapid transit systems offer only superficial remedies.

The most significant failure of past transportation programs has been a conceptual one; the failure to create an organization that is flexible enough to recognize and quickly adapt to emerging transportation problems. Urban public transport at the local level is beset with inconsistencies which result from its involvement with a variety of government levels and agencies, and its struggle with the problems of private and public ownership and operation.

With citizen awareness lodged at the local level, but with resource control isolated at state and federal levels the failure to respond to local needs has been pronounced. The dominance and centralization of finance, expertise and research and planning resources in national and state government agencies, at some distance from the city's local problems, distort city and regional priorities. Resolutions to this type of incongruity can possibly be resolved through a state transportation planning agency that is closely linked to local problems and possesses flexible funding devices. The integration of transportation planning and land-use regulation so that economic relationships are understood should also be encouraged.

The funds necessary to finance a transportation system come primarily from local sources and federal grants. Because transportation responsibility is divided among several levels of government, financing is complex and the appropriate level of financing depends upon the responsibilities assumed by each level of government. Therefore, the first step is to determine these responsibilities. Once this is accomplished, and there is consistency among their plans, policies and financial capabilities, implementation of a balanced transportation system can begin.

The other failure is an institutional one. Transportation expertise and financing tends to be devoted to single purpose activities such as highways, personal rapid transit systems or the operation of day to day services such as a bus company and a city traffic department. Instead of searching for transportation solutions through exotic systems, improvement of present systems and increasing their performance level should have highest priority. This means operating the present street and highway network more equitably and efficiently by utilizing existing surface capacity, especially at peak hours, for the movement of people, not vehicles. A movement is needed which is away from the penchant for highway construction and toward optimizing mass transit and private vehicle use on our city streets.

Finally, although there is growing flexibility in the urban transport field there is no consensus. A consensus should be developed and agency fragmentation reduced. There should be no attempt to outlaw the automobile nor to seize upon new technological innovations, such as fixed rapid rail, as the panacea for urban transportation ills.

Austin's street system in terms of capacity and volume of traffic, street surface and maintenance, and transit in terms of level of service is good. The time-span for the completion of transport related construction projects is relatively short. Public awareness and efficient planning, has provided a solid base for the development of an effective transportation program. With programs such as the Austin Tomorrow Program and the Joint Transportation Study Office, the City of Austin continues its concern for the provision of a balanced transportation system for its residents.

There is a need to correct present deficiencies and to avoid future crises. Proposals which break with Austin's present urban transportation program must be studied carefully for their long-term effects, prior to irrevocable commitments to long-range high cost programs which in the hindsight of 20 years from now may look as bleak as our present view of the single-minded highway approach of 20 years ago.

APPENDIX Ia

TRANSPORTATION SURVEY

PART 1

1. In a typical week, about how many trips do you take from home to work or school? None_____ 1 to 4_____ 5 or more_____ (If none, go to Part 2).
2. For these trips to work or school, how do you usually get there? (Please check one only.)
   As car driver_____ Car pool_____ City bus_____ UT shuttle bus_____ Walking_____ Bicycle_____ Motorcycle_____ Other_____
3. Do you usually travel alone? Yes_____ No_____
4. In general, are you satisfied with the transportation you use for getting to work or school?
   Definitely yes_____ Moderately yes_____ Neutral_____ Moderately no_____ Definitely no_____

IMPORTANCE RATING FORM
Transportation to Work, (or School, if you are a Student)

The following is a list of attributes or features that might affect a decision of what transportation mode you might choose for getting to work (or your school). Assume you are to choose a mode of transportation from among several alternative types (private car, bus, car-pool, taxi, etc.). After each attribute, please place a check in the appropriate column, to indicate how important each of these features is in your own choice of a transportation mode for getting to work (or your school). Please check only one column for each attribute.

