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Integrated Transit System and Intermodal Transit Center Charlotte, N.C.

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INTEGRATED TRANSIT SYSTEM
and
INTERMODAL TRANSIT CENTER
Charlotte, N.C.

by
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A terminal project submitted to the faculty of the College of Architecture, Clemson University in partial fulfillment of the requirements for the degree of Master of Architecture

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INTEGRATED TRANSIT SYSTEM

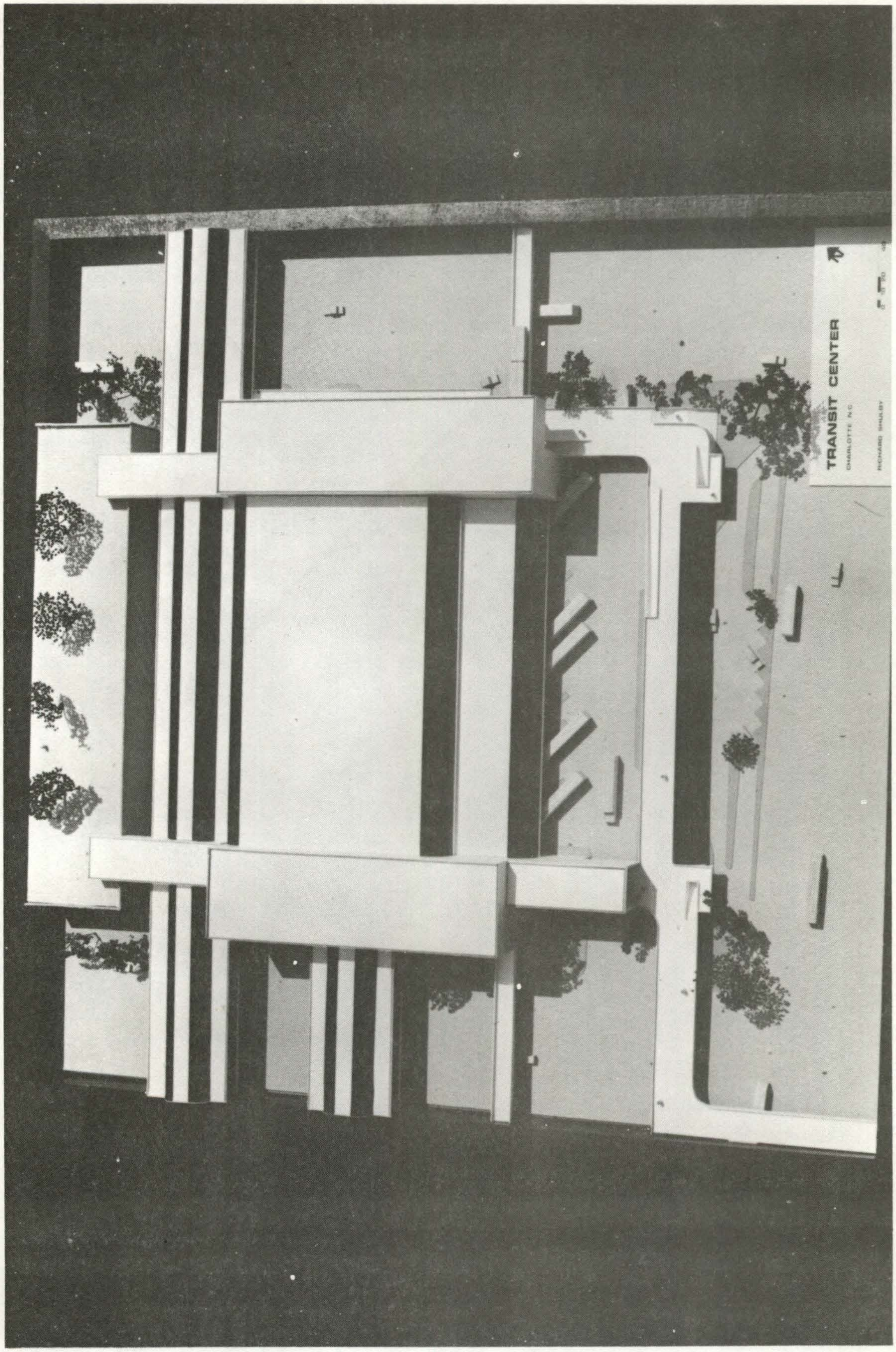
AND

INTERMODAL TRANSIT CENTER

CHARLOTTE, N.C.

RICHARD B. SHULBY

TRANSPO



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TO SUSAN

for her assistance
and encouragement

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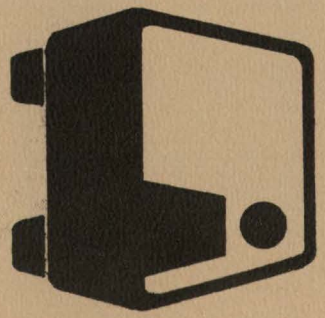
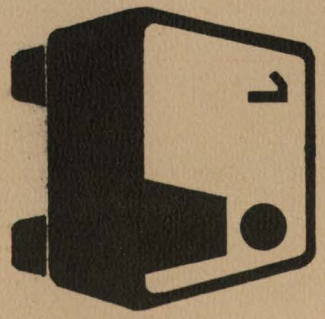


INTRODUCTION

The development of a comprehensive transit system for an urban environment has no standardized solutions. Each case must be dealt with on an individual basis, considering such items as available technology, present examples, the specific area's needs, and many others. Charlotte, North Carolina, requires the same degree of consideration. The first segment of this paper deals primarily with this aspect.

There are many factors which may also affect a transit terminal, whose main function is to move people from one place to another in an orderly, pleasing fashion. The second segment of this paper shall deal with the location and design of an inter-modal transit center to be located in downtown Charlotte. This will function as the major tie for the existing and proposed transit systems.



TRANSPORTATION AND THE URBAN ENVIRONMENT

The city has long been associated with the concept of transportation. As one of the major functions of the city is to move people through in order to serve the various functions within, city planners must concern themselves with conveying the masses quickly and efficiently. The present vogue in planning seems to concern itself primarily with the idea of building more highways in order to alleviate congestion. But it has become increasingly difficult to ease auto congestion in the city at a reasonable cost. New roads may have provided temporary relief from congestion, but they add to traffic woes by enticing more cars into already congested areas. The lack of adequate parking facilities also causes extreme parking problems.

However, the vast amounts of money and time which have been put into developing private transportation cannot be discarded in favor of public transit solutions. A balance between the two must be found and implemented if the city is to survive.

HISTORY OF TRANSIT

The problems of mobility caused by traffic are not new to the cities. Breakthroughs in technology seem to have alleviated the critical congestion problems. During the period of the empire, Rome had immense traffic problems. London suffered from early forms of traffic jams in the 19th century. The horsedrawn streetcar could move people faster than the omnibus and alleviated the clotting of omnibus

traffic in the larger cities. The cablecar and streetcar accomplished the same goals. In the last half of the 19th century, elevated and underground railways provided private rights-of-ways when surface traffic threatened to grind to a halt in such cities as Philadelphia, New York, and Chicago. Public forms of transit made for intensive use of scarce city land while providing transportation at relatively low cost.

MASS TRANSIT VERSUS THE HIGHWAY

The number of valid arguments on either side of the mass transit -highway clash are incalculable. Nevertheless, they each share in several problems which arise.

At the present, there are not enough travel corridors of either type into urbanized regions. The routes which do exist cause a variety of problems. Transit routes and facilities rob the city of land; one of it's most valued commodities. Also, people must be relocated from time to time. Transit routes, public and private alike, cause land values to fluctuate. Land needed for the route may skyrocket, while surrounding land values may go up or down, depending on the land use. Facilities on established routes may suffer as a result of the construction of newer, more desirable routes. Transit systems are also major contributors to noise and air pollution (table 1.1).

NOISE LEVELS OF VARIOUS SOURCES - TABLE 1.1

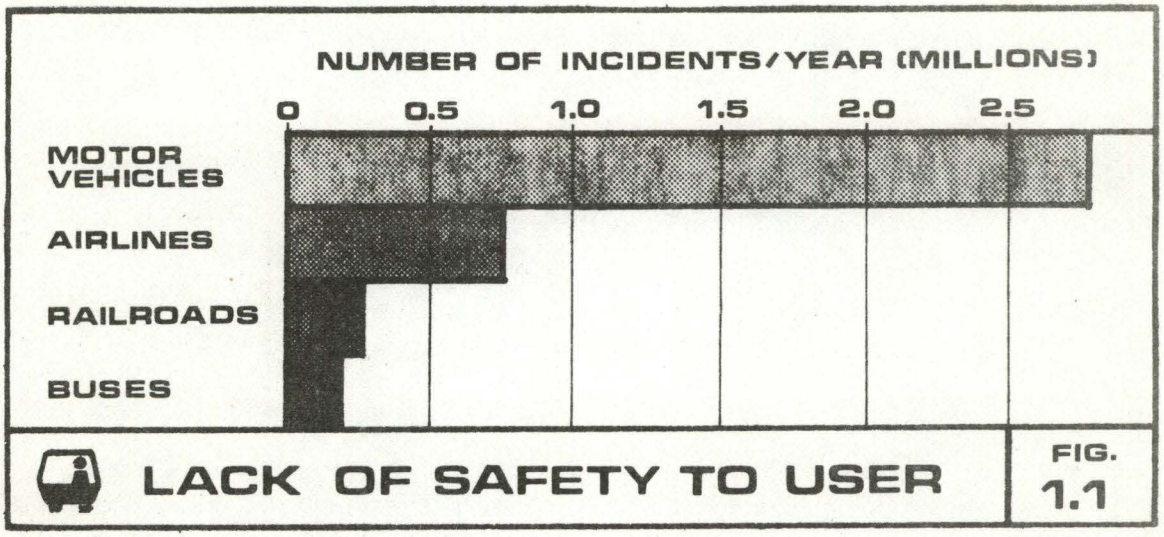
Source		Decibel Level
Conversation		55-60
Industrial Processes Known To Cause Hearing Loss		84
Threshold of Pain		140
Heavy Trucks		86
Motor Buses (Starting)		85
Light Trucks		74
Automobiles		71
Subway Trains		90
Railroad Trains		85
Old Trolleys		88
New PCC Cars		75
Electric Trains		75
2000 Lb. Thrust Four-engine Jet Airliner At Takeoff	At Source	150
	500' Away	115

In 1968, transportation sources contributed 42.3% of the 213.8 million tons of emissions.

The automobile provides the ultimate in privacy, convenience, and comfort. The United States is so dependent upon the automobile that they have increased at a faster rate than people in the period between 1950 and 1970. The number of cars has jumped from 49 million to 112 million in that period. It became clear in the 1960's that the ever-growing traffic jams could not be dissolved with more asphalt. The congestion of the automobile in the city has polluted the atmosphere to dangerous levels. It robs the traveler of time and causes related problems in truck deliveries to the city, as well as impeding fire, police, and sanitation departments in their work. Cars and highways also

create a visual intrusion of the landscape. Signs, parked cars, and abandoned vehicles virtually litter the city.

Highways are more costly than rail rapid transit and less efficient. Automobiles are also the cause of more accidents, injuries, and fatalities than any other form of transit (fig. 1.1).



Automobiles take up more room in the city than any other form; in most CBD's under one square mile, 40-50% of land area is devoted to streets and parking. Finally, contrary to current thought, the automobile is by no means an all-weather transport vehicle. It can easily be stopped by heavy snow or dense fog.[1]

Mass transit is on the rise in the United States. Although mileage provided dropped 38% between 1945 and 1963 overall route miles increased 11%. Demonstration programs have shown that the following items are important in

determining the need for mass transit:

1. Going where people want to go
2. Access (can public get to system easily)
3. Time (how long does trip take)
4. Cost
5. Comfort

Transit generally occurs in the form of rural-urban or urban-urban systems. Most airline and rail routes go only from city to city. Interfaces between the various modes occur in cities, as that's where each mode concentrates. This causes a good deal of "bridge" or "inter-modal" traffic.

Mass transit need not be totally inflexible. Patrons can supply their own connections to transit lines, allowing housing to be moved out of the areas immediately adjacent to the lines. The types of urban transportation available can influence the aesthetic character and form of a city, as well as serve as a population centralizer. Stockholm, Sweden found that people tended to concentrate to a certain degree around transit lines. Sweden has a similar level of automobile ownership to the United States.

Mass transit is also plagued with a variety of problems. In terms of privacy, it cannot offer the relative quiet of the automobile. It causes discomfort in that passengers have to face such problems as: noise, appearance, temperature, smell, vibration, etc. Congestion caused by delay, overcrowding, and slow inherent speeds is also prevalent in some systems. Some systems require that the user do certain things for himself, which causes problems for the handicapped,

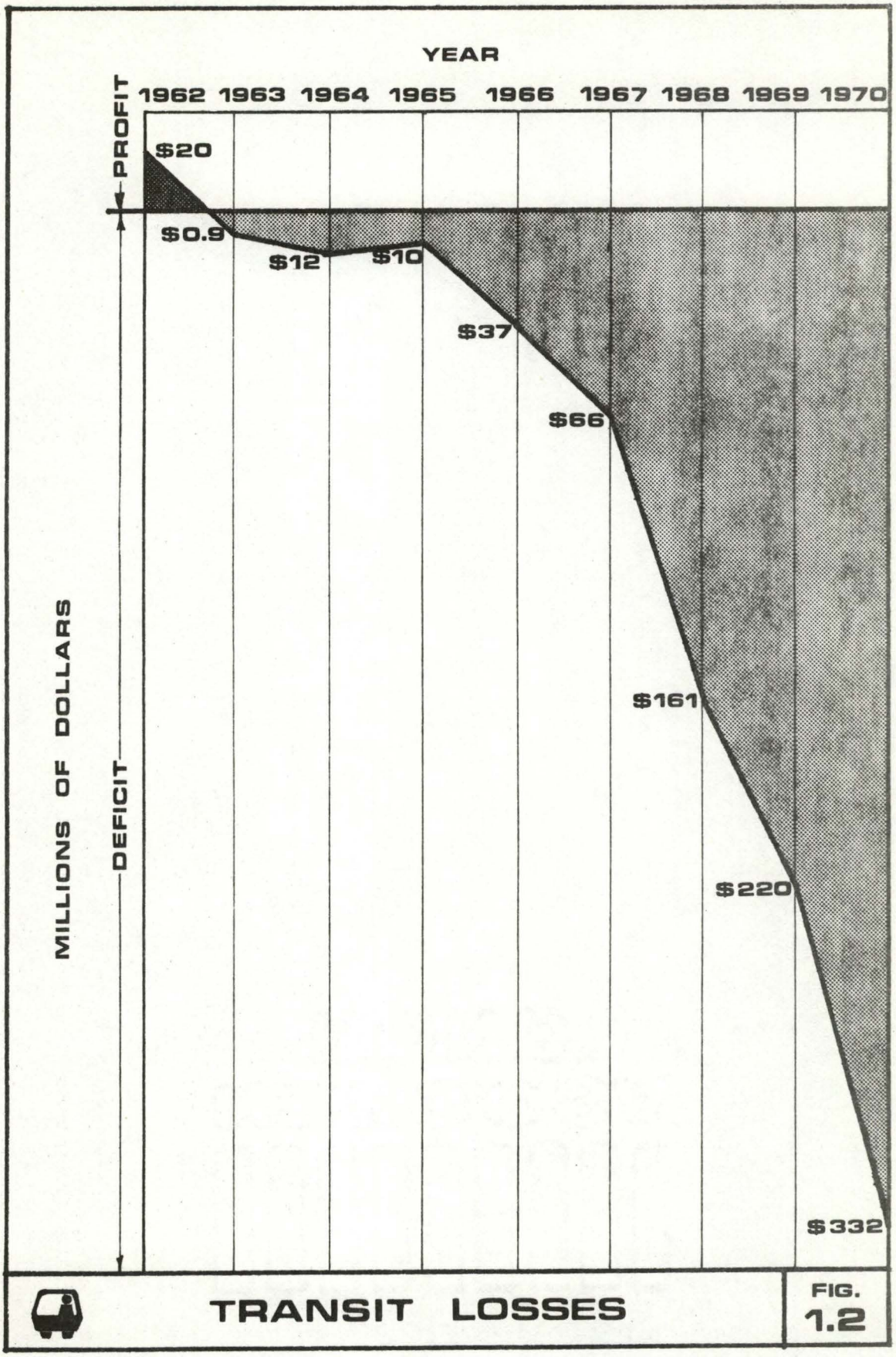
illiterate, young, and others. The user and facility costs coupled with a low rate of return have caused serious deficits (fig. 1.2).

TRANSIT COSTS

The private car is not only the most convenient transportation available, but is generally considered the cheapest. This holds true in low-density situations, but the situation can change in medium-and high-density situations, once the costs of ownership, insurance, maintenance, and parking are added to that of gasoline. As speed increases (up to 40 miles per hour), total cost per vehicle mile decreases. Above 40 miles per hour, cost per vehicle mile increases again.

Bus and rail are considerably cheaper than automobiles for meeting peak hour line-haul transportation requirements. At low and medium densities, bus systems are almost invariably cheaper than rail. But express bus costs, with an exclusive roadway, run somewhat higher than rail. At medium density and high volume, rail cost approximates bus cost. Rail becomes the most economical when density is high, runs short, and trip volume high.

Transit is still operating at a loss. Even though total operating revenue increased 100.6% between 1940 and 1966, total payroll outdistanced revenue by going up 176.4%. Labor accounts for the major cost in transit operations. It accounted for $994.9 million out of $1,478.5 million in 1966.



TRANSIT LOSSES

FIG. 1.2

Commuter trips comprise a good portion of transit ridership. A commuter trip pattern between home and downtown consists of three functional compenents:

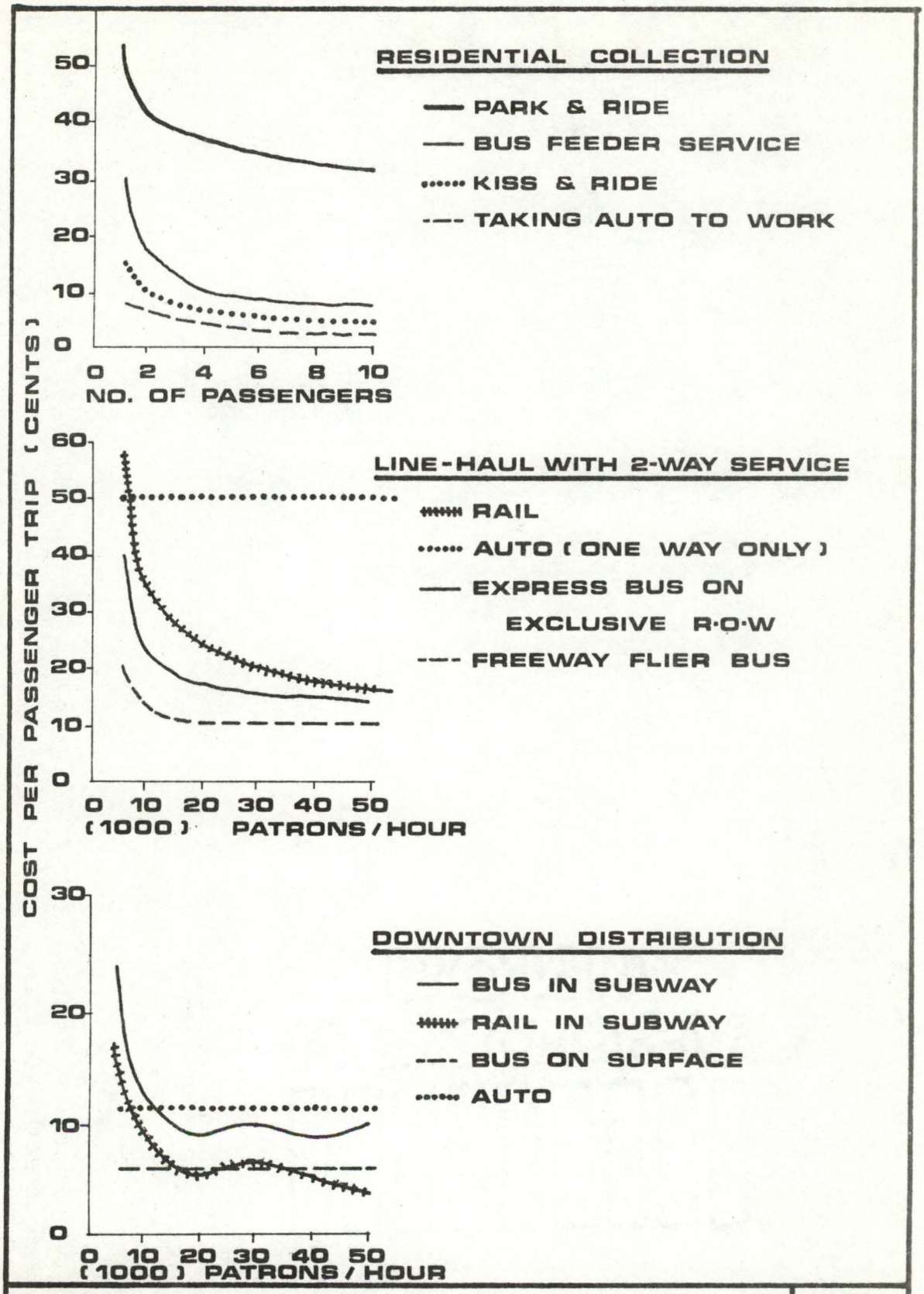
1. Residential collection
2. Line-haul service
3. Downtown distribution

Residential collection can be handled in a variety of ways, with an equal variety in costs. "Park and Ride" refers to a system where the transit rider leaves his car at the Line-Haul station all day, and "Kiss and Ride" refers to a system where the rider's wife, etc., would take him to the station. This and other cost comparisons are shown in figure 1.3.

FEDERAL GOVERNMENT AND MASS TRANSIT

In an effort to save existing mass transit systems from obliteration, and to alleviate the pollution and overcrowding of the nation's cities, the federal government has begun subsidizing systems and backing new modes of transit. The Department of Transportation (DOT) and the Urban Mass Transportation Administration (UMTA) are directly responsible for backing up the nation's transit systems. They also give money for Federal Demonstration programs.

Money can be obtained under the demonstration programs by showing that results of the new system may be applicable on a national level if it should prove useful. The National Rail Passenger Corporation (Amtrak) was formed in 1970 to bail out the railroads. It began operation on May 1, 1971. Amtrak does not run the railroads, but it pays deficits and



COMMUTER TRIP COSTS FIG. 1.3

guarantees a 9% profit. Amtrak's ridership is up 4% since last year (1975-1976), in part due to USA Rail Pass and trains to Florida (Autotrain and car rental packages).

TRANSPORTATION GOALS

The ultimate goals of transportation are as varied and as intricate as the present transportation problems. Certain general goals include providing a rational arrangement for the city. Service to the people is paramount. Transportation must also create such amenities as convenience, safety, healthfullness (as opposed to pollution), variety and ease of contact. Efficiency and economy in this use of public and private funds is also important.

Transit and pedestrian pathways must be planned in conjunction with urban spaces. Initial planning procedures must include attention with regard to access, urban design, and land value regulation. Transit systems must be developed to serve the outlying areas as well as the CBD. Financial responsibility for the systems must be carried by federal and state agencies. The best arrangement of systems is by one management with free transfer for the passengers between modes.

The automobile will continue to play an important role in transportation. Public transit cannot feasibly serve every district or situation, and it is here that the automobile will perform a necessary function. In low-density situations, the automobile must provide transportation to

businesses within the region, to transit stations, and for any local travel. In medium-density areas, the automobile must perform duties during off-peak hours and in sparsely traveled directions. Commuters who need their cars during the course of the day must be accommodated in the CBD.

Suburban railroad lines, with headways between trains from 10 minutes to one hour, link the outlying low-density areas to the downtown. This may be done directly or by transfer to rapid transit lines.

Rapid transit, with headways ranging from 90 seconds to 5 minutes (more in certain cases) provides most of the links to the downtown, some links of longer distances in medium-density areas, and movements within the downtown area.

Public surface transportation serves most short runs in medium density areas as well as very short runs in the downtown area.

Specific transportation goals must be dealt with individually in the case of each region. Many factors such as economy, population, and geography play important roles in shaping a transit system.

URBAN PROBLEMS

Since the advent of the automobile, the city has undergone a number of changes. By allowing for convenient transportation over larger distances, the automobile has supported the growth of suburbia. This growth has come in part from population growth, but a good portion has come from a transfer

of the city's population to the outer fringes. The shift in population, as well as various other benefits including lower land costs, easier access, less restriction, has drawn many of the retailing and industrial functions to the fringes.

A good number of job opportunities still lie in the city. These generally take such forms as banks, which need the density and interaction which only the urban environment can provide. But a strain is being felt by present transportation forms, due to a doubling of travel in the United States between 1940 and 1960. The working day also creates two peak hours which cause transit equipment to lie idle the rest of the day. Transit systems are on the decline because most were developed for high-density situations, and cannot be adapted to serve the present population dispersion. This leads to a "vicious circle" in transit where reductions in transit usage lead to reductions in service, leading to more reductions in usage, etc.

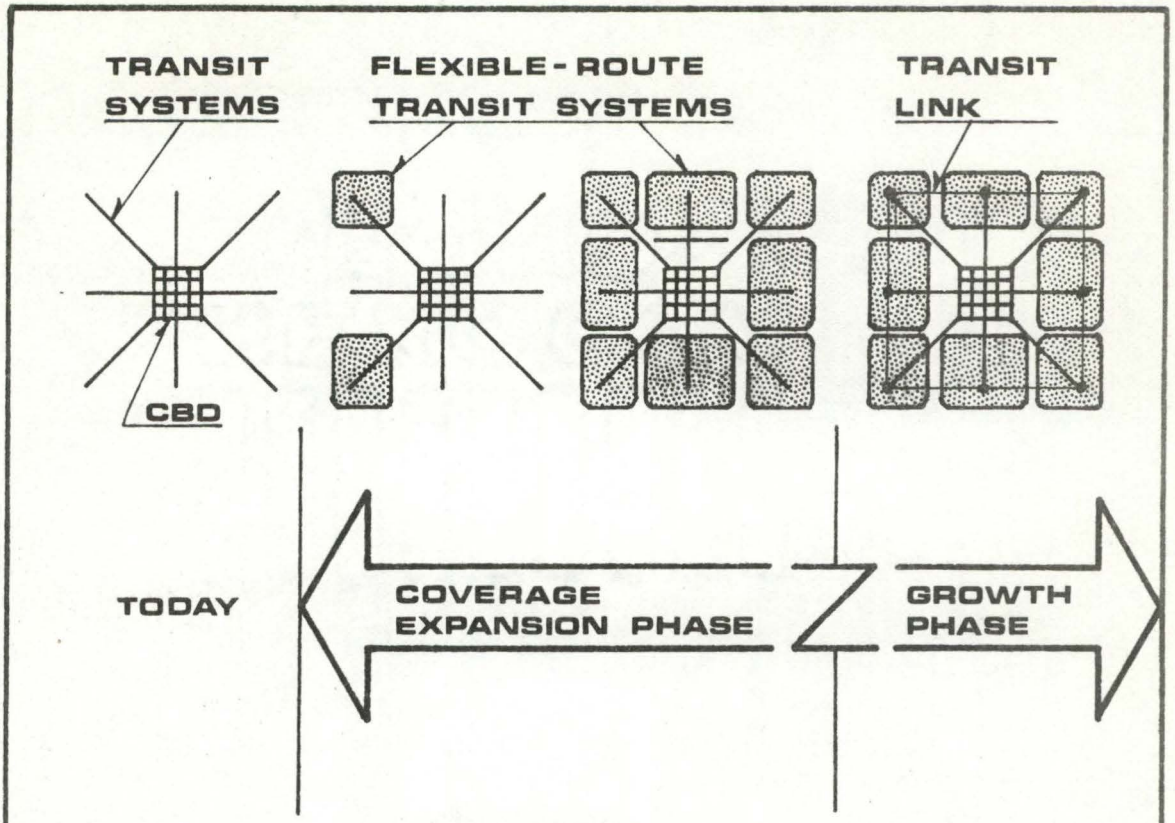
PLANNING FOR THE URBAN ENVIRONMENT

The decline of the urban environment has allowed a unique situation to avail itself to the city; the opening up of much urban land for redevelopment. With a change in thinking about how to plan for the city, many opportunities for a vital and active environment are available.

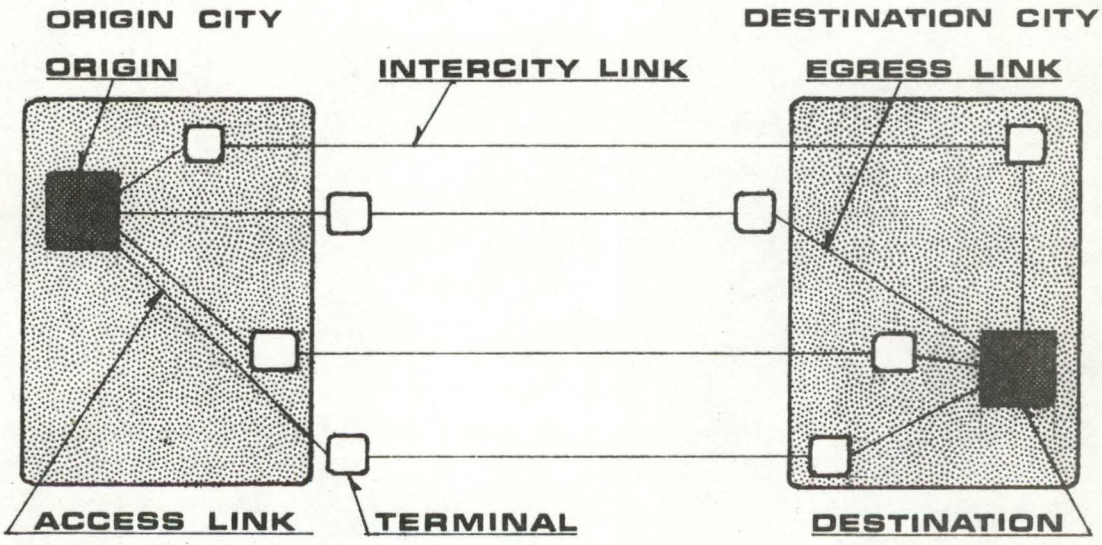
The new city should be planned for people instead of cars. This is not to say that cars should be excluded, but that they should not be allowed to run unchecked in the city plan. Public spaces and services must be included. Urban

housing, built and renovated for all income levels, will work best in locations served by transit. All parts of the urban environment should be integrated fully with transit. The downtown could be made the regional center for various tightly clustered institutions, businesses, and government functions. The accomplishment of this will attract residents and investment on a rising scale.

Transportation into the city must come about as a function of demand. Demand increases as distance to the CBD decreases. Transit into the city can be phased to allow for potential growth of the city. Intercity transportation must also follow a certain pattern of development (fig. 1.4) in order to make it convenient to the traveler. But in order to accomplish this, money is needed. Government agencies must "stop subsidizing freeways and start to subsidize transportation."[2]



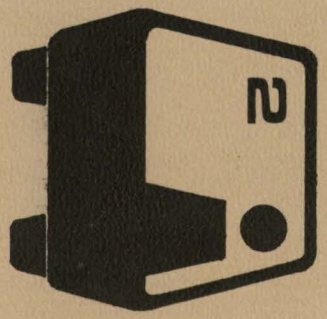
LOCAL



INTERCITY

TRANSIT CONSIDERATIONS

FIG. 1.4



TRANSIT TYPES

CONVENTIONAL TRANSIT

The major forms of transit have changed little in the past 50 years. The auto, bus, and rail systems still operate in much the same way as they did when they were initiated.

Taxis. There are about 7,200 fleet cab operations with an estimated greater number of individually owned and operated cabs. This works out to a national average of one (1) cab for every 2,000 people. Taxi service is provided in approximately 3,300 communities in the United States.

Motor Bus (Urban). The average bus carries about 50 people and costs $32,000. It provides one of the most economical means of mass transit, because it does not require a special guideway. Service is generally reliable, even in bad weather; and routes can be changed easily. The bad points of buses stem from the fact that many are 30 years old, smell bad, and are frequent victims of vandalism.

Innovations in bus systems could include centralized fare collection, more loading doors, and use of high-speed, diagonal loading stations. This would permit a greater capacity in terms of riders/hour.

Rail Service. Rail service can be divided into three categories: rapid transit, commuter service, inter-urban rail. This includes only the so-called "heavy rail" systems which have their own right-of-ways.

Rapid transit has the ability to handle a great number of riders and is more economical in terms of space needed than are the other modes. Storage of vehicles can be accomplished

on the fringe instead of wasting valuable downtown land.

Commuter railroads, which run on less frequent schedules than rapid transit, have held their own against the bus and automobile because they have a private right-of-way. The quality of the service has also helped to a good degree.

The future of inter urban rail seems to be in terms of trips lasting from 1-6 hours. Amtrak, which has lost $375 million in three years of operation, is expected to come closer to break even within the next few years. This compares with $19 billion allocated for highways during the same period.[3] In an effort to attract riders, Amtrak now offers the USA Rail Pass to Americans, which pays for a coach seat on any Amtrak or Southern Railway train.

NEW DEVELOPMENTS IN TRANSIT MODES

Automated Highway. This system involves a specially-designed roadway with guidance cables buried beneath the pavement. Individual guidance units, costing about $150, are mounted in each car. These control speed and spacing of the vehicle by linkup to a central computer. With an average speed of 58 mph, the system could carry 9,000 vehicles/hour/lane, with access points spaced at a minimum of 2 miles. The cost for the system is estimated at $3,843,000/lane mile.

Dial-A-Bus. This is a taxicab service utilizing small buses on a demand response basis. Potential riders would call a dispatcher, and a computer would coordinate calls to allow for maximum passenger loads. Fares would range between transit

and taxi fares, and the system would be most effective in low-density areas.

Exclusive Bus Lanes. As opposed to separate guideways for buses, these lanes, located integrally with freeways or roads, could be switched back to automobile usage during certain hours. They have a capacity of 1200 buses/lane or 60,000 passengers/hour. Costs would be lower than for separate guideways.

Multi-Modal Capsule Systems. Small capsules, limited to 2 passengers apiece, would be transported over long distances by special vehicles similar to flatbed trucks. For short trips, the capsules would be self-powered.

StaRR Car. The StaRR Car is a small dual mode vehicle which can operate on conventional roads powered by a storage battery, or within a special guideway. It has a capacity of 27,900 passengers/hour when automatically guided, and eliminates passenger transfer in commuting trips.

Dashaveyor. This system consists of capsules powered by a conveyor which has a high capacity and low cost of operation. It has a good potential use in major activity centers.

Duo-Rail Subway. Based on the amenities of the conventional subway, this system used pneumatic tires on concrete rails. The result is increased acceleration and deceleration, and a smoother quieter ride.

Aerotrain. The Aerotrain is an air-cushion vehicle which rides on a T-shaped rail made of prestressed concrete.

Inherent problems in the system include high winds, snow, and large obstructions.

Safege Monorail. A monorail which hangs under the rail. A minimum rail-to-ground clearance of 32 feet is required but the system has theoretical speed advantages on curves due to a pendulum activity which throws the center of gravity within the car to the car floor.

Alweg Monorail. Basically the same as the Safege system, this system rides on top of the rail. This allows the costs for the system to drop, but because the car rides on top of the rail, it is subject to interference from snow, ice, and debris.

Minirail. A smaller varsion of the Alweg monorail, this system is suitable for use as a downtown distribution system.. it has been designed to run through buildings. System cost is extremely low, but it suffers from the same problems as the Alweg.

Gravity-Vacuum Transit. This is a theoretical system in which a cylindrical vehicle in an air-evacuated tube could operate at great depths and distances. Control would be costly and emergency procedures would be a problem if the vehicle stopped in the middle of a run.

Heliports. While the heliport is not new, the inclusion as an urban transport is. Although there would be no congestion, costs are high, capacity low, and there is an extreme noise problem.

Moving Walkways. A totally automated system, the walkway allows movement of great numbers of people over short distances. They are ideal for transfer situations.

SERVICE COMPARISONS

Transit services are in constant competition with each other. They also must compete to a large degree with the automobile. Each form of transportation has its own feature: water and rail are superior in capacity, the automobile excels in convenience, the bus combines convenience (flexibility) and capacity, and the aircraft is superior in speed. The demand for various services fluctuates from time to time, although the demand for taxi service has remained relatively stable.

A single lane of traffic which is subject to cross traffic will allow 1,600 people/hour to pass. A single rail line will allow 40,000 people/hour for locals, and 60,000/hour for express trains. Translated, this means that one local line equals 25 lanes of ordinary street, and that one express line equals 23 lanes of freeway. The amount of street area required by cars is greater than that of other street-based modes. Also, roads require larger right-of-ways than transit systems (see Appendix).

CHARLOTTE, N.C. - A STUDY

Charlotte is North Carolina's largest city, and has been labeled "The Queen City". It is situated in Mecklenburg County, which is North Carolina's most affluent and populous county. The city covers 65.1 square miles and has a CBD (central business district) of 0.74 square miles.

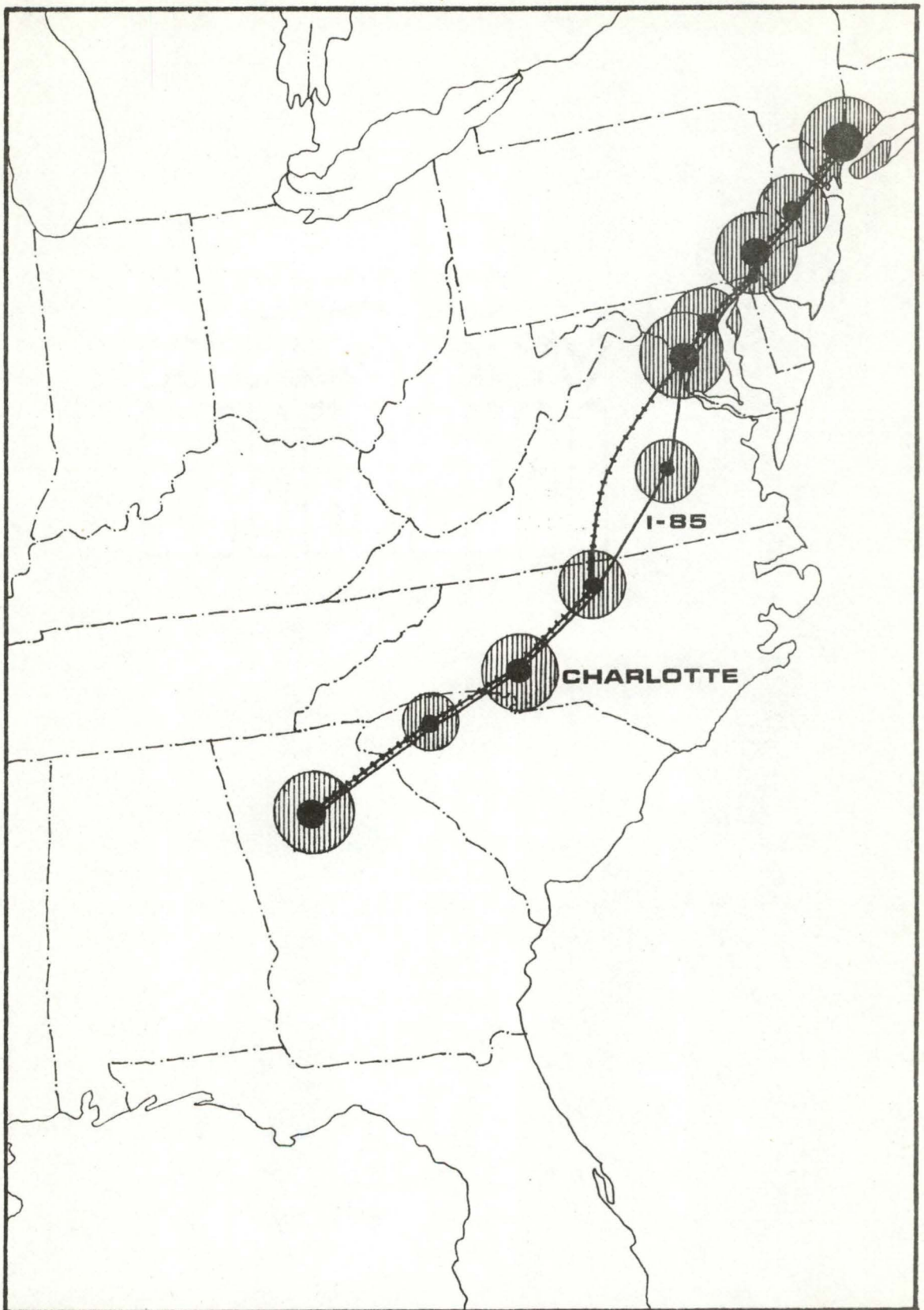
LOCATION

Situated in the southwestern portion of the state, Charlotte lies along I-85, a major link between the southern states and the Northeast (fig. 3.1). Charlotte helps form the southern anchor of an urbanized belt which is forming from Atlanta to Boston. The city is 250 miles from Atlanta, 380 miles from Washington, and 95 miles from Columbia, South Carolina.