	No Importance	Slightly Important	Moderately Important	Very Important	Extremely Important
5. Economy					
6. Convenience					
7. Brief Travel Time					
8. Smooth Ride					
9. Freedom from Weather (door to door)					
10. Opportunity to Socialize					
11. Avoid Traffic Congestion					
12. Socially Accepted Transportation Mode					
13. Lack of Parking Problems					
14. Flexibility					
15. Uncrowded					
16. Freedom from Accidents					
17. Freedom from Repairs					
18. Safe from Dangerous People					
19. Low Pollution per Passenger					
20. Lack of Tension					
21. Ease of Travel with Packages					
22. Ability to Look at Scenery					
23. Low Energy Use per Passenger					
24. Can Listen to Radio or Tape					
25. Dependability					
26. Pleasant Riding Surroundings					
27. Privacy					
28. Ease at Traveling with Children					

CONTINUE ON OPPOSITE SIDE WITH QUESTION 29

DIFFERENCE RATING FORM
Transportation to Work (or School, if you are a Student)

From your knowledge of various transportation modes, how much difference do you feel there is among modes for getting to work, or your school (private car, bus, car-pool, taxi, etc.), in each of these attributes? Please place a check in the column (one check only) which best indicates your opinion of the extent to which these differences are present.

	No Differences	Slight Differences	Moderate Differences	Large Differences	Extreme Differences
29. Economy					
30. Convenience					
31. Brief Travel Time					
32. Smooth Ride					
33. Freedom from Weather (door to door)					
34. Opportunity to Socialize					
35. Avoid Traffic Congestion					
36. Socially Accepted Transportation Mode					
37. Lack of Parking Problems					
38. Flexibility					
39. Uncrowded					
40. Freedom from Accidents					
41. Freedom from Repairs					
42. Safe from Dangerous People					
43. Low Pollution per Passenger					
44. Lack of Tension					
45. Ease of Travel with Packages					
46. Ability to Look at Scenery					
47. Low Energy Use per Passenger					
48. Can Listen to Radio or Tape					
49. Dependability					
50. Pleasant Riding Surroundings					
51. Privacy					
52. Ease at Traveling with Children					

CONTINUE WITH QUESTION 53

Now, please use the scales on this page to indicate your feelings about the degree to which owning your car would be suitable for trips made to work (or your school). Place a check on the position between each pair of terms that best describes your feelings about the suitability of your own car (whether or not you own one) for trips made to work or school. For example, if you feel that your car would be likely to be moderately interesting as a transportation mode for getting to work or school, you would place a check on the "Interesting-Boring" scale as shown below. Please do this for EACH pair of items, without skipping any.

EXAMPLE:	Extremely	Moderately	Neutral	Moderately	Extremely	
Interesting	_______	: ___X___ :	_______ :	_______ :	_______	Boring

YOUR OWN CAR FOR TRIPS TO WORK OR SCHOOL

53.	Economical	_____:_____:_____:_____:_____	Expensive
54.	Convenient	_____:_____:_____:_____:_____	Inconvenient
55.	Brief Travel Time	_____:_____:_____:_____:_____	Long Travel Time
56.	Smooth Ride	_____:_____:_____:_____:_____	Rough Ride
57.	Free from Weather (door-to-door)	_____:_____:_____:_____:_____	Exposed to Weather (door-to-door)
58.	Easy to Socialize	_____:_____:_____:_____:_____	Hard to Socialize
59.	Avoids Traffic Congestion	_____:_____:_____:_____:_____	Gets into Traffic Congestion
60.	High Status	_____:_____:_____:_____:_____	Low Status
61.	Few Parking Problems	_____:_____:_____:_____:_____	Many Parking Problems
62.	Flexible	_____:_____:_____:_____:_____	Inflexible
63.	Uncrowded	_____:_____:_____:_____:_____	Crowded
64.	Safe from Accidents	_____:_____:_____:_____:_____	Likely to have Accidents
65.	Free from Repairs	_____:_____:_____:_____:_____	Not Free from Repairs
66.	Safe from Dangerous People	_____:_____:_____:_____:_____	Not Safe from Dangerous People
67.	High Pollution per Rider	_____:_____:_____:_____:_____	Low Pollution per Rider
68.	Relaxing	_____:_____:_____:_____:_____	Full of Tension
69.	Easy with Packages	_____:_____:_____:_____:_____	Difficult with Packages
70.	Can Look at Scenery	_____:_____:_____:_____:_____	Can't Look at Scenery
71.	Low Energy Use per Passenger	_____:_____:_____:_____:_____	High Energy Use per Passenger
72.	Radio or Tape Deck Available	_____:_____:_____:_____:_____	No Radio or Tape Deck Available
73.	Dependable	_____:_____:_____:_____:_____	Undependable
74.	Pleasant Riding Surroundings	_____:_____:_____:_____:_____	Unpleasant Riding Surroundings
75.	High Privacy	_____:_____:_____:_____:_____	Low Privacy
76.	Difficult with Children	_____:_____:_____:_____:_____	Easy with Children

In a typical week, about how many trips do you take from home to work or school, driving your car? None_____ 1 to 4_____ 5 or more _____

CONTINUE ON OPPOSITE SIDE WITH QUESTION 77

Now, please use these scales to indicate your feelings about the degree to which a bus would be suitable for trips made to work or school. Please do as you did before, without skipping any of the scales.