HISTORY

Settlers first came to the Mecklenburg region in the mid-18th century. They were of Scotch and Irish/English descent and came from Maryland and Pennsylvania. In 1762, Mecklenburg was established as a county, and in 1768, was divided into Mecklenburg and Tryon Counties. In November 1768, 100 ½-acre lots were laid out for houses, thus incorporating Charlotte.[4]

The first college south of Virginia was chartered on January 15, 1771, as Queen's College. Charlotte's first school system was started in the 1830's, and public health services were initiated in the 1880's.



URBANIZED BELT PLAN

FIG. 3.1

There are three important epochs in Charlotte's industrial and commercial history. The first was the discovery of gold in the Carolina Piedmont and the opening of the first branch of the United States Mint in 1837. The mint was subsequently closed in 1913. The establishment of Charlotte as a railroad junction led to the growth of an industrial center; Charlotte's second period of development. The third epoch was the derivation of Charlotte as a major trucking center in the eastern seabord.[5]

Charlotte is one of the nation's great transport and distribution centers. The first railroad serving Charlotte was the Charlotte and South Carolina Railroad, which opened in 1852. Soon more railroads were attracted to the area, and they brought industry with them. The Piedmont Traction Company was formed in 1910 to connect Charlotte and Gastonia, although electric streetcars had been serving Charlotte since 1893, and horse-drawn cars since 1887. Air service was brought to Charlotte in 1930 and now is handled at Douglas Municipal Airport. In the 1940's, Union Bus Terminal was built to handle the various interurban and interstate bus lines.[6]

POPULATION

Charlotte's population stands at 306,000 as of late 1975. Projections put the city's population at 575,000 by 1995. This is in keeping with a trend in which Charlotte has been growing at a rapid pace since the turn of the century. Mecklenburg County's population stands at 397,850, and is projected

to go as high as 725,000 by 1995 (fig. 3.2).

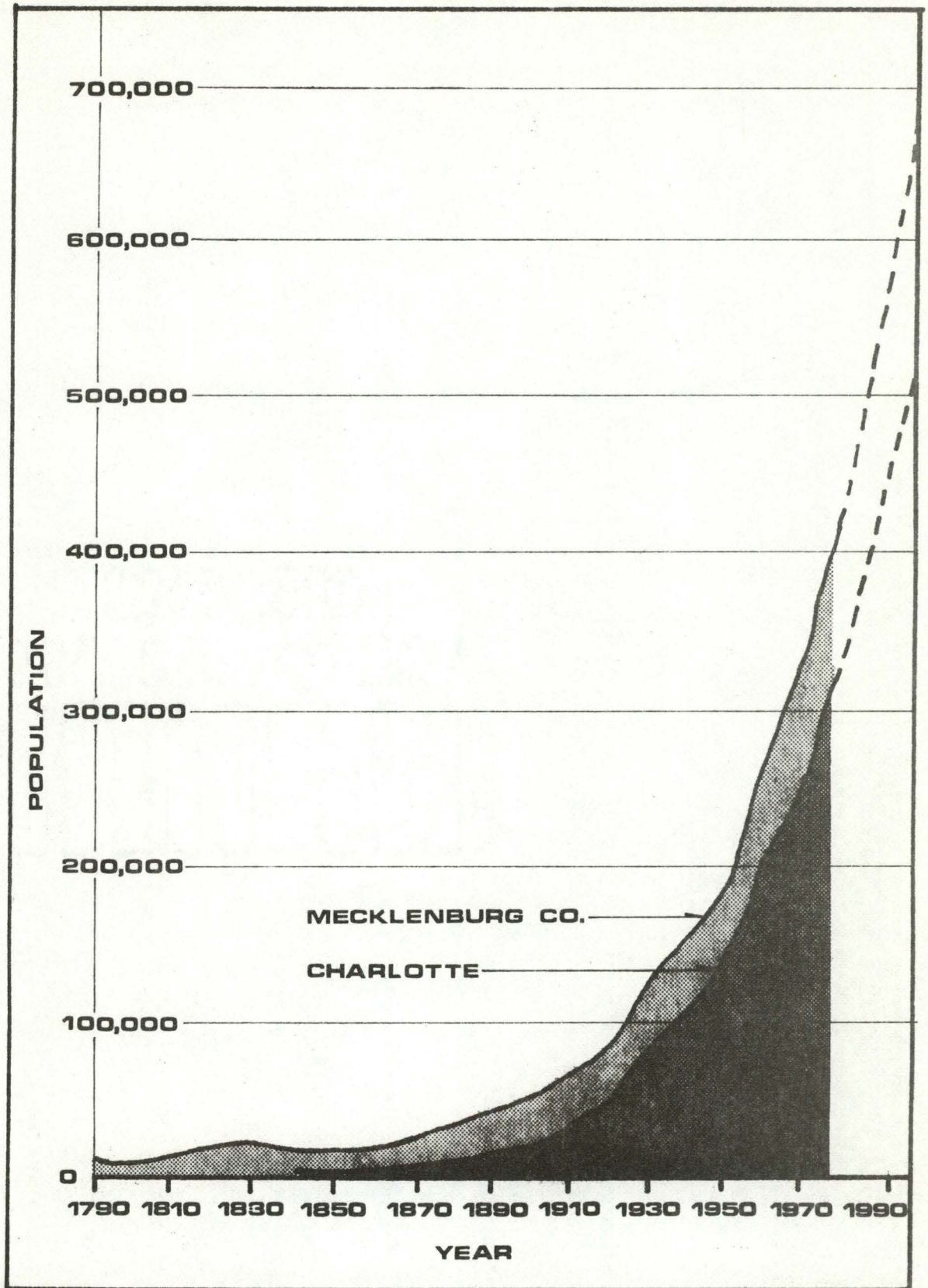
ECONOMY

One of the major factors affecting the growth of any city is the economy it is based upon. Charlotte's rapid growth stems from the fact that it is one of the banking centers of the South, and is considered the "Crossroads of Carolina". A number of financial institutions are establishing headquarters in Charlotte.

Retailing interests naturally tend to fluctuate directly with population trends. In the period between 1964 and 1974, Charlotte's retail sales increased 15% a year. This has allowed Charlotte to become the 17th largest sales center in the country. Charlotte's population is divided into three basic categories: 22.4% in manufacturing, 53.6% in white-collar jobs, and 10.5% in government. Of the remaining 13.5%, 7.9% work outside of Mecklenburg County, 2.7% are unemployed, and the rest work in jobs not covered by the categories above. Distribution of businesses by type are listed in the Appendix.

PROJECTED TRENDS

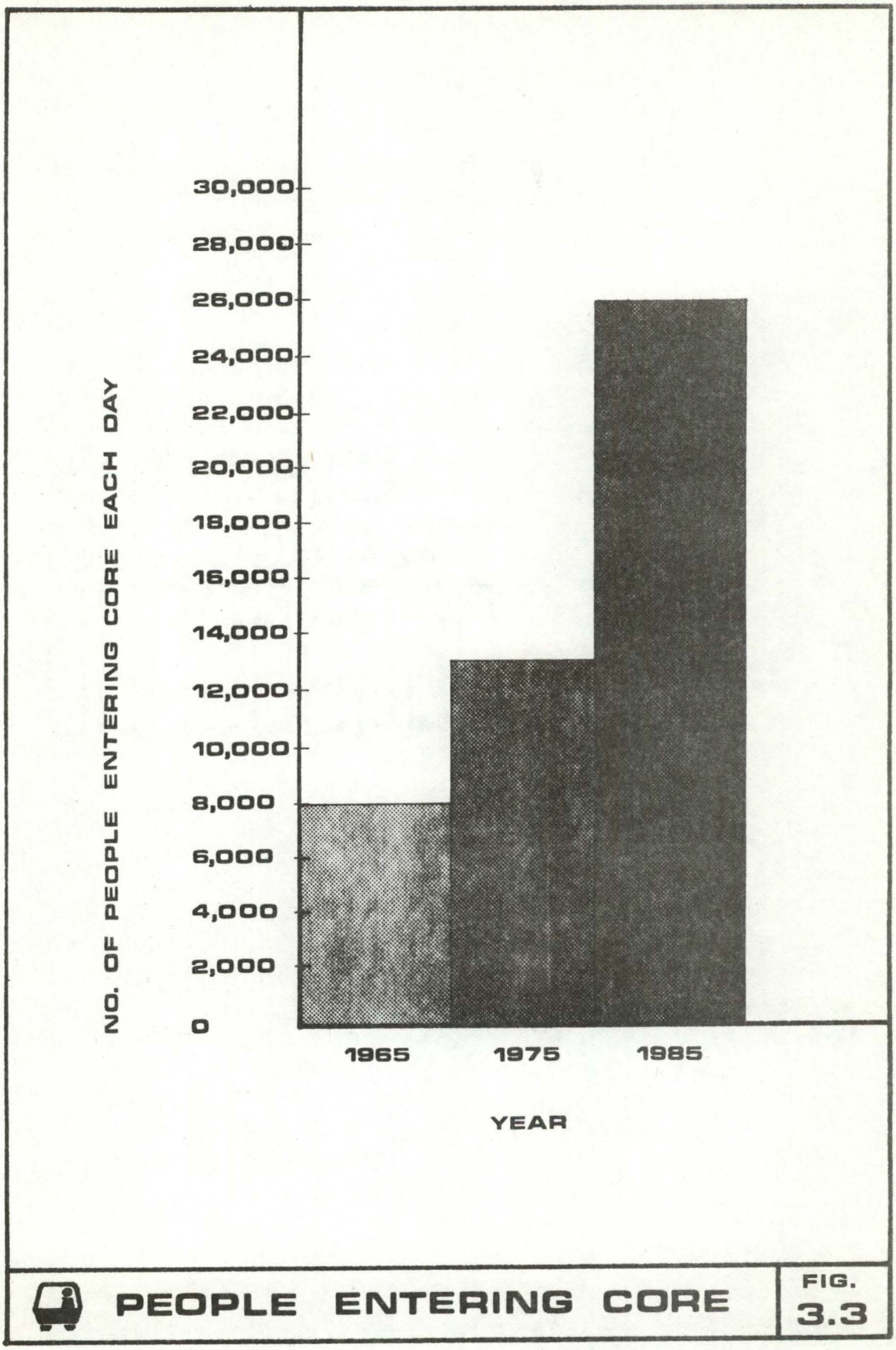
Charlotte is in the process of undergoing a period of rapid growth. Most planning for Charlotte is carried out in conjunction with the Charlotte-Mecklenburg Planning Commission. Two major plans have been proposed for Charlotte in recent years. The latest one, prepared in 1974-1975, is entitled Comprehensive Plan 1995. In 1971 a planning guide was prepared for the city of Charlotte by Vincent Ponte of the firm



POPULATION GROWTH

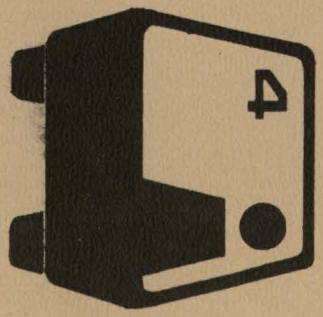
FIG. 3.2

Ponte/Travers/Wolf. The major goal of this booklet, Central Area Development Guides, was to establish a pattern for development in the CBD, and to integrate it with a proposed system of pedestrian walkways. The area in question, called the "Core", is a heavily urbanized portion of the CBD of approximately 110 acres. By 1980, it is forecast that 2-3 million additional square feet of office space will be needed in the core. This is an increase over existing space of up to 200%. It will also cause the movement of an additional 18,000 people in and out of the core daily. Eight thousand (8,000) people presently enter the core each day (fig. 3.3).



PEOPLE ENTERING CORE

FIG. 3.3



CHARLOTTE:
THE NEED FOR
TRANSPORTATION

In conjunction with the rapid growth that Charlotte is experiencing will come greater congestion of Charlotte's streets. The building of new and larger roads have not solved this problem in the past, but merely checked it for a few years. Parking has become a major problem in downtown Charlotte. Parking lots and garages literally dominate the CBD. Increased development will only serve to make this problem more acute, unless use of mass transit is encouraged.

EXISTING FACILITIES

Charlotte is served by a number of transit systems, none of which are linked very well to the others. They are located at various points throughout the city, and are not always easy to locate.

Local transit service is offered by the Charlotte Transit System. Recently bought by the city, this system incorporates bus routes which are laid out in a radial pattern, stemming from the CBD. There are 11 routes, each one serving two (2) fringe areas located directly across the CBD from each other. The radial pattern allows for a good coverage of most of metropolitan Charlotte. The system is hampered by heavy rush hour traffic, lack of coverage of the county suburbs, and the age and appearance of the buses. A number of taxi companies offer the only alternate mode of transport within Charlotte.

Intercity transit service is offered by a number of companies. Bus service is handled by Trailways and Greyhound. Trailways operates out of Union Bus Terminal, which is located

on West Trade Street. It offers 90 runs each day, and uses 6 of its 9 loading platforms. Greyhound Bus Lines operates out of a 2-year-old facility located a block west of the Trailways facility on Trade Street. Forty (40) schedules are presently offered at 4 of 6 available platforms.

Southern Railway offers four trains out of a new passenger station located next to its freight yard on the North Tryon Street extension. The terminal location seems not to have been very well planned, as it is located in a warehousing and wholesaling district.

Airline service is handled at Douglas Municipal Airport, situated 5 miles west of the center of town. Passenger enplanements reached an all-time high of 1,198,590 in 1974.

CURRENT PROPOSED SOLUTIONS

The major proposal in the transit solution currently put forth by the city government is the expansion of Douglas Airport. With an expected traffic growth to 2,250,000 enplanements by 1980, the present facilities have been deemed inadequate. Plans include a new runway, passenger terminal, control tower, crash/fire/rescue facility, and various related projects.

The possibility of a new transit terminal serving the CBD has been discussed, and a somewhat arbitrary cost figure of $16 million has been recorded in conjunction with the project. No plans have been drawn up, and the scope of such a facility has not even been drawn up.

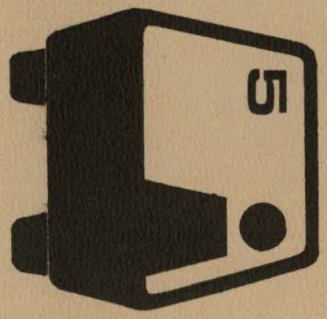
Bus service is to be improved and updated, and the designation of several "busways" has been discussed. Other improvements, such as express or "Metro" bus service has been proposed, connecting fringe parking areas with the CBD. These Metro buses would run to a proposed transit center, located within the CBD.

Present plans seem to rely upon the completion of a shaky "inner loop freeway" to solve most of the city's transit problems. At best, this can allow only a slight alleviation of traffic problems for a year or two after it is completed.

NEEDED FACILITIES

The bus system in Charlotte is basically sound - it connects the CBD with the edge of the city limits in a logical pattern. With extension and alteration of routes, establishment of the Metro buses, and upgrading of equipment, it should adequately serve Charlotte's expected growth.

Charlotte's road system is likely to remain congested, and a system utilizing an exclusive right-of-way should be considered. The city also lacks any form of downtown distribution system, which is sorely needed if the downtown area is expected to grow. Finally, an intermodal transit terminal is needed in order to tie all of these various systems together, and to form a tightly-knit and well-organized transit system for Charlotte.



CASE STUDIES

COMMUTER POOLING

The Tennessee Valley Authority (TVA), with offices in Knoxville, Tennessee initiated a commuter pooling program as part of an energy conservation program. The Knoxville Transit Corporation (KTC) worked with TVA to develop an express bus system. Routes were established by listing employees' home addresses and noting concentrations. Park and Ride lots were located in existing parking lots. The system carried 109,850 riders in 1974, its first year of operation.

A second system to be explored was a "Van Pool Program." In this system, employees drive vans in a pooling service. The driver is not charged, but riders pay from $17 to $26 per month. Other pooling programs are now being explored and bicycle and motorcycle racks are being installed downtown.

HADDONFIELD DIAL-A-RIDE

The Haddonfield Dial-A-Ride ceased operations in March 1975. Located in Camden County, New Jersey, the demand-responsive bus service was sponsored by the New Jersey DOT under a $5 million grant from UMTA. Operations were suspended when a requested $450,000 subsidy was refused by UMTA.

In order to use the system, customers dialed a control center and informed the operator of their travel plans. They were picked up within 30 minutes by a minibus handling 10 to 17 people. This service was offered 24 hours a day. In order to probe the market, the fare was changed three times with the following results:

Fare	Ridership on Weekday (average)
$.70	800
.30	1,000
.80	600

A peak total of 1,300/day was reached when a shuttle bus to Cherry Hill Mall was added. While ridership dropped 32% with the higher fare, revenue actually increased 80%. The system operated at an average per-rider cost of $2.90.

LRV - PHILADELPHIA

Otherwise known as the trolley or the streetcar, LRV stands for "Light Rail Vehicle". The LRV is capable of being used on streets or a private guideway and can use either high or low loading platforms. Power comes from overhead wire in most cases, but it can come from a third rail system.

Philadelphia offers several examples of a wide range of LRV applications. The first type is the street system. Five of Philadelphia's street lines also enter a subway in order to reach the center of the city. The Red Arrow Division operates to a good degree on a grade-separated right-of-way. The third variety is the Philadelphia and Western system which uses high platform loading. This is a high-speed, third rail system on a private right-of-way. These three systems combine with bus, subway, and commuter railroads to offer Philadelphia a comprehensive transportation system.

METRO

Located in Washington, D.C., Metro is a controversial subway/rapid transit system which is scheduled to be completed by 1981. The reasons for the controversy stem from construction delays and total costs being raised from $2.5 billion to $4.5 billion. Proposed financing will be 80% federal and 20% local money. The system will be operated by Automatic Train Control (ATC) with computerized monitoring.

An automatic fare system has been designed for Metro. The rider purchases a reusable fare card for any amount from 30¢ to $99.95. By placing the card in a turnstile, the user is admitted to the system on the card. To leave the system, the user must again place the card in a turnstile. The station of entry is noted, the proper fare deducted, and the card, now sporting a lower value, is returned to the user.

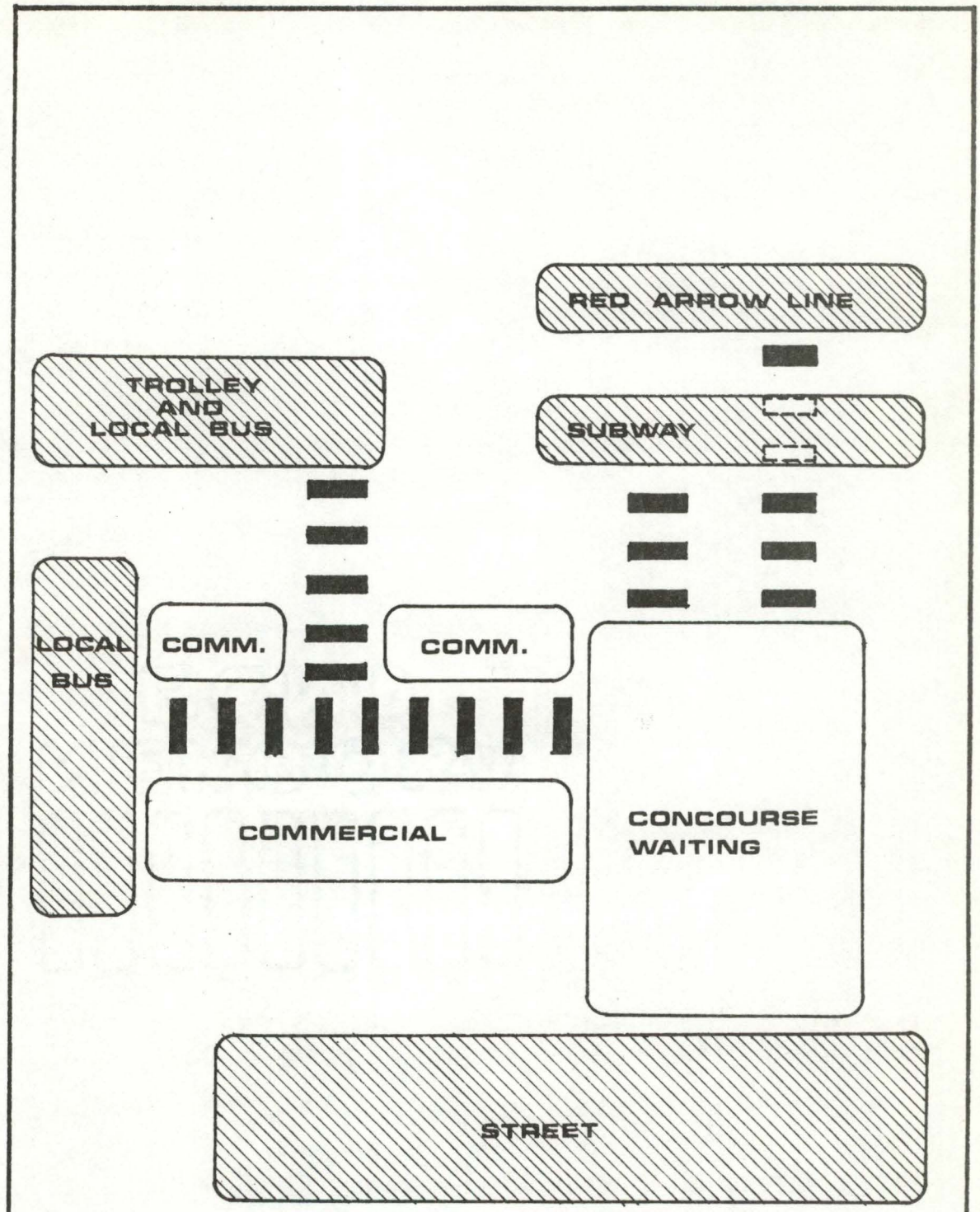
The subway stations are a radical departure from conventional subway design. They are open and lofty, allowing a sweeping vista down the train tunnel. The paving pattern is changed from tile to granite at the edge of the platforms, and lights set in the granite begin pulsating as the train arrives. As the first 4 miles of the system have only been in operation since April, 1976, effects upon riders cannot be measured.

69TH STREET - PHILADELPHIA

69th Street Terminal is located in West Philadelphia, Pennsylvania. It is designed as a major link in the South-eastern Pennsylvania Transit Authority's (SEPTA) vast network of mass transit in and around Philadelphia. The facilities there handle five different modes of transit, each serving a different purpose. There is also a clear separation of modes by destination, allowing for less confusion to the public.

The main hall of the terminal houses token sales for all modes, shops, and direct access to 3 of the modes. Taxi service is handled by offices in the main hall, with a pulloff area on the street outside. At the other end of the hall there are two ramps: one leads up to the Red Arrow Rapid Rail Line which links outlying towns and cities to Philadelphia; the other ramp leads down to two of the downtown's subway lines.

Leading out of the main hall are two tunnels lined by shops which lead to the bus and light rail (trolley) loading zones. One tunnel is seldom used as the bus loading areas have been more efficiently combined with the light rail loading areas. These two systems connect to the city's western suburbs, unloading incoming passengers at one platform, and loading outgoing passengers at another. The only major fault with the terminal is the lack of parking facilities in the immediate areas, aside from street parking (fig. 5.1).

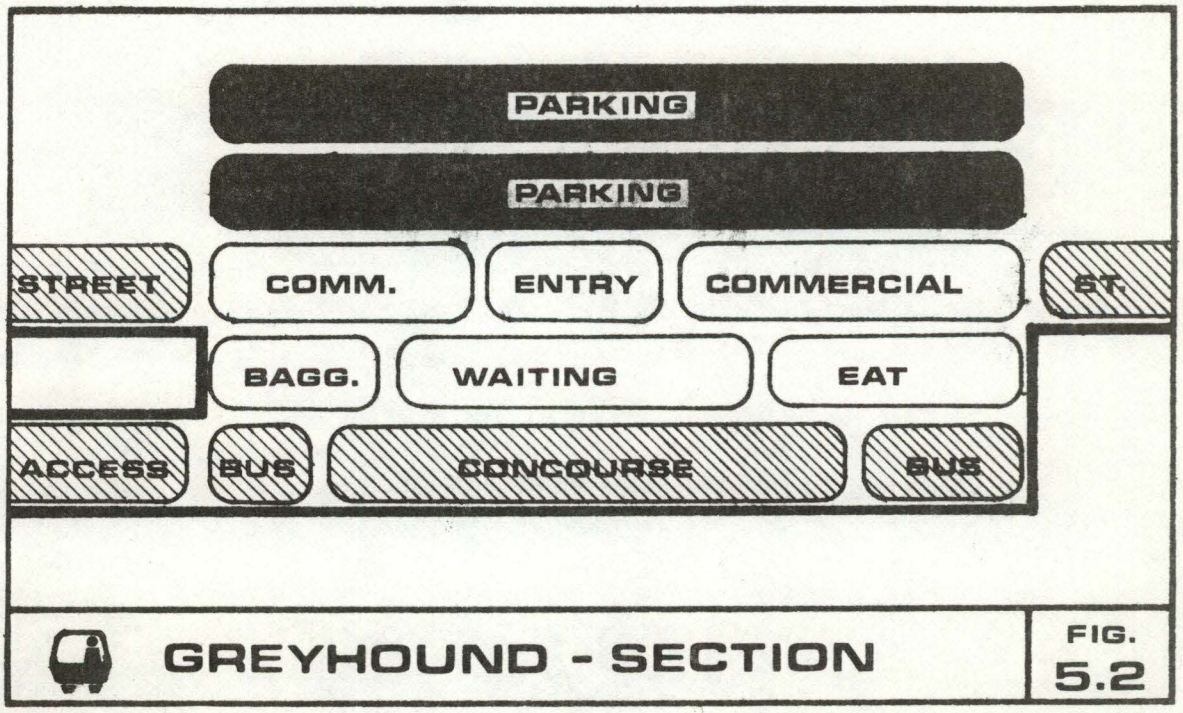


69TH ST. TERMINAL - PLAN

FIG. 5.1

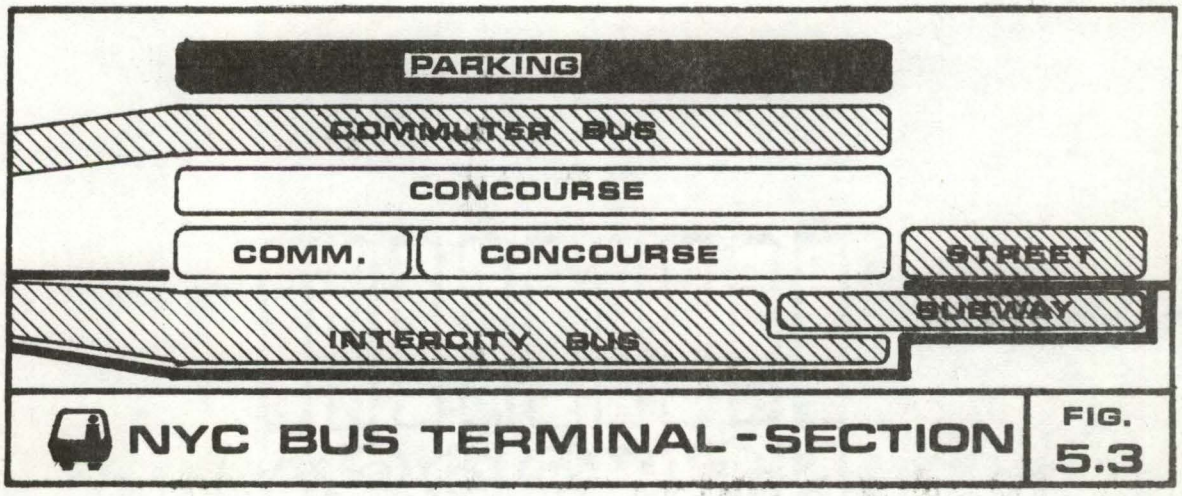
GREYHOUND TERMINAL - CHICAGO

In 1953, Greyhound's new Chicago Terminal, designed by Skidmore, Owings, and Merrill, was opened. Planned exclusively as an intercity bus terminal, it provides a logical separation of functions. The street level provides several well-marked entrances, as well as space for a number of shops and concessions. Escalators take patrons down one level to the waiting room, ticket sales, baggage rooms, restaurant and offices. Another flight down is an island-type passenger concourse and bus loading area for 31 buses. All buses enter through a tunnel which connects directly to one of the main thoroughfares a few blocks away. Parking is conveniently handled on two levels on top of the complex. With 15 minutes for loading, the facility can handle 120 buses/hour, or 18,000 people/day (fig. 5.2).



BUS TERMINAL - NEW YORK CITY

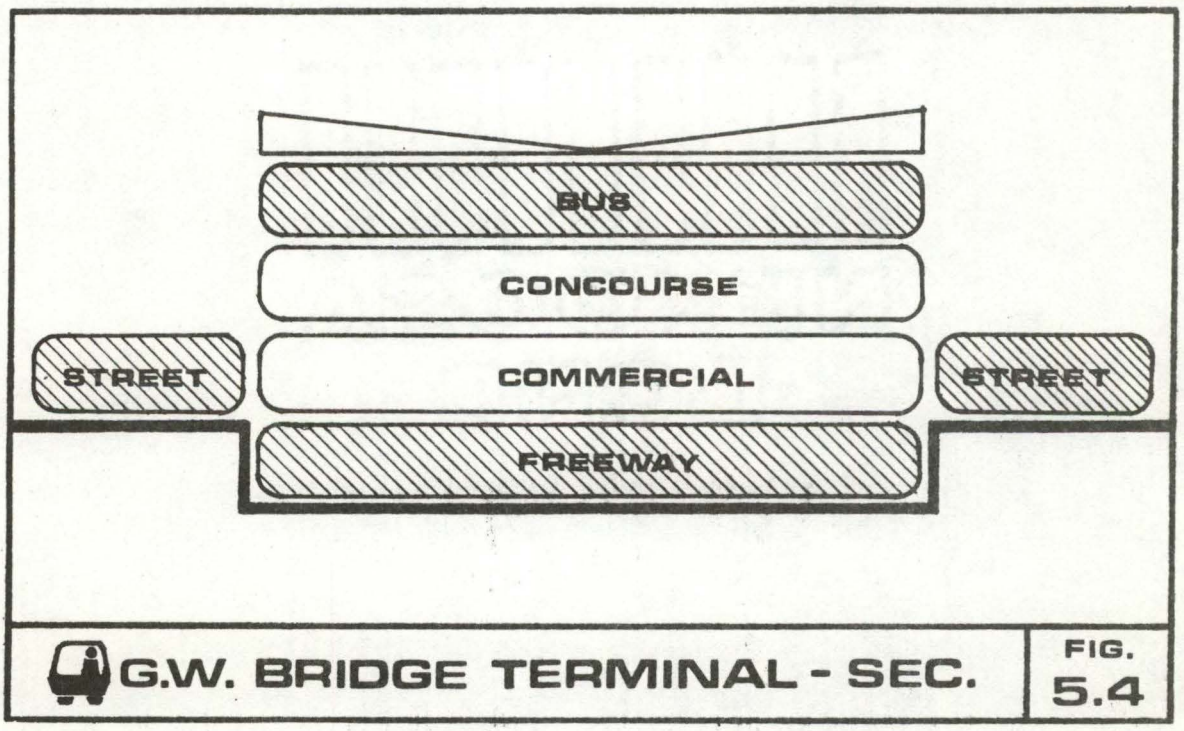
The New York Port Authority's bus terminal, which was built in 1949, was planned as a terminal which could handle all interstate bus traffic going into New York City, as well as the commuter bus traffic from the West. Using a direct ramp connection to Lincoln Tunnel, it is set up as a high-volume, quick turnover transfer point. Bus traffic is divided into three segments. The commuter or suburban buses are handled on the third floor, with a suburban concourse on the second floor. The majority of the terminal's traffic is generated at these two levels. The ground level holds the main concourse, as well as most of the ancillary functions. Long distance buses in the basement are served by this concourse, as are the local buses on the street. There is also a direct connection to one of the city's subway lines at a mezzanine level just below the street. Parking is handled on the roof of the structure. In terms of function, the Port Authority's Bus Terminal provides a well-segmented, easy-to-read layout for the transit rider (fig. 5.3).



GEORGE WASHINGTON BRIDGE TERMINAL - NEW YORK CITY

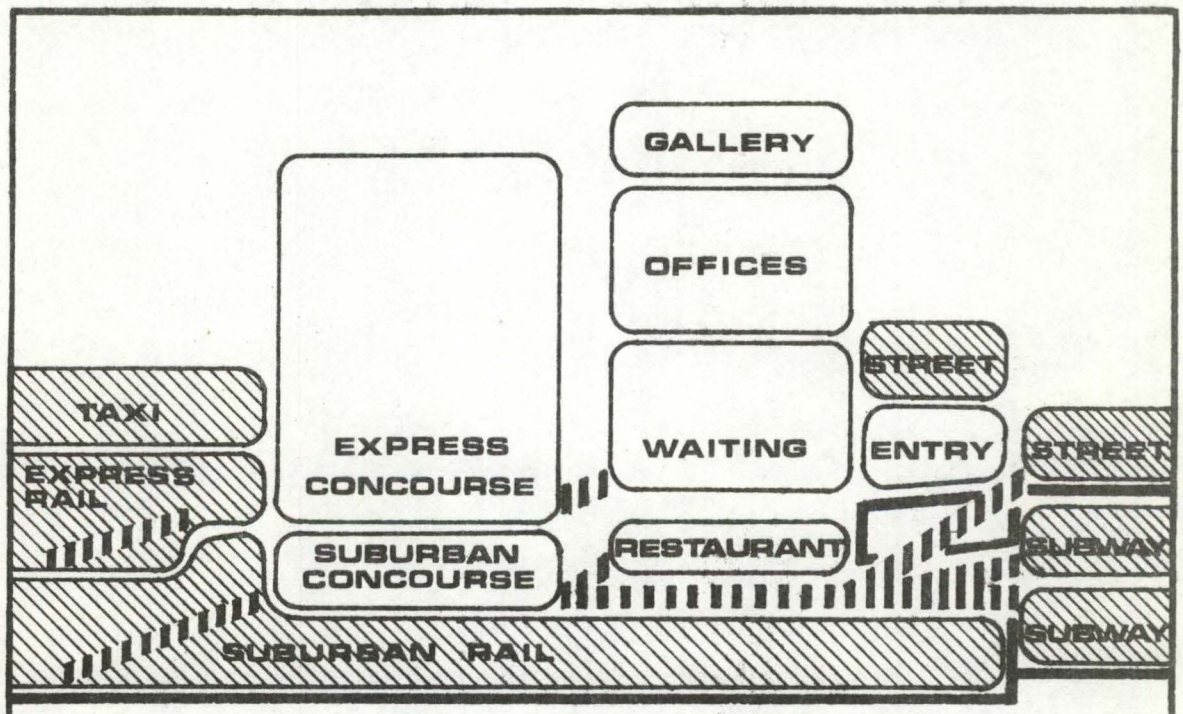
The George Washington Bridge Bus Terminal is another example of the New York Port Authority's attempt to alleviate transit problems into New York. Located just off the George Washington Bridge, the terminal, designed by Nervi and completed in 1963, straddles the Cross Bronx Expressway. Bus loading is handled on the top deck, with the concourse located directly below it on the second level. Street level has shops and some terminal functions, and the freeway is located in a level below the shops.

This complex works very well in that it provides easy access for buses while taking advantage of air rights over a major freeway. Parking is not handled integrally with the terminal, and this causes an otherwise funtional plan to weaken (fig. 5.4).

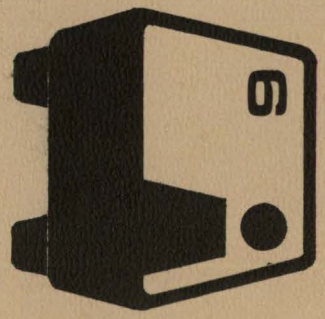


GRAND CENTRAL TERMINAL - NEW YORK CITY

Grand Central was built for the New York Central Railroad in 1912. This terminal was designed to be an interchange point between local and long-distance modes, as well as an entrance to the city. It handled suburban and intercity rail platforms on separate levels, and provided direct connections between these and three of the city's subway lines. With a hotel located in the complex, this was truly a city within a city. Because of the high traffic volumes, ramps were made liberal use of in connecting the various levels of this imposing structure. The grand concourse serves as a unifying element, as well as housing the information and ticketing booths (fig. 5.5).



GRAND CENTRAL - SECTION FIG. 5.5



TRANSIT SYSTEM CONCEPTS

On the basis of the research conducted, and considering the potential growth of Charlotte, a bus system seems to be best suited to serve Charlotte's present needs. But special cases and long-term needs require the development of a more integral transit solution. The development of this system will be based upon need, present situations, and economic feasibility. Immediate transit needs include the development of the Metrobus system, connection of the Core to the high density node along Independence Boulevard, an integral link with Douglas Airport, and a downtown distribution system. Also needed is an intermodal transit center to tie these various systems together (this will be covered in the second portion of this paper).

Improvement of the local bus system would require several changes. The institution of a Park and Ride system utilizing express or "Metrobuses" would greatly alleviate the traffic flow into the city. Local feeder buses could also help connect the express buses to the neighborhoods.

As the city grows, commuter traffic will become increasingly worse. To offset the predicted traffic flow into the city, some form of exclusive guideway system should be developed to augment the improved bus system. The first link in this new system would connect Independence Boulevard, Ovens Auditorium and Coliseum, and Eastland Mall to the Core. The expense of a subway cannot be justified, and the streets are too crowded to allow widening. An overhead system seems to be

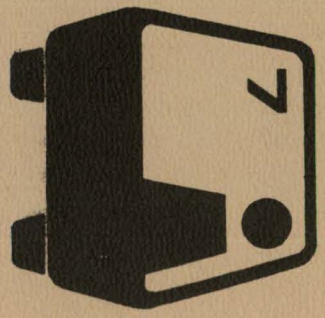
the answer. This system, known as a Transveyor, utilizes rubber-tired cars, each holding 20 passengers. These cars are run on a concrete guideway, and are electrically powered, drawing this power from a central energy plant. They may be run singly or in sets, and have the ability to become automated.

A loop will be developed in the downtown area which each segment will tie into as it is built. Much of the system will be elevated, utilizing air rights over the roads. This system should also be able to stimulate development along the corridors it serves. The Independence link will have stops at Central Piedmont College, the Coliseum/Auditorium complex, and Eastland Mall. Later additions will extend the line along NC 27 as needed. Trains will operate on a 5-10 minute headway, depending on the time of day.

The Douglas Airport link will serve to connect the airport to the Core. This system needs to be separate from the Transveyor because of the amounts of baggage it must handle. In order to cut costs, the system will utilize the existing Southern Railroad trackage, which runs near the airport. A rail link serving the intercity lines will have to be built between the old and new rail lines, and can be accomplished in connection with the final portion of the proposed inner loop freeway. The vehicles will be standard LRV vehicles, drawing power from overhead electrical lines. Trains would operate on a 15-minute headway, which would require 2 trains operating.

The downtown system will require a good degree of route and scheduling flexibility. The development of a Minibus system would provide this, and could serve to link the various portions of the CBD and the Core, economically and efficiently. Stops could be flexible, and the units would operate on 2-5 minute headways.