BUS FOR TRIPS TO WORK OR YOUR SCHOOL

77.	Economical	_____:_____:_____:_____:_____	Expensive
78.	Convenient	_____:_____:_____:_____:_____	Inconvenient
79.	Brief Travel Time	_____:_____:_____:_____:_____	Long Travel Time
80.	Smooth Ride	_____:_____:_____:_____:_____	Rough Ride
81.	Free from Weather (door-to-door)	_____:_____:_____:_____:_____	Exposed to Weather (door to door)
82.	Easy to Socialize	_____:_____:_____:_____:_____	Hard to Socialize
83.	Avoids Traffic Congestion	_____:_____:_____:_____:_____	Gets into Traffic Congestion
84.	High Status	_____:_____:_____:_____:_____	Low Status
85.	Few Parking Problems	_____:_____:_____:_____:_____	Many Parking Problems
86.	Flexible	_____:_____:_____:_____:_____	Inflexible
87.	Uncrowded	_____:_____:_____:_____:_____	Crowded
88.	Safe from Accidents	_____:_____:_____:_____:_____	Likely to have Accidents
89.	Free from Repairs	_____:_____:_____:_____:_____	Not Free from Repairs
90.	Safe from Dangerous People	_____:_____:_____:_____:_____	Not Safe from Dangerous People
91.	High Pollution per Rider	_____:_____:_____:_____:_____	Low Pollution per Rider
92.	Relaxing	_____:_____:_____:_____:_____	Full of Tension
93.	Easy with Packages	_____:_____:_____:_____:_____	Difficult with Packages
94.	Can Look at Scenery	_____:_____:_____:_____:_____	Can't Look at Scenery
95.	Low Energy Use per Passenger	_____:_____:_____:_____:_____	High Energy Use per Passenger
96.	Radio or Tape Deck Available	_____:_____:_____:_____:_____	No Radio or Tape Deck Available
97.	Dependable	_____:_____:_____:_____:_____	Undependable
98.	Pleasant Riding Surroundings	_____:_____:_____:_____:_____	Unpleasant Riding Surroundings
99.	High Privacy	_____:_____:_____:_____:_____	Low Privacy
100.	Difficult with Children	_____:_____:_____:_____:_____	Easy with Children

In a typical week, about how many trips do you take from home to work or school, using a bus? None_____ 1 to 4_____ 5 or more_____

TURN PAGE OVER AND CONTINUE WITH QUESTION 101

PART 2

101. Now we would like to know something about the transportation you use for trips for shopping or personal business. In a typical week, how many trips do you take to some place to shop or do personal business? None_____ 1 to 4_____ 5 or more_____ (If none, go on to Part 3 on next page.)

102. For these trips to work or school, how do you usually get there? (Please check one only).

As car driver_____ Car pool_____ City bus_____ UT shuttle bus_____ Walking_____ Bicycle_____ Motorcycle_____ Other_____

103. Do you usually travel alone? Yes_____ No_____

104. In general, are you satisfied with the transportation you use for shopping or personal business?

Definitely yes_____ Moderately yes_____ Neutral_____ Moderately no_____ Definitely no_____

IMPORTANCE RATING FORM
Transportation for Shopping or Personal Business

Please place a check in the appropriate column, to indicate how desirable you feel each of these traits would be in choosing a transportation mode for shopping trips or personal business (medicine, groceries, clubs, etc.)