These improvements to Charlotte's transit systems could be the basis for more extensions, should Charlotte ever require them. An extensive park-and-ride system can also be initiated, utilizing the extensive bus system and downtown distribution system. Park-and-ride locations would be located at key points 2-4 miles from the city center, depending upon the area it would serve. Parking rates for all-day parking in the CBD could be raised to a degree that would make transit more attractive, while short term parking could be lowered slightly, in an effort to attract the short-term shopper. This would greatly alleviate peak-hour traffic, yet would keep the downtown area alive and active throughout the day and night. With these changes, Charlotte will be ready to face the growth which it anticipates in an orderly fashion.



TRANSIT CENTER

The first portion of this paper dealt with the development of a comprehensive transit system for Charlotte. In order to tie all of Charlotte's available transit systems together, both existing and proposed, a multi-modal transit center should be developed for the city. This center would serve not only as an efficient means of transporting people, but would serve as an introduction, for the transit user, to the city of Charlotte.

SITE SELECTION (fig. 7.1)

Site no. 1 - (adjacent to present Greyhound facilities)

Amenities- 4

- located along present Southern RR mainline
- access to major roads can be made via RR right-of-way
- can tie into present Greyhound facility, avoiding abandonment of a useful structure
- area slated for urban renewal

Disadvantages - 5

- located too far from governmental center
- presently sound structures must be removed
- located too far from present location of local bus transfer
- Southern RR station must be abandoned
- Union Bus Terminal must be abandoned

Site no. 2 - (behind Civic Center on Trade Street)

Amenities - 7

- the land is owned by the city
- located along Southern RR right-of-way
- access to major roads via RR right-of-way
- easy access to Core and governmental center
- can provide transfer point for local bus routes
- fits into present transportation plans
- easy tie to present pedestrian system via Civic Center Plaza

Disadvantages - 5

- Union Bus Terminal must be abandoned
- Southern RR station must be abandoned
- Greyhound terminal must be abandoned
- new RR trackage must be added
- site extremely restricted in size

Site no. 3 - (across 4th Street from Civic Center)

Amenities - 5

- located along Southern RR right-of-way
- access to major roads via RR right-of-way
- easy access to Core and governmental center
- can provide transfer point for local bus routes
- fits into present transportation plans

Disadvantages - 4

- Union Bus Terminal must be abandoned
- Southern RR station must be abandoned
- Greyhound terminal must be abandoned
- new RR trackage must be added

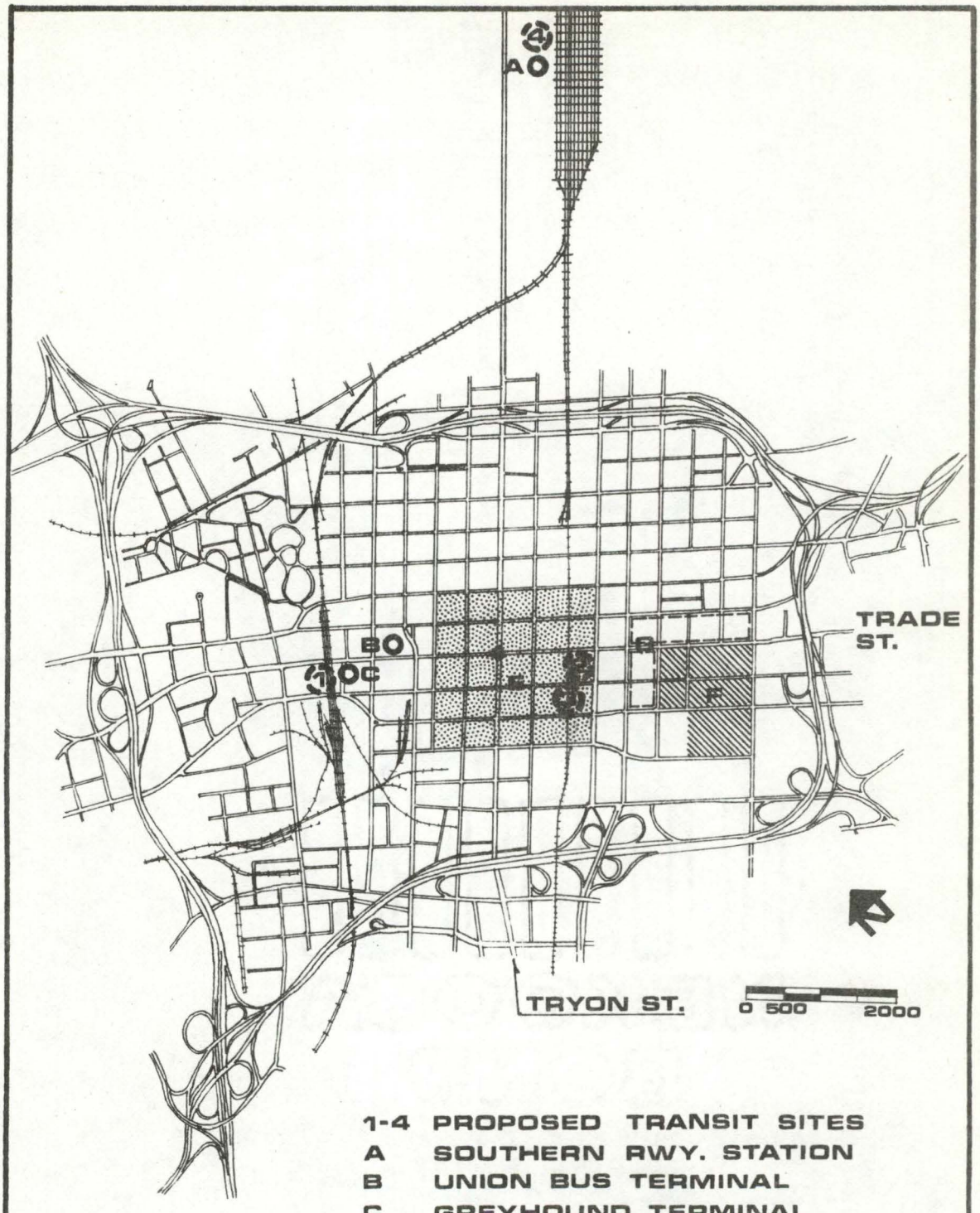
Site no. 4 - (adjacent to present Southern RR facilities)

Amenities - 2

- can utilize present Southern RR facilities
- good access to major roads

Disadvantages - 6

- too far from center of town
- located too far from present location of local bus transfer
- located in wholesale and warehouse district
- no direct connection with proposed "Metro" line
- Union Bus Terminal must be abandoned
- Greyhound terminal must be abandoned



PROPOSED SITES — FIG. 7.1

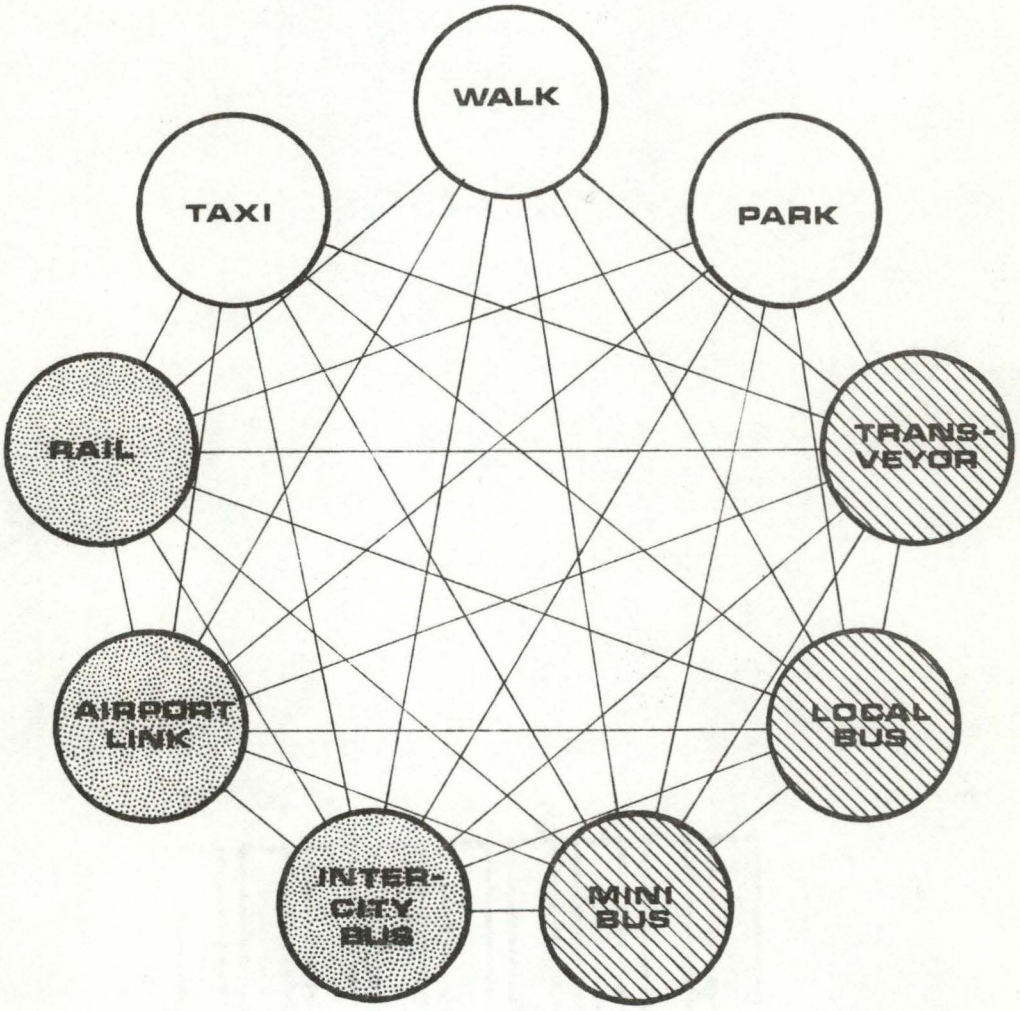
Site no. 2 provides the best opportunities for development of a transit center. It is located well within the downtown area and has good access to the various existing transportation modes. Although the site is restricted, some of the functions may be placed within a portion of Site no. 3.

Some problems will arise with the abandonment of 3 transportation terminals. The present Southern RR station can be easily taken over by the freight office, which already operates the facility. The waiting room can be used as a lounge for train crews, which also happens at the present. The major problem is caused by the abandonment of the bus terminals. These must give way in favor of a more unified transportation system for Charlotte.

PROGRAM DEVELOPMENT

A transit center is first and foremost a people space. It exists in order to move people from one place to another in a pleasant, orderly fashion. In the case of a single-purpose center (i.e., a RR station), this involves a more-or-less direct transfer (from car to station to train). This movement becomes much more difficult when there is more than one option. In this case, there are 33 major origin-destination routes, with many more minor variations (fig. 7.2). Therefore, the major emphasis shall be placed upon the movement of people, incorporating such influencing factors as space, texture, direction, order, and graphics.

SINGLE FUNCTION



MULTIPLE FUNCTION

TRANSFER ALTERNATIVES

FIG. 7.2

SPACE ALLOCATION

Due to the nature of a transit center of this type, many areas cannot be calculated by size in a program. Certain minimum areas will be shown.

TRAFFIC REQUIREMENTS

150-plus intercity bus schedules daily

18 (36)-plus local bus routes

5 "Metro" bus routes

Minibus system

Transveyor platform

Airport link

4-plus intercity trains

Parking (public and staff)

Drop-off point (taxi and kiss-and-ride)

SPACES NEEDED	REQUIREMENTS
Minibus -	
- platform	
- fare collection	
Transveyor -	
- platform	250 linear ft.
- fare collection	
Local bus -	
- 5 platforms: routes 1-4,A routes 5-8,B routes 9-12,C routes 13-16,D routes 17-18 (20),E	

Airport link -	
- platform	2 platforms
- fare collection	
- baggage counter	
- baggage room	250 sq.ft.
Intercity bus -	
- 10 platforms	
- 2 baggage counters	
- 2 baggage rooms	400 sq.ft. ea.
- 2 ticket counters	
Intercity train -	
- 2 platforms	1,000 linear ft. covered
- baggage counter	
- baggage room	500 sq.ft.
- ticket counter	
Circulation	provide for handicapped
- entrances	
- concourse(s)	
- waiting area(s)	
- vertical circulation: public private	
- patron drop-off	
- taxi ramp	
- public parking	
- staff parking	
Convenience -	
- information counter	

- rest rooms
- telephones
- restaurant
    - food preparation
    - food storage
- cafeteria
- concessions
- vending areas
- lounges
- staff lounges
- staff rest rooms
- car rental counter(s)

Offices -

- Charlotte Transit Authority (CTA)	7,000 sq. ft.
- Terminal Authority	3,000 sq. ft.
- Greyhound	600 sq. ft.
- Continental Trailways	600 sq. ft.
- Southern RR	600 sq. ft.
- Airlines	2,400 sq. ft.
- Security	400 sq. ft.

Service -

- service dock
- janitorial rooms
- mechanical room(s)

SPATIAL CHARACTER

The emphasis in a transportation center should be on movement. Patrons must be able to move easily from one transit mode to another, yet must not feel pressured into these decisions. Spaces must not be tight, but they should retain an air of intimacy. Movement spaces can be shrunk in order to keep people moving, but areas of rest need to be provided for. Waiting areas should be of softer textures than circulation areas, and should have a finer detail.

Colors should be chosen carefully, in order to provide a warm, airy feeling. Where emphasis is desired, use will be made of brighter colors against more subdued, or darker shades against lighter.

Lighting, both natural and artificial, should be made liberal use of, in order to offset the notion that transit centers are dark, dank places. Glazing will relate the center more closely to the city, and good lighting will provide greater security and comfort.

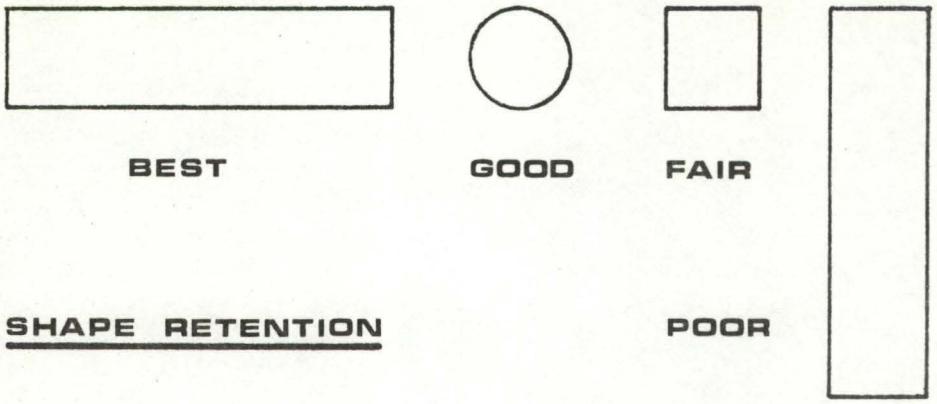
GRAPHICS

The use of graphics in a transportation center can be of tantamount importance, especially if the patron must choose between a number of different functions. Information must be displayed to the public in a manner which is clear and legible.

Maps are vital to a transportation center. The traveler needs to know exactly how he will be able to reach his destination. Therefore, maps must be as simple, yet as concise as

possible. They may be displayed in linear, graphical, or geographical patterns. The selection depends upon the information which is to be converyed.

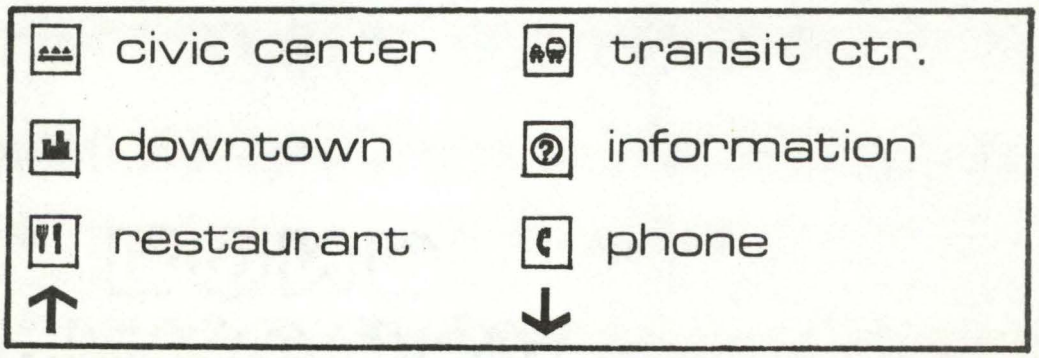
Signs must be designed so as to convey their information in a quick, easy manner. Digits will give a longer memory span than letters, and letters more so than words. The shape of the sign may also affect recall; it is best for a 2 by 8 longitudinal display (2nd for circular), and worst for an 8 by 2 vertical display. Recall will also be improved on confirmation of the original memory input of the sign. Certain color combinations, which are more legible than others, will also improve retention of information (fig. 7.3).



BEST GOOD FAIR POOR

SHAPE RETENTION

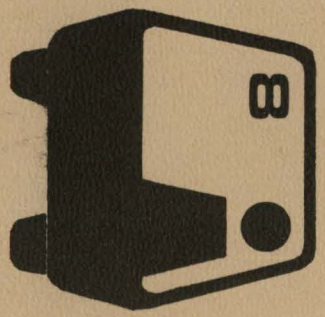
STANDARD SYMBOLS



TYPICAL SIGN

GRAPHICS

FIG. 7.3

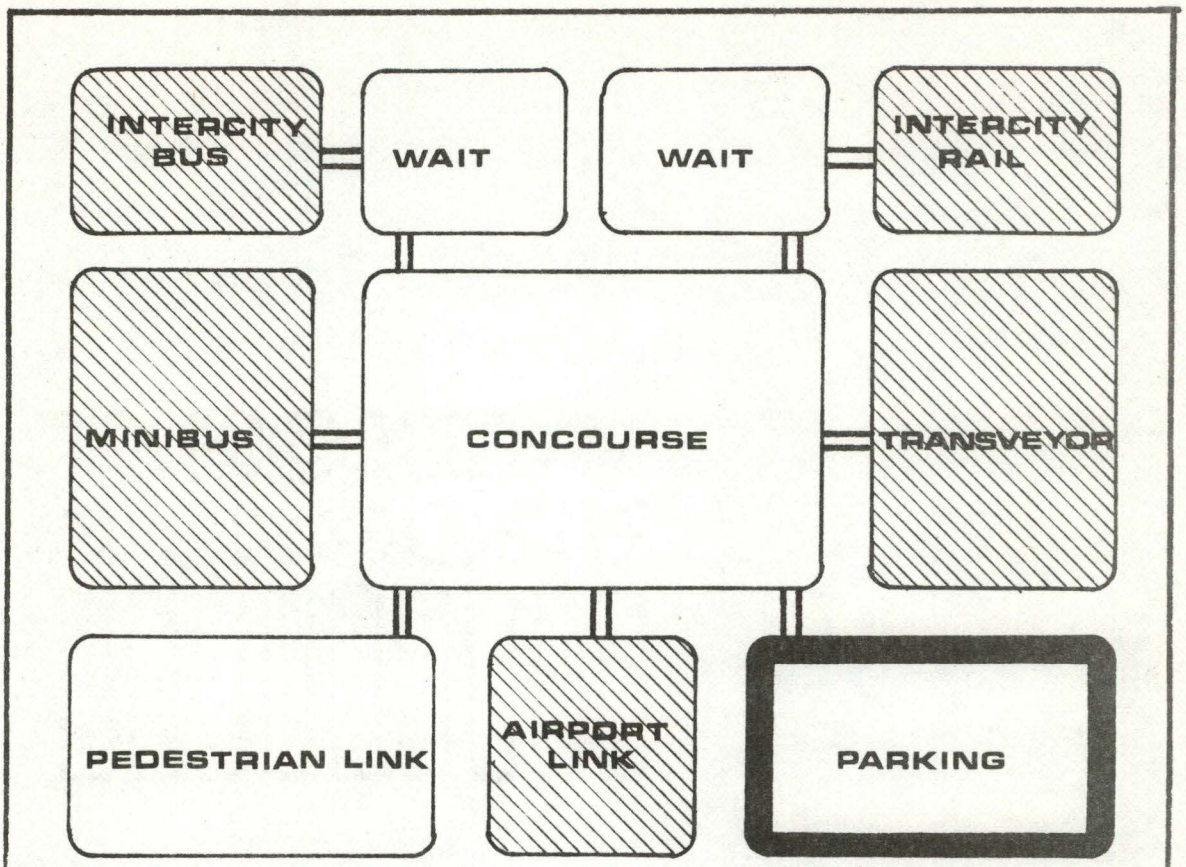


TRANSIT SOLUTIONS

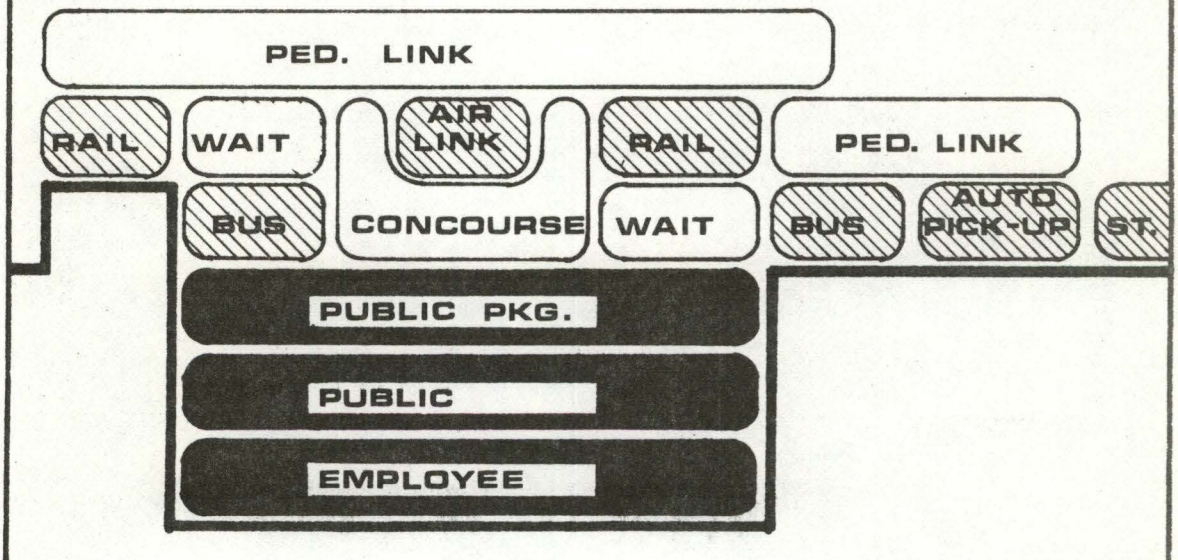
The solution to this program is based upon circulation. There are two major types of circulation prevalent in the scheme. The first is that of the pedestrian/rider and the second is the transit system movements. These are kept separate from each other except at loading platforms. Emphasis is placed upon movement of people and vehicles within the complex and the city. The form of the building reflects this movement, especially in the horizontal linearity which it displays.

The complex is tied together by the main concourse. This multi-storied space creates a nucleus about which the various transportation modes are grouped (fig. 8.1). Visual recognition of each transit mode can be attained from this space and the idea of movement is reinforced in the rythym of escalators which connect the various levels.

Structural requirements of large (60-ft. span) bays carrying heavy loads are met through the use of a coupled pan space frame. This two-way concrete floor system has a space between the upper and lower chords which allows for easy insertion of the mechanical systems. It can also be kept open, giving a patterned ceiling to the various spaces. The space frame, along with the concrete columns and slabs, allow for a high fire rating when combined with concrete block walls. This is a major consideration in considering a public space,



CONCEPT



SECTION

CENTER CONCEPT

FIG. 8.1

PROJECT COST

The transit center complex comprises the following areas, listed in table 8.1.

	Unadjusted Sq. Ft.	Adjustment Factor	Adjusted Sq. Ft.
Building	170,240	1	170,240
Platforms	108,300	1/2	54,150
Parking	192,600	2/3	128,400
Total	471,140		352,790

The cost of the complex was computed and adjusted using the Dodge Cost Guide. The project should run $55 per square foot, with the parking costing $20 per square foot. This comes to a total cost of $16,193,450.

Financing of the transit center and the proposed transit system can be accomplished by taking advantage of the UMTA's Federal Demonstration Program. Under this program, the federal government will fund approximately 80% of a transit program if the system is appropriate to application in other situations. Charlotte's system could demonstrate the results of a comprehensive transit program for a mid-sized city.

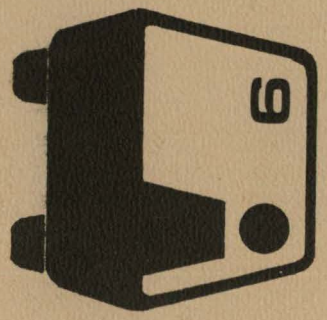
ENVIRONMENTAL CONSIDERATIONS

Due to the nature of a transit center, light and space are imperative in creating a lively atmosphere. This requires some compromise in the establishment of the environmental control systems. Care was taken to minimize glass, direct sunlight, and excessive space wherever possible, in order to ease conditioning loads.

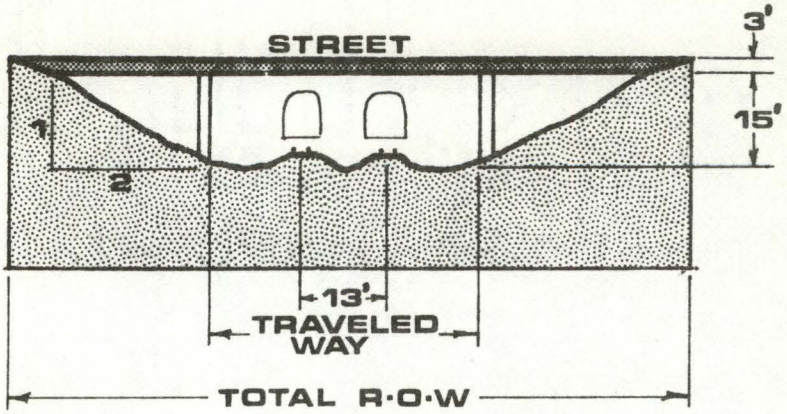
The system best suited to this center would be a high velocity mixed air system. This would have two major zones; one serving the major public spaces, the second serving the offices and commercial spaces. The second zone would be divided into sub-zones, each individually controlled by the users of the space.

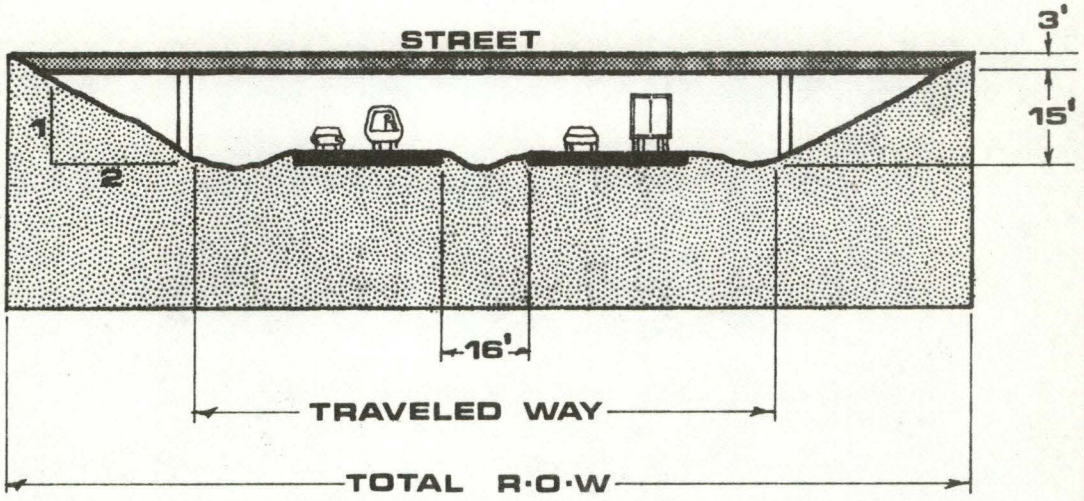
CONCLUSIONS

This project has been a valuable addition to my education. Although it has been primarily a planning project, definite directions concerning design development have presented themselves during the process of design. The complexities of urban planning have also been touched upon, and the development of a large project with a direct concern for people has been rewarding.



APPENDIX





Widths of Depressed Rail and Highway Facilities

Facility	Traveled Way(Ft.)	Total R.O.W.(Ft.)
2-track rail	37	109
3-track rail	50	122
2-lane highway	62	134
4-lane highway	86	158
6-lane highway	110	182
8-lane highway	134	206

RIGHT·OF·WAY WIDTHS

FIG. A.1

CAPACITIES OF VARIOUS FACILITIES IN INNER CITY AREAS
TABLE A.1

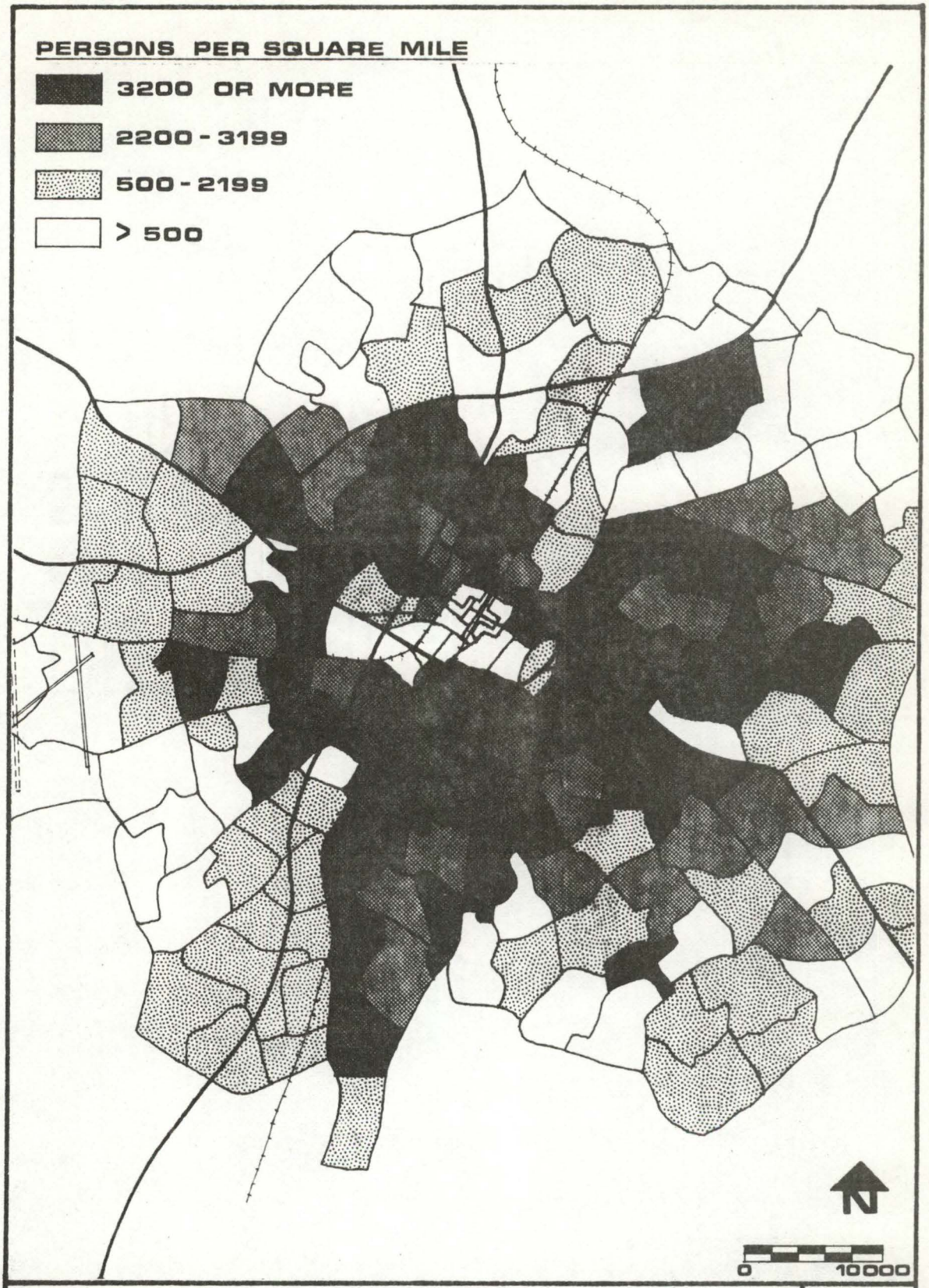
Facility	Average No. of Persons Carried Per Hour
Automobile	1,000
Bus or Trolley	4,000
Street Car	10,000
Rapid Rail (Local)	40,000
Rapid Rail (Express)	60,000

COMPARISON OF AREAS USED BY ONE PERSON* - TABLE A.2
(*Street Areas in Terms of Movement)

Areas Unit % of 100	Mode of Travel			
	Car	Bus	Streetcar	Rapid Transit
Areas Needed For Movement	40	3	2	0
Stopping and Parking	60	3	10	1
Total Area	100	6	12	1

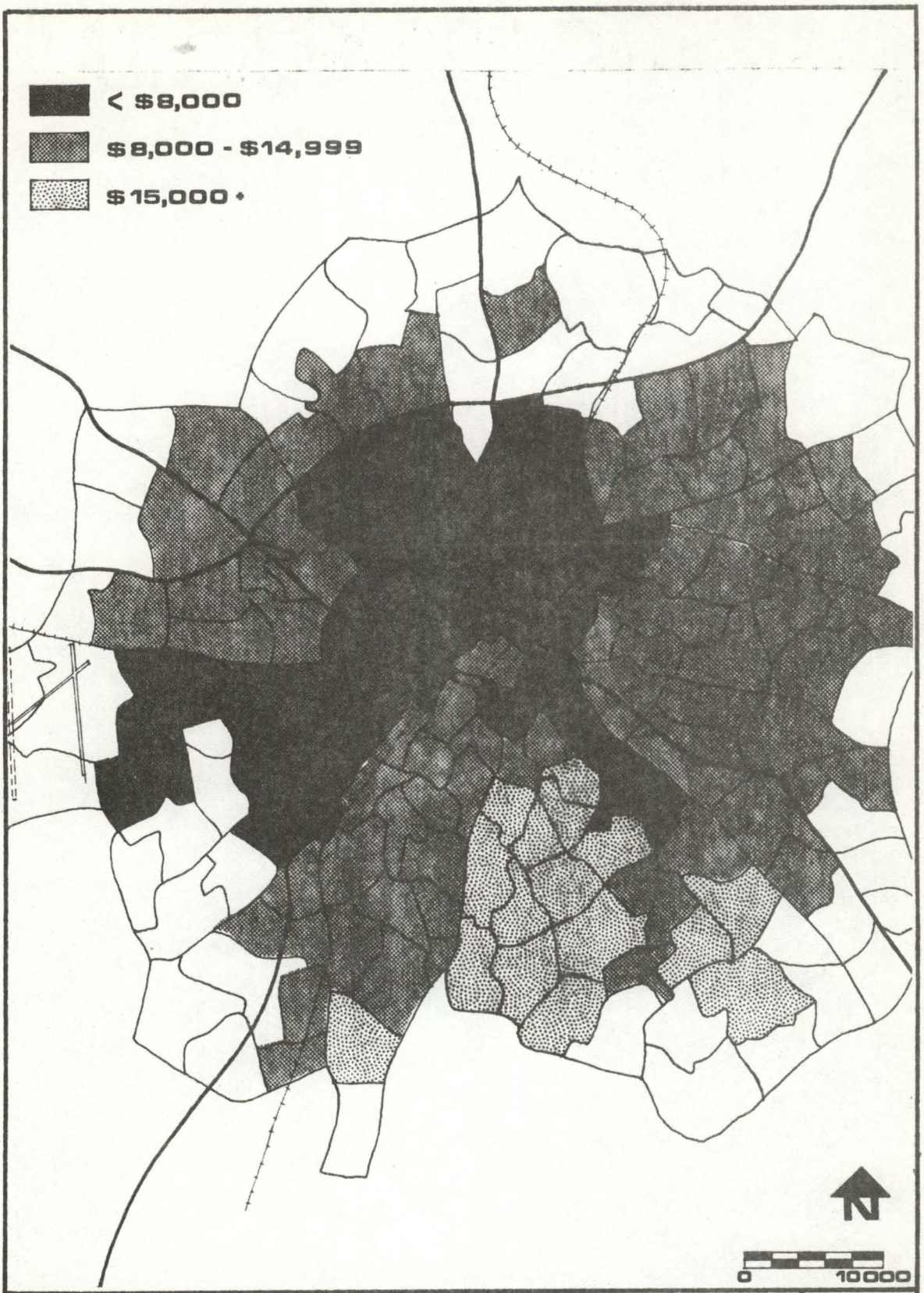
DISTRIBUTION OF BUSINESSES BY TYPE - TABLE A.3

Business	Number of Establishments	
	Charlotte	Mecklenburg County
Retail Trade	2,629	3,350
Selected Services	2,502	3,095
Wholesale	1,363	1,599
Manufacturing-Total	538	725
-20 workers or more	229	297
Mineral Industries-Total	---	7
-20 to 99 workers	---	3