	No Importance	Slightly Important	Moderately Important	Very Important	Extremely Important
105. Economy					
106. Convenience					
107. Brief Travel Time					
108. Smooth Ride					
109. Freedom from Weather (door to door)					
110. Opportunity to Socialize					
111. Avoid Traffic Congestion					
112. Socially Accepted Transportation Mode					
113. Lack of Parking Problems					
114. Flexibility					
115. Uncrowded					
116. Freedom from Accidents					
117. Freedom from Repairs					
118. Safe from Dangerous People					
119. Low Pollution per Passenger					
120. Lack of Tension					
121. Ease of Travel with Packages					
122. Ability to Look at Scenery					
123. Low Energy Use per Passenger					
124. Can Listen to Radio or Tape					
125. Dependability					
126. Pleasant Riding Surroundings					
127. Privacy					
128. Ease at Traveling with Children					

CONTINUE ON OPPOSITE SIDE WITH QUESTION 129

DIFFERENCE RATING FORM
Transportation for Shopping or Personal Business

Now, please place a check in the appropriate column for each attribute, indicating how much you feel various possible transportation modes (private car bus, car-pool, taxi, etc.) might differ in their suitability for transportation for shopping or personal business.

	No Differences	Slight Differences	Moderate Differences	Large Differences	Extreme Differences
129. Economy					
130. Convenience					
131. Brief Travel Time					
132. Smooth Ride					
133. Freedom from Weather (door to door)					
134. Opportunity to Socialize					
135. Avoid Traffic Congestion					
136. Socially Accepted Transportation Mode					
137. Lack of Parking Problems					
138. Flexibility					
139. Uncrowded					
140. Freedom from Accidents					
141. Freedom from Repairs					
142. Safe from Dangerous People					
143. High Pollution per Passenger					
144. Lack of Tension					
145. Ease of Travel with Packages					
146. Ability to Look at Scenery					
147. Low Energy Use per Passenger					
148. Can Listen to Radio or Tape					
149. Dependability					
150. Pleasant Riding Surroundings					
151. Privacy					
152. Ease at Traveling with Children					

CONTINUE WITH QUESTION 153

Now, please use these scales to indicate your feelings about the degree to which a car driven by you would be suitable for trips made for shopping or personal business.

PRIVATE CAR FOR SHOPPING OR PERSONAL BUSINESS

153.	Economical	____:____:____:____:____	Expensive
154.	Convenient	____:____:____:____:____	Inconvenient
155.	Brief Travel Time	____:____:____:____:____	Long Travel Time
156.	Smooth Ride	____:____:____:____:____	Rough Ride
157.	Free from Weather (door-to-door)	____:____:____:____:____	Exposed to Weather (door-to-door)
158.	Easy to Socialize	____:____:____:____:____	Hard to Socialize
159.	Avoids Traffic Congestion	____:____:____:____:____	Gets into Traffic Congestion
160.	High Status	____:____:____:____:____	Low Status
161.	Few Parking Problems	____:____:____:____:____	Many Parking Problems
162.	Flexible	____:____:____:____:____	Inflexible
163.	Uncrowded	____:____:____:____:____	Crowded
164.	Safe from Accidents	____:____:____:____:____	Likely to have Accidents
165.	Free from Repairs	____:____:____:____:____	Not Free from Repairs
166.	Safe from Dangerous People	____:____:____:____:____	Not Safe from Dangerous People
167.	High Pollution per Rider	____:____:____:____:____	Low Pollution per Rider
168.	Relaxing	____:____:____:____:____	Full of Tension
169.	Easy with Packages	____:____:____:____:____	Difficult with Packages
170.	Can Look at Scenery	____:____:____:____:____	Can't Look at Scenery
171.	Low Energy Use per Passenger	____:____:____:____:____	High Energy Use per Passenger
172.	Radio or Tape Deck Available	____:____:____:____:____	No Radio or Tape Deck Available
173.	Dependable	____:____:____:____:____	Undependable
174.	Pleasant Riding Surroundings	____:____:____:____:____	Unpleasant Riding Surroundings
175.	High Privacy	____:____:____:____:____	Low Privacy
176.	Difficult with Children	____:____:____:____:____	Easy with Children

In a typical week, about how many trips do you make for shopping or personal business, driving your car?

None_____ 1 to 4 _____ 5 or more _____

CONTINUE ON OPPOSITE SIDE WITH QUESTION 177

Now, please use these scales to indicate your feelings about the degree to which a bus would be suitable for trips made for shopping or personal business.