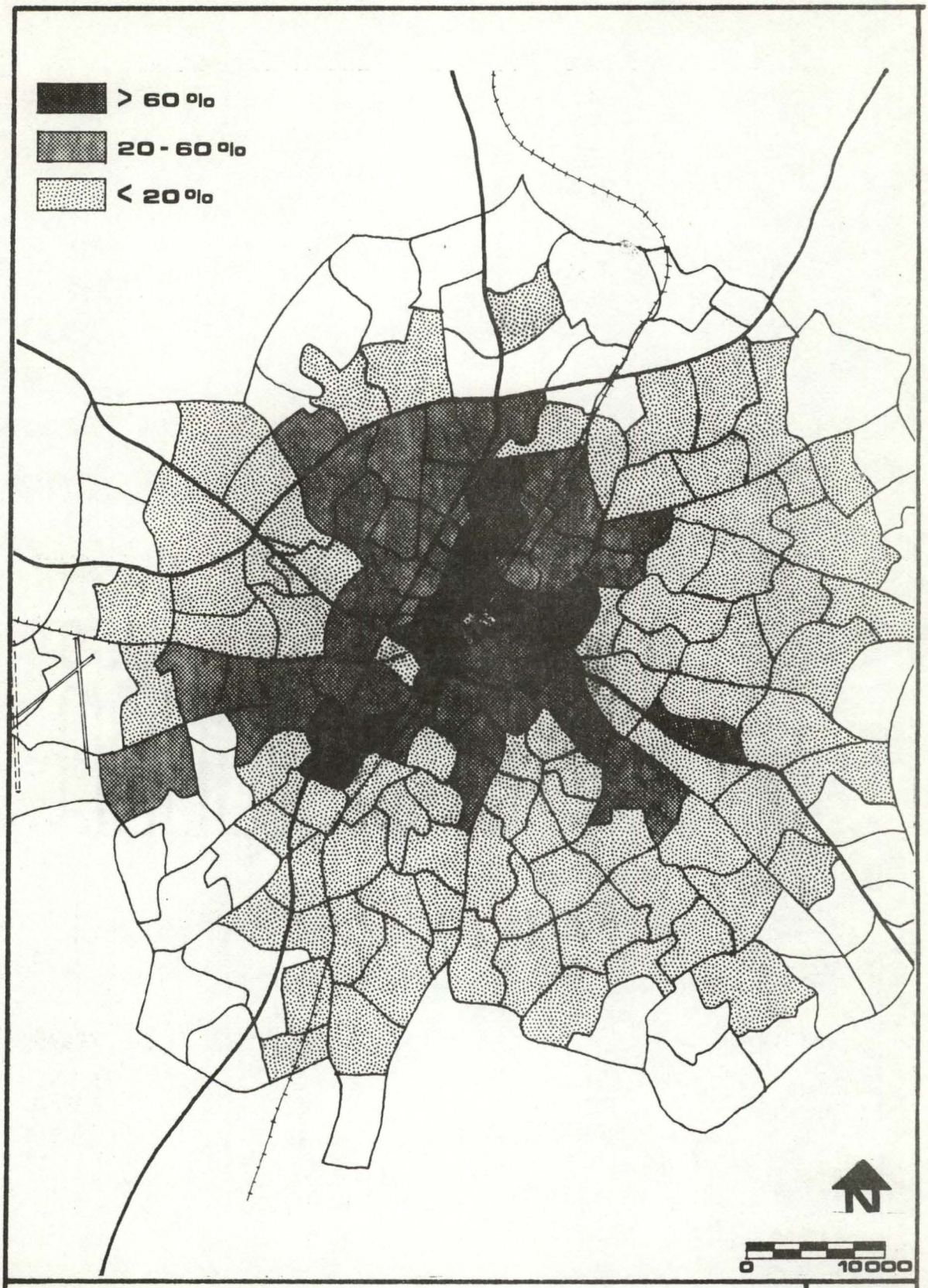
POPULATION DENSITY

FIG. A.2



MEDIAN YEARLY INCOMES

FIG. A.3

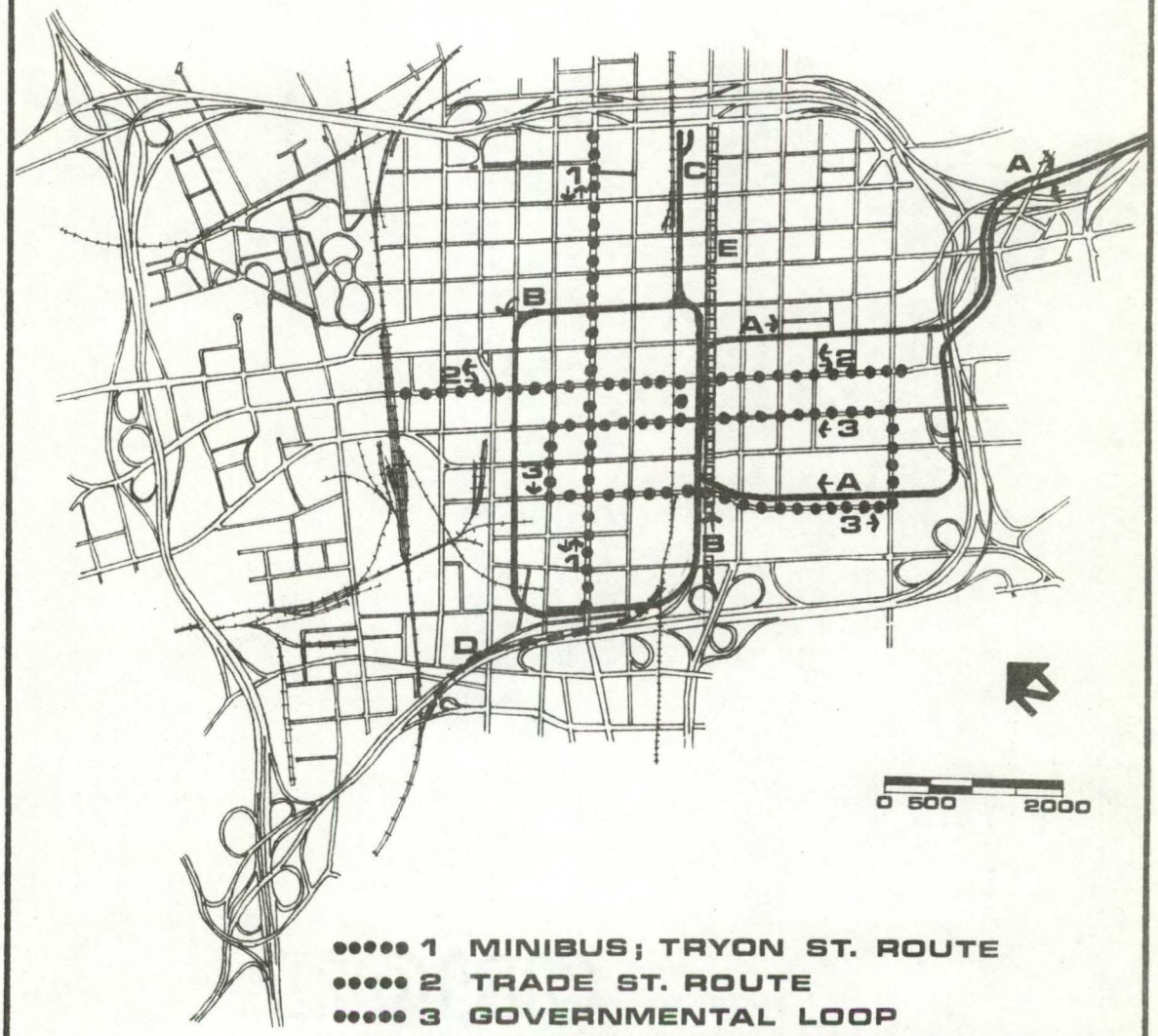


HOUSES WITHOUT CARS

FIG. A.4

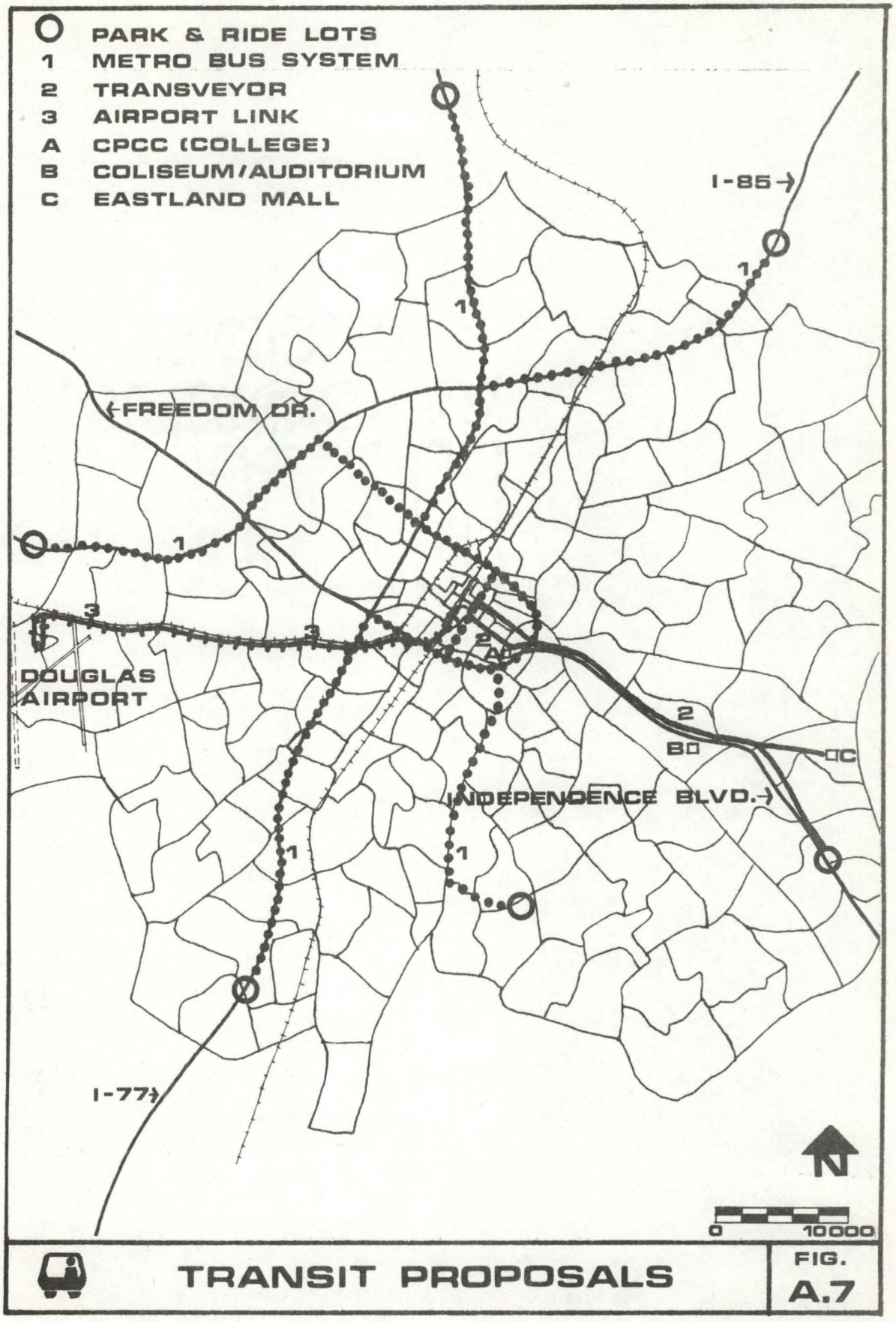
% OF TRANSIT TRIP ORIGINS

FIG. A.5



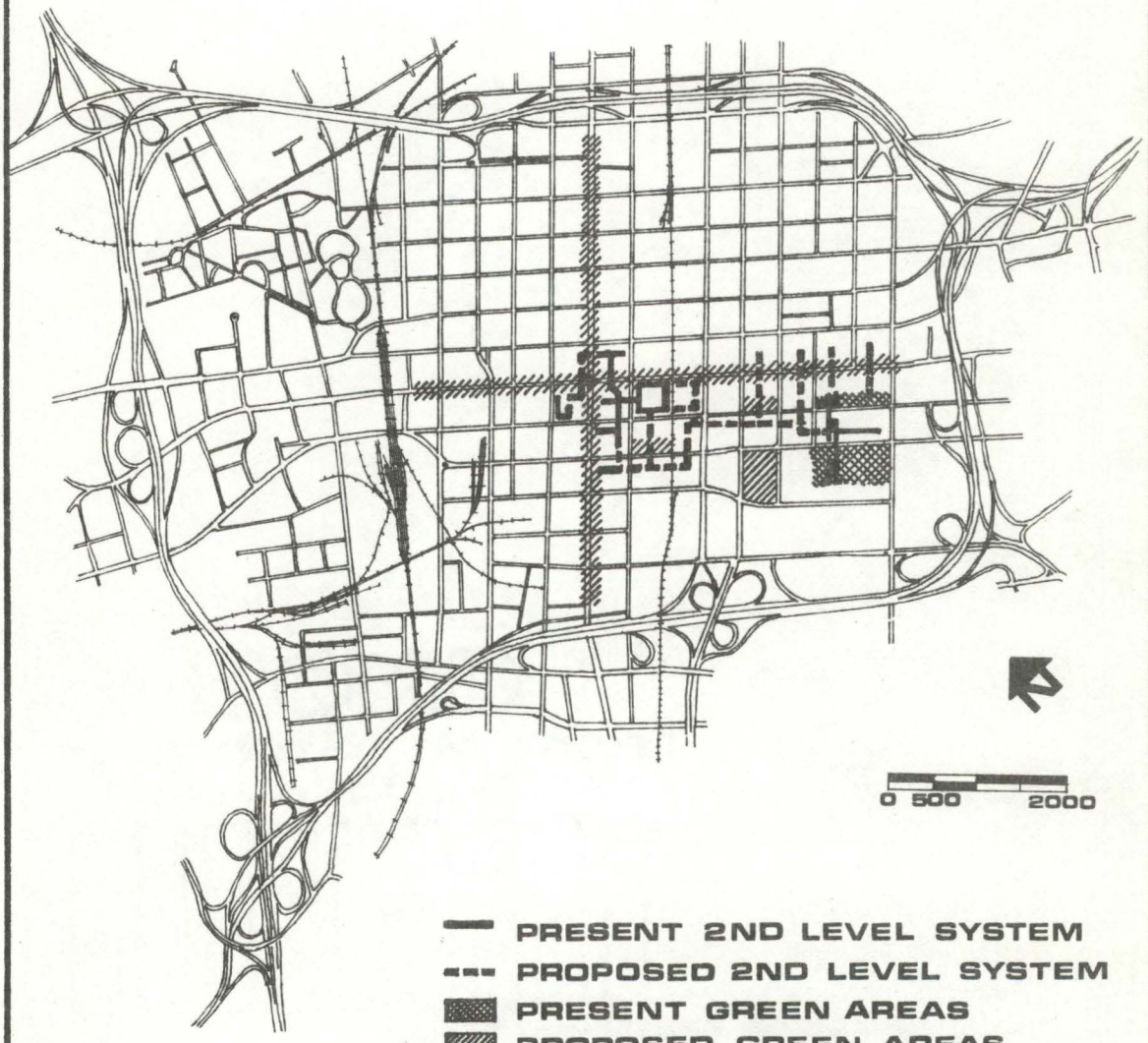
●●●●● 1 MINIBUS; TRYON ST. ROUTE
●●●●● 2 TRADE ST. ROUTE
●●●●● 3 GOVERNMENTAL LOOP
——— A TRANSVEYOR; INDEPENDENCE RTE.
——— B LOOP FOR FUTURE ROUTES
——— C SERVICE SPUR
- - - - - D RAIL LINK
□□□□□ E BUS ACCESS

CITY TRANSIT LINKS — FIG. A.6



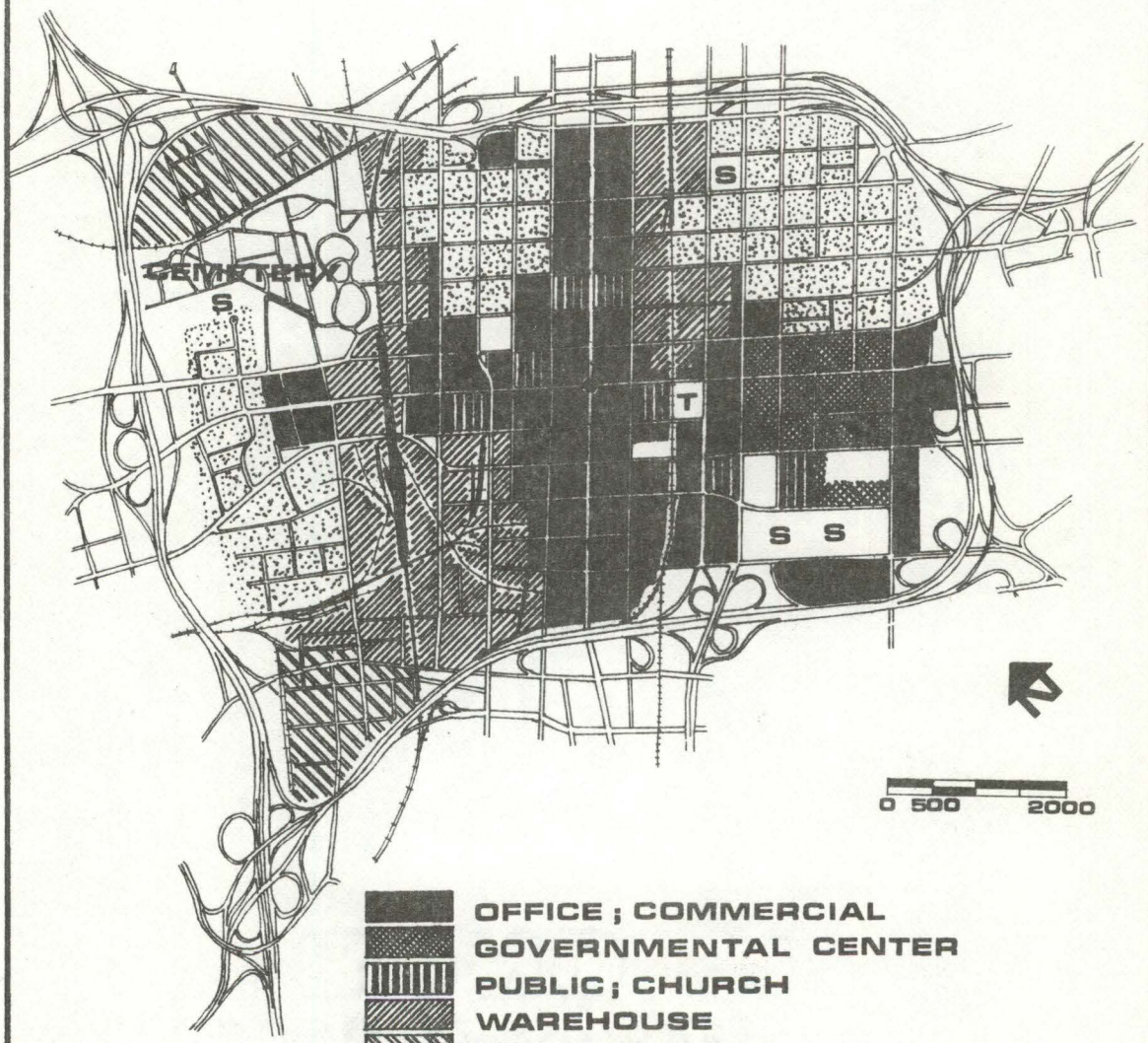
TRANSIT PROPOSALS

FIG. A.7



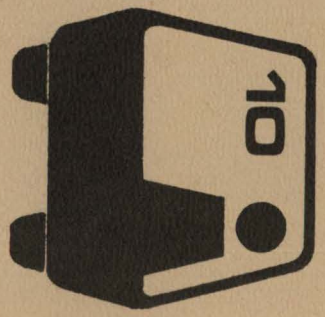
PEDESTRIAN SYSTEMS

FIG. A.8



PROPOSED LAND USE

FIG. A.9



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FOOTNOTES

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[2]Tass, Leslie, Modern Rapid Transit, p. 118.

[3]Wolf, Peter, The Future of the City, p. 65.

[4]Blythe, LeGette, and Brockmann, Charles Raven, Hornet's Nest: The Story of Charlotte and Mecklenburg County, p. 18.

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[6]Ibid., pp. 259-265.