BUS FOR SHOPPING OR PERSONAL BUSINESS

177.	Economical	____:____:____:____:____	Expensive
178.	Convenient	____:____:____:____:____	Inconvenient
179.	Brief Travel Time	____:____:____:____:____	Long Travel Time
180.	Smooth Ride	____:____:____:____:____	Rough Ride
181.	Free from Weather (door-to-door)	____:____:____:____:____	Exposed to Weather (door-to-door)
182.	Easy to Socialize	____:____:____:____:____	Hard to Socialize
183.	Avoids Traffic Congestion	____:____:____:____:____	Gets into Traffic Congestion
184.	High Status	____:____:____:____:____	Low Status
185.	Few Parking Problems	____:____:____:____:____	Many Parking Problems
186.	Flexible	____:____:____:____:____	Inflexible
187.	Uncrowded	____:____:____:____:____	Crowded
188.	Safe from Accidents	____:____:____:____:____	Likely to have Accidents
189.	Free from Repairs	____:____:____:____:____	Not Free from Repairs
190.	Safe from Dangerous People	____:____:____:____:____	Not Safe from Dangerous People
191.	High Pollution per Rider	____:____:____:____:____	Low Pollution per Rider
192.	Relaxing	____:____:____:____:____	Full of Tension
193.	Easy with Packages	____:____:____:____:____	Difficult with Packages
194.	Can Look at Scenery	____:____:____:____:____	Can't Look at Scenery
195.	Low Energy Use per Passenger	____:____:____:____:____	High Energy Use per Passenger
196.	Radio or Tape Deck Available	____:____:____:____:____	No Radio or Tape Deck Available
197.	Dependable	____:____:____:____:____	Undependable
198.	Pleasant Riding Surroundings	____:____:____:____:____	Unpleasant Riding Surroundings
199.	High Privacy	____:____:____:____:____	Low Privacy
200.	Difficult with Children	____:____:____:____:____	Easy with Children

In a typical week about how many trips do you make for shopping or personal business using the bus?

None_____ 1 to 4_____ 5 or more _____

CONTINUE WITH QUESTION 201 ON NEXT PAGE

PART 3 TRANSIT ATTITUDES

201. A public mass transit system could be financed in a number of ways. Please rate the following in terms of your preference for financing a public mass transit system:

a) Riders should pay the full cost of service.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

b) "No fare" for riders; mass transit financed by gasoline tax revenues.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

c) "No fare" for riders; mass transit financed by tax added to electric bills.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

d) "No fare" for riders; mass transit financed by tax added to property taxes.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

e) Riders pay most costs, with balance from gasoline tax revenues.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

f) Riders pay most costs, with balance from tax on electric bills.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

g) Riders pay most costs, with balance from tax added to property taxes.
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

202. Indicate which four of the following areas should receive high importance for city tax dollar priorities. (Please check the four most important).

______ a) local street paving
______ b) street crossing safety
______ c) traffic safety
______ d) automobile noise control
______ e) automobile pollution control
______ f) rail mass transit
______ g) bus mass transit
______ h) exclusive bus lanes
______ i) residential sidewalks
______ j) hike and bike trails

203. How much is the fare for a typical (about 5 miles) bus trip in the City of Austin? (If you don't know, leave blank).
a) 20¢ ______ b) 25¢ ______ c) 30¢ ______ d) 35¢ ______ e) 40¢ ______

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204. If you were to change residence would you consider the distance of the new residence from your place of employment as a major selection criteria?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

205. If shuttle service were provided at the auditorium or other locations outside the downtown area, would you be willing to park there and take the shuttle to downtown?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

206. Which form of mass transit would you prefer?
a) buses as now ______ b) buses with special bus lanes ______ c) rail mass transit ______ d) other ______

207. Should government encourage the use of non-auto transportation as a solution to traffic congestion and air pollution?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

208. Do you believe that Austin will soon have a severe air pollution problem because of excessive automobile traffic?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

209. Does the lack of sidewalks deter you from walking short distances in your neighborhood?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

210. Are the streets in your neighborhood well maintained?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

211. Should employers be responsible for supplying parking for their employees to reduce on-street parking?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

212. Do you often use streets that have bicycle lanes? Yes______ No______ If so, do these lanes interfere with traffic?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

213. Would you be in favor of bus passes as a fringe benefit of your employment?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

214. Would a bus pass as a fringe benefit cause you to ride the buses more frequently, especially to and from work?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

215. Would you be in favor of car-pools to travel to and from work if your car were in the pool?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

216. If vehicles (cars, vans, trucks, etc.) were supplied by employers, would you favor car pools?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

217. Would you pay 1 or 2 cents more per gallon of gasoline with that money being used to help pay for the transit system?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

218. Would you be in favor of paying higher annual vehicle license plate fees on your personal vehicles with the money collected earmarked for transit improvement?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

219. Do you think that it is less expensive to ride the bus to and from work (assuming 60¢ or less per round trip) than it is to drive your own car (taking into account gas, oil, parking, depreciation, insurance, etc.)?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

220. Do you need your car for business trips during the day?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

221. Are the bus schedules and maps easy for you to understand? (If you have not seen any, leave this question blank).
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

222. If you had to pay to park your car, what price for parking your vehicle each day would cause you to switch to using transit?

__________50 cents
__________51 cents to $1
__________ $1
__________ $1.01 to $1.50
__________$1.51 to $2.00
__________$More than $2.00

223. If you do not ride the bus, why not? Or if you ride the bus, which of the following items bother you? (Rank the worst three with No. 1 being the worst.)

__________Long walks to bus stop (How far is too long--on level ground? ______blocks; uphill? ________blocks)
__________Risk of being stranded, especially at night
__________Long waits for buses
__________Cost of fare
__________Dirty
__________Old buses
__________Rude bus drivers
__________Other ____
__________No bus shelters
__________Not good when you have children with you
__________Slower than car
__________Routes do not go where you want to go
__________Too many bus riders are dangerous or undesirable people
__________Loss of personal freedom
__________Inconvenient when you have packages
__________No bus service available

224. If city mass transit were improved, low-cost and provided convenient service, would you use it?
Definitely yes______ Moderately yes______ Neutral______ Moderately no______ Definitely no______

225. How long does it take you to get to work (or your school, if student) usually?

__________0 to 5 minutes __________6 to 15 minutes __________20 to 30 minutes __________More than 30 minutes

226. If you drive to work, where do you usually park?

Parking garage __________
Parking lot __________
Street without meter __________
Street with parking meter__________
Other____

227. How far from your work place do you usually park?

______________________blocks

PLEASE TURN PAGE AND CONTINUE WITH PART 4

PART 4

We would like to find out some good ways of informing people about changes and improvements in the transportation system for roads, safety buses, etc. Please answer the following questions concerning your preferences in radio, t.v., newspapers, and the like.

228. How much time on the average, do you spend each day using a newspaper, the radio, etc?

Reading the Newspaper
- ________Don't read the newspaper
- ________1-30 minutes
- ________31-60 minutes
- ________Over 1 hour

Reading Magazines
- ________Don't read magazines
- ________1-30 minutes
- ________31-60 minutes
- ________Over 1 hour

Listening to the Radio
- ________Don't listen at all
- ________1-60 minutes
- ________1-3 hours
- ________Over 3 hours

Watching Television
- ________Don't watch at all
- ________1-60 minutes
- ________1-3 hours
- ________Over 3 hours

229. Which newspaper(s) do you normally read at least 3 times per week?

- ________None
- ________AUSTIN AMERICAN STATESMAN
- ________Spanish Language Newspaper
- ________THE DAILY TEXAN
- ________Other (Which one?________________)

230. What sections of the newspaper do you usually read (Please check your 4 favorites)?

- ________General news (first section)
- ________Comics
- ________Sports
- ________Woman's Section
- ________Business Section
- ________Want Ads
- ________Ann Landers or Dear Abby
- ________Entertainment
- ________Advertisements
- ________Other (which?______)

231. What radio stations do you usually listen to? Please check the one(s) you listen to at least 3 times per week, and ALSO check the time(s) you normally listen to each.

	Station		Times 7-9 a.m.	9a.m.-Noon	Noon-4p.m.	4-6p.m.	6-10p.m.	10p.m. on
____	None	AM						
____	KLBJ	590	____	____	____	____	____	____
____	KTAP	970	____	____	____	____	____	____
____	KVET	1300	____	____	____	____	____	____
____	KOKE	1370	____	____	____	____	____	____
____	KNOW	1490	____	____	____	____	____	____
		FM						
____	KMFA	89.5	____	____	____	____	____	____
____	KUT	90.7	____	____	____	____	____	____
____	KLBJ	93.7	____	____	____	____	____	____
____	KOKE	95.5	____	____	____	____	____	____
____	KHFI	98.3	____	____	____	____	____	____
____	KASE	101	____	____	____	____	____	____
____	KRMH	103.7	____	____	____	____	____	____

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232. What programs do you usually listen to (please rank your first 4 choices)?

- ________None
- ________News
- ________Variety
- ________Sports
- ________Talk-shows
- ________"Top-40" Music
- ________Country-Western Music
- ________Classical Music
- ________"Easy-Listening"
- ________Other Programs

233. What T.V. stations do you usually watch? Please check the one(s) you watch at least 3 times per week, and ALSO check the time(s) you normally watch each.

	Channel Station Cable	Times 7-9 a.m.	9a.m.-Noon	Noon-4p.m.	4-6p.m.	6-10p.m.	10p.m. on
____	24 KVUE Cable 3 (Austin)	____	____	____	____	____	____
____	36 KTVV Cable 4 (Austin)	____	____	____	____	____	____
____	7 KTBC Cable 5 (Austin)	____	____	____	____	____	____
____	9 KLRN Cable 8 (San Antonio and Austin)	____	____	____	____	____	____
____	11 KTVT Cable 9 (Ft. Worth)	____	____	____	____	____	____
____	41 KWEX Cable 13 (San Antonio)	____	____	____	____	____	____
____	Other	____	____	____	____	____	____

234. What programs do you usually watch (please rank your first 4 choices)?

- ________None
- ________Variety
- ________Sports
- ________Children's
- ________News
- ________Talk Shows
- ________Movies
- ________Soap Operas
- ________Game Shows
- ________Westerns
- ________Comedies
- ________Police/Detective
- ________Plays
- ________Other (which? ________________)

235. What clubs or organizations do you belong to and attend about once per month or more?

- ________None
- ________Church Organizations
- ________Other(s) (which?________________)
- ________Political Groups
- ________PTA
- ________Athletic Team
- ________Card Group
- ________Neighborhood Organizations

PART 5

Finally, we would like to have some information about you, for analysis and tabulation purposes. Please answer the following CONFIDENTIAL questions.

236. Sex: ____Male ____ Female
237. Marital Status: _____Single ____Married ____Other
238. Are you a student? _____Full time student ____Part time student _____Not a student
239. What is the approximate address of your place of employment? (If not employed, leave blank) Address or nearest intersection ______________
240. Your Age: ____Less than 21 years ____21-29 years ____30-44 years ____45-59 years ____60 years or older
241. How many people are in your household? ____One ____Two ____Three ____Four ____Five or more
242. Please indicate the age of your oldest child living at home. If you have no children living at home, leave question blank.
____3 years or younger ____4-5 years ____6-12 years ____13-19 years ____20 years or older
243. What is the highest level of education attained by you?
____Junior High or less ____Some High School ____High School Graduate _____Some College/Professional Training ____College Grad or Higher
244. Which category best describes your total family income for 1972? If you are a student, indicate only the combined total of your and your spouse's incomes. Your answer to this question and ALL other questions, is COMPLETELY CONFIDENTIAL.
_____Less than $5,000 _____$5,000-$9,999 _____$10,000-$14,999 _____$15,000-$19,999 _____$20,000 or more
245. What is your ethnic background? _____Mexican-American _____Black _____White _____Other
246. Do you ? _____Own home _____Live in Mobile Home _____Rent home _____Rent Apartment ____Other
247. How many automobiles are in your household? _____None _____One _____Two ____Three or More
248. How long have you lived in Austin? ____Less than 6 months _____6 months to 1 year _____1 to 3 years _____3 to 5 years ____5 years or more
249. Do you work in the downtown area of Austin? _____Yes _____No
250. Approximately how often do you shop in stores in the downtown area of Austin?
_____Twice a week or more often _____2 or 3 times a month _____Once a month _____Every 2 or 3 months _____Almost never
251. Approximately how often do you shop in stores in Highland Mall?
_____Twice a week or more often _____2 or 3 times a month _____Once a month _____Every 2 or 3 months _____Almost never
252. Approximately how often do you shop in stores in Hancock Center?
_____Twice a week or more often _____2 or 3 times a month _____Once a month _____Every 2 or 3 months _____Almost never
253. Approximately how often do you shop in stores in Southwood Center?
_____Twice a week or more often _____2 or 3 times a month _____Once a month _____Every 2 or 3 months _____Almost never

Comments: ____

Your help and cooperation are greatly appreciated. If you would like a summary of the results of this study, please indicate it and fill in your name and address. Yes______ No ______

NAME AND ADDRESS (if results desired) ______________________

APPENDIX I_b
Summary of Accident Data, City of Austin

No.	Street Name	Block No.	New Hampshire Hazard Index	Oregon Formula Projected 5 Yr. Accidents	Accident Experience 67	68	69	Existing Protection Device
1.	N. Lamar Blvd.	6900	77796.0	3.3445			1	Flashers
2.	W. Oltorf St.	1300	60551.9	2.5037				Flashers
3.	Anderson Lane	3200	39300.0	1.7190				Flashers
4.	Canadian St.	500	33088.0	1.6639				Crossbuck
5.	E. 53rd St.	700	27930.0	1.2413			1	Crossbuck
6.	Chicon St.	500	27683.9	1.3088		1	1	Crossbuck
7.	Guadalupe St.	6700	25320.0	1.3260		1	1	Crossbuck
8.	Comal St.	400	25040.0	1.3297				Crossbuck
9.	Rosewood Ave.	2200	24270.0	1.2481		1	1	Crossbuck
10.	Stassney Lane	1600	23748.0	1.1071			1	Crossbuck
11.	E. 19th St.	2900	21348.0	1.0167				Flashers
12.	E. 7th St.	2400	20718.0	0.9998			1	Flashers
13.	Webberville Rd.	2600	20400.0	1.0263				Crossbuck
14.	W. Mary St.	1300	19944.0	1.0097	1			Flashers
15.	U.S. 183	9000	19680.0	1.0824				Flashers
16.	38 1/2 St.	1500	19200.0	0.9815	1			Crossbuck
17.	S. Congress Ave.	4100	17649.6	0.6624				Flashers
18.	E. 51st St.	900	16350.0	0.8747		3	1	Flashers
19.	Manor Road	2800	16163.9	0.8827		1		Flashers
20.	E. 45th St.	1100	13733.9	0.7567	1			Flashers
21.	Mathews Lane	1600	13404.0	0.7384	1			Crossbuck
22.	Denson Dr.	100	12815.9	0.8021		1		Flashers
23.	S. First St.	4200	12468.0	0.5422		1		Crossbuck
24.	Steck Ave.	3300	11160.0	0.6787				Flashers
25.	E. 6th St.	2300	10050.0	0.6173				Crossbuck
26.	Waller St.	400	9480.0	0.6658		1	1	Crossbuck
27.	Pedernales St.	500	7914.6	0.5586				Flashers
28.	Springdale Rd.	900	7792.2	0.5501				Flashers
29.	Navasota St.	400	7048.0	0.5600				Crossbuck
30.	St. Elmo Rd.	800	6858.0	0.4112				Crossbuck
31.	Tillery St.	600	6843.0	0.5138	1	2		Crossbuck
32.	Pleasant Valley Rd.	500	6696.0	0.5114				Crossbuck
33.	Banister Lane	1000	5922.0	0.4828				Flashers
34.	Morrow St.	1200	5720.0	0.4965			1	Crossbuck
35.	Koenig Lane	400	4161.0	0.4048				Crossbuck
36.	Cherrywood Rd.	3400	3900.0	0.4008				Crossbuck
37.	E. 46th St.	4500	3810.0	0.3960				Crossbuck
38.	Lyons Rd.	1000	3777.0	0.3918				Crossbuck
39.	Wilshire Blvd.	1600	3180.0	0.3775				Gates
40.	Anderson Lane	1100	2950.0	0.3700	1			Gates
41.	12th St.	2700	2787.0	0.3672				Crossbuck
42.	Rutland Dr.	2300	1680.0	0.3224				Gates
43.	Ohlen Rd.	1900	688.0	0.2797				

Source: Railroad At-Grade Crossing Study, City of Austin, Department of Urban Transportation, 1969.