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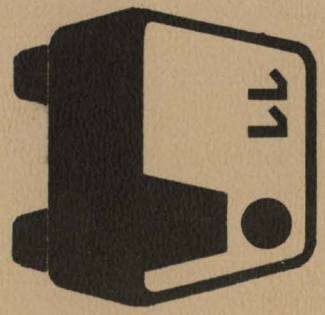
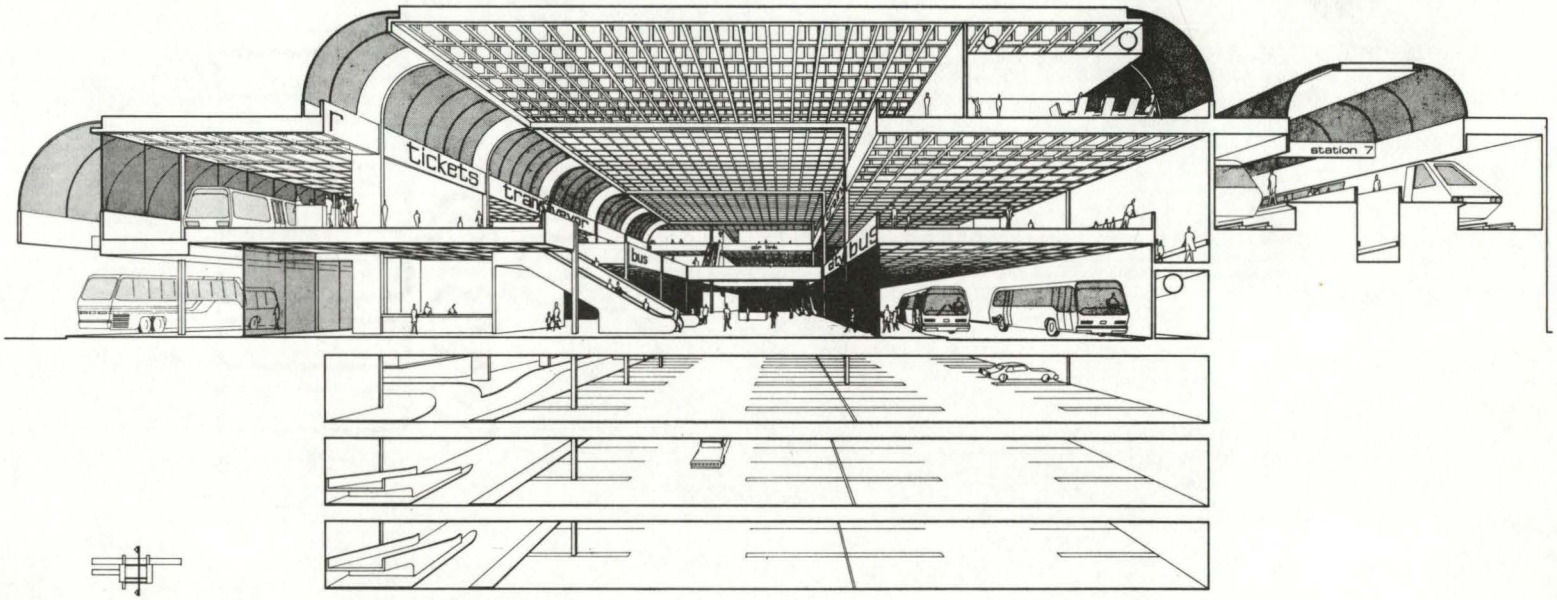


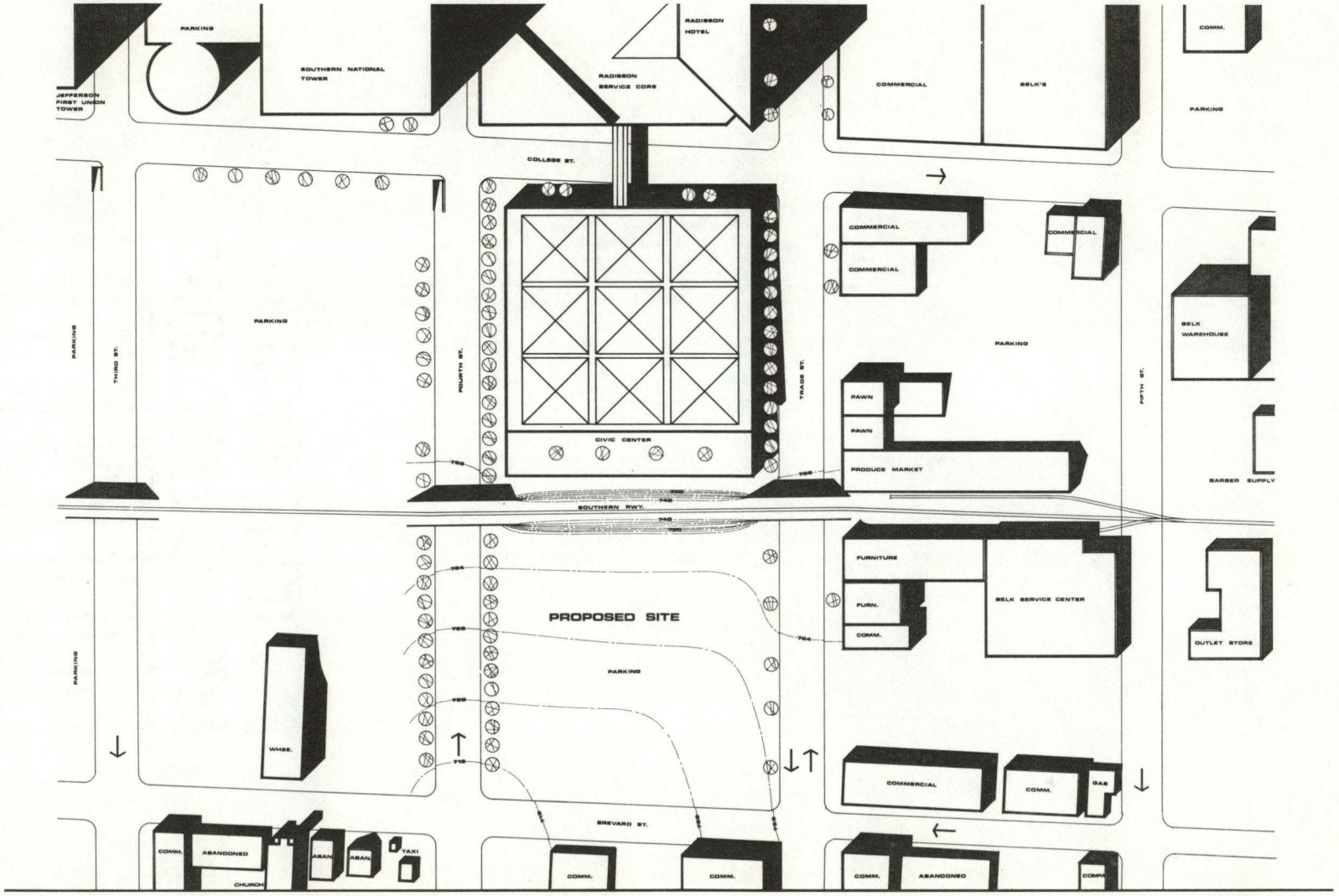
VISUAL PRESENTATION

A
TRANSIT CENTER
FOR



CHARLOTTE, N.C.

RICHARD B. SHULBY
TERMINAL PROJECT
FALL 1977



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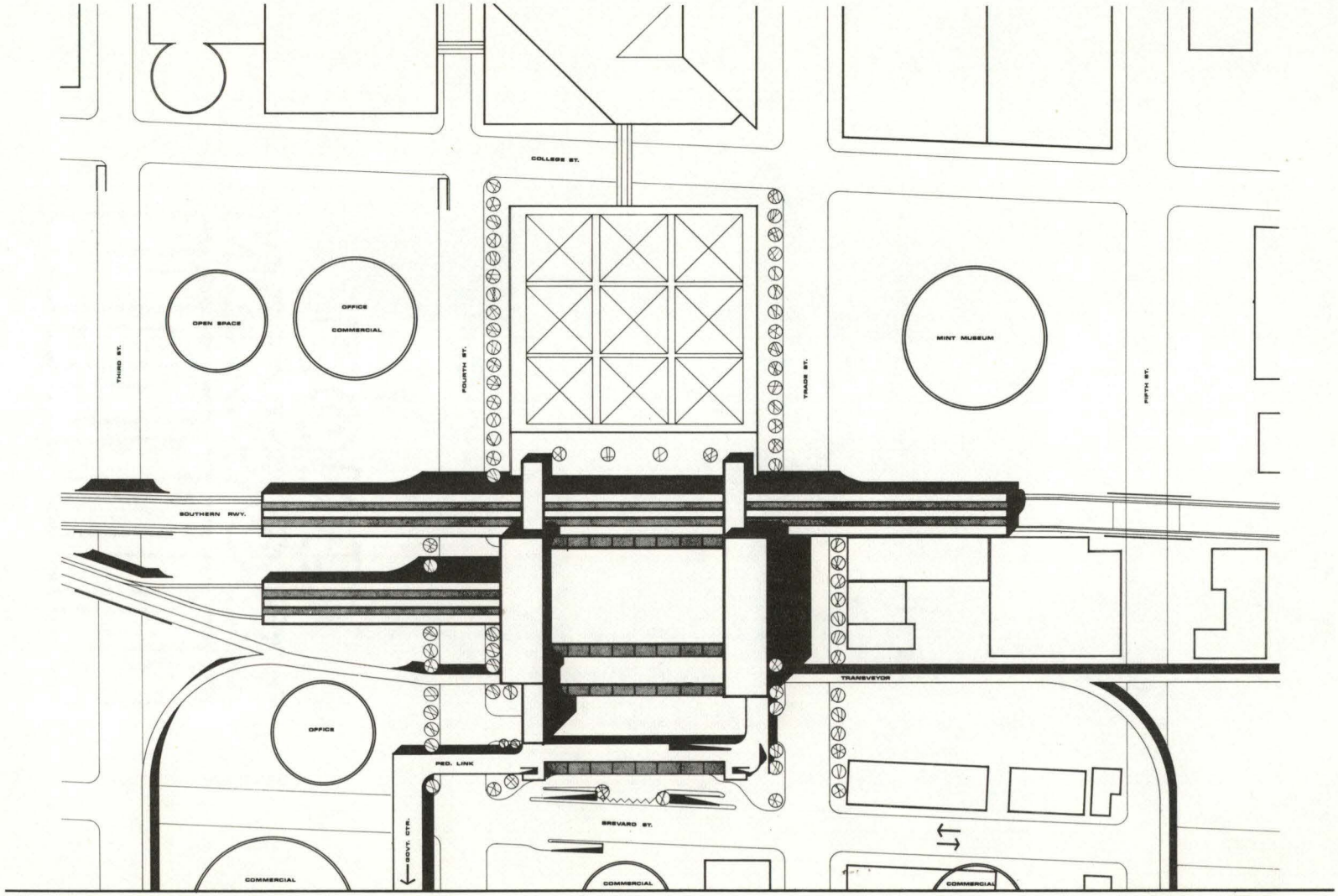
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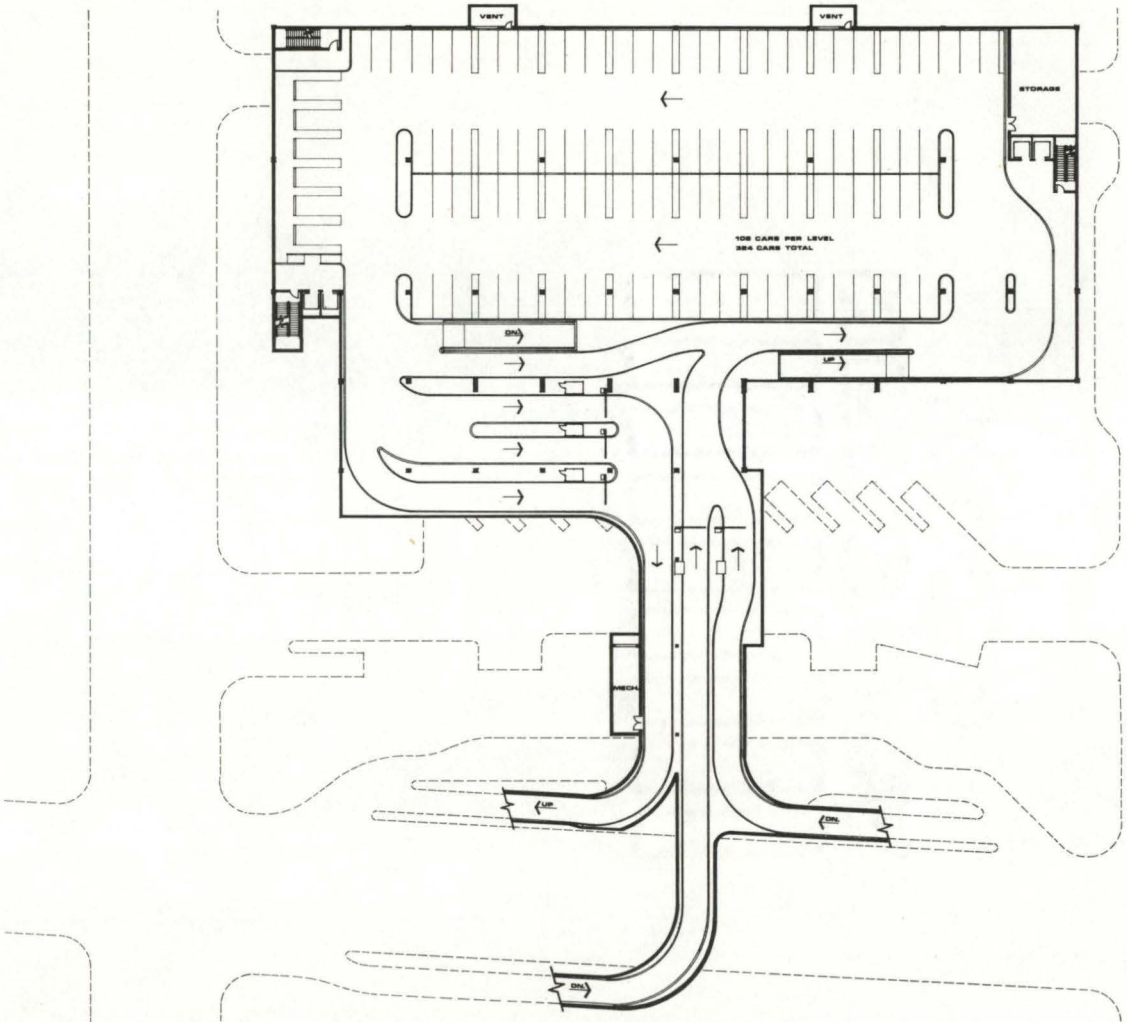
THIRD ST.
OPEN SPACE
OFFICE
COMMERCIAL
FOURTH ST.
TRADE ST.
MINT MUSEUM
FIFTH ST.
SOUTHERN RWY.
TRANSVEYOR
OFFICE
PED. LINK
BREVARD ST.
GOVT. CTR.
COMMERCIAL
COMMERCIAL
COMMERCIAL

SITE PLAN



PARKING LEVEL PLAN

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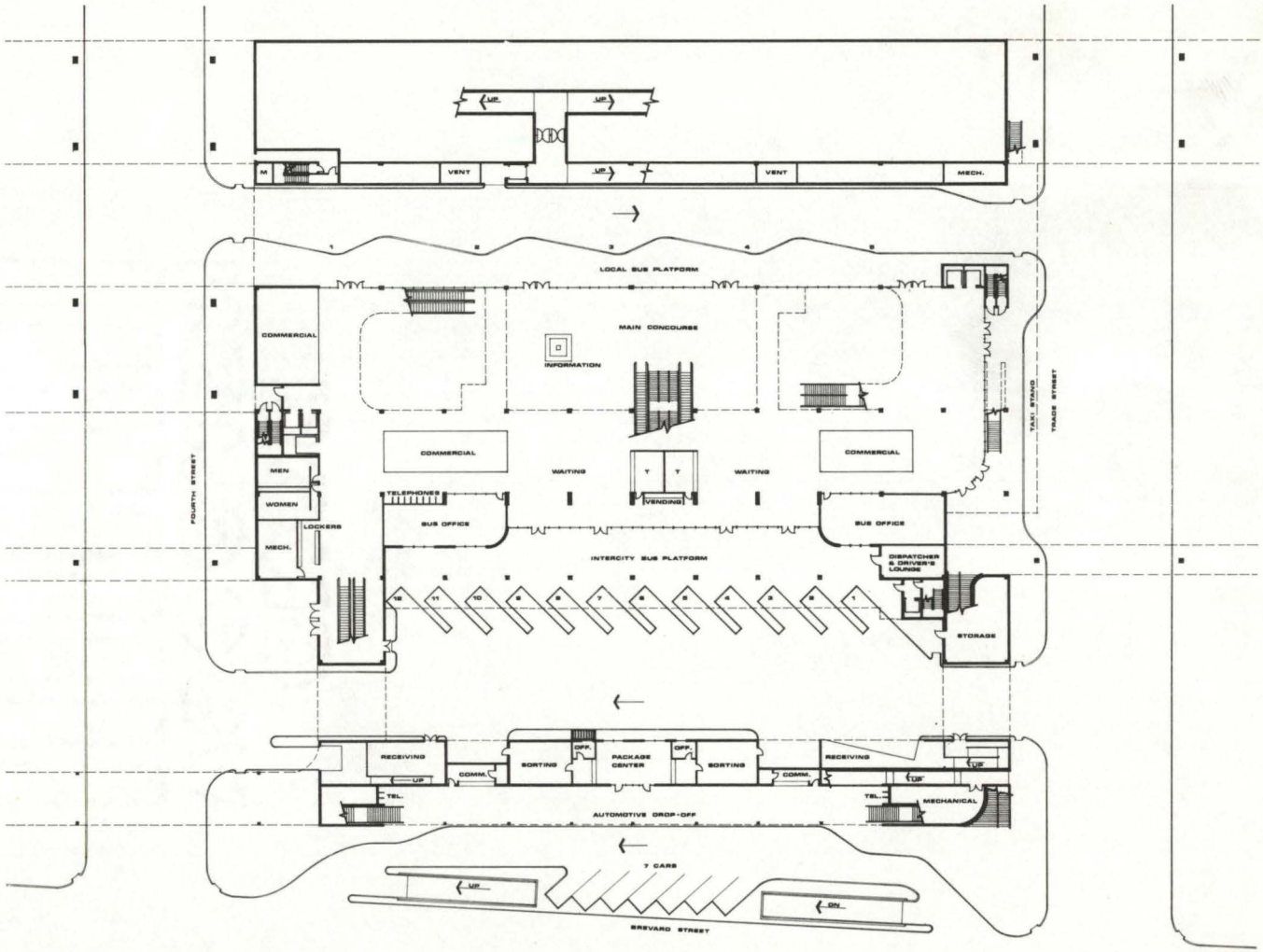
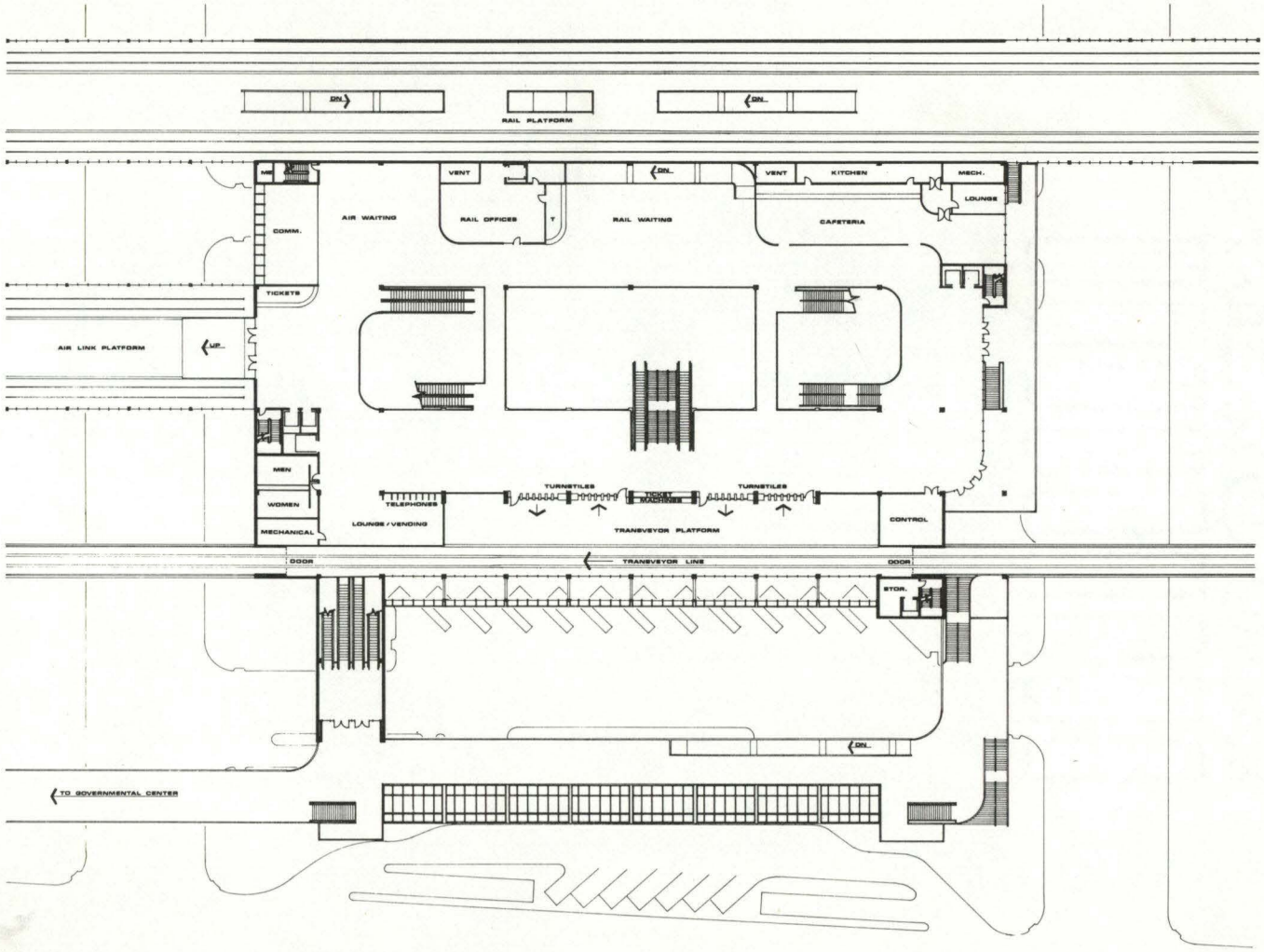


STREET LEVEL PLAN

0 5 10 20 40

5



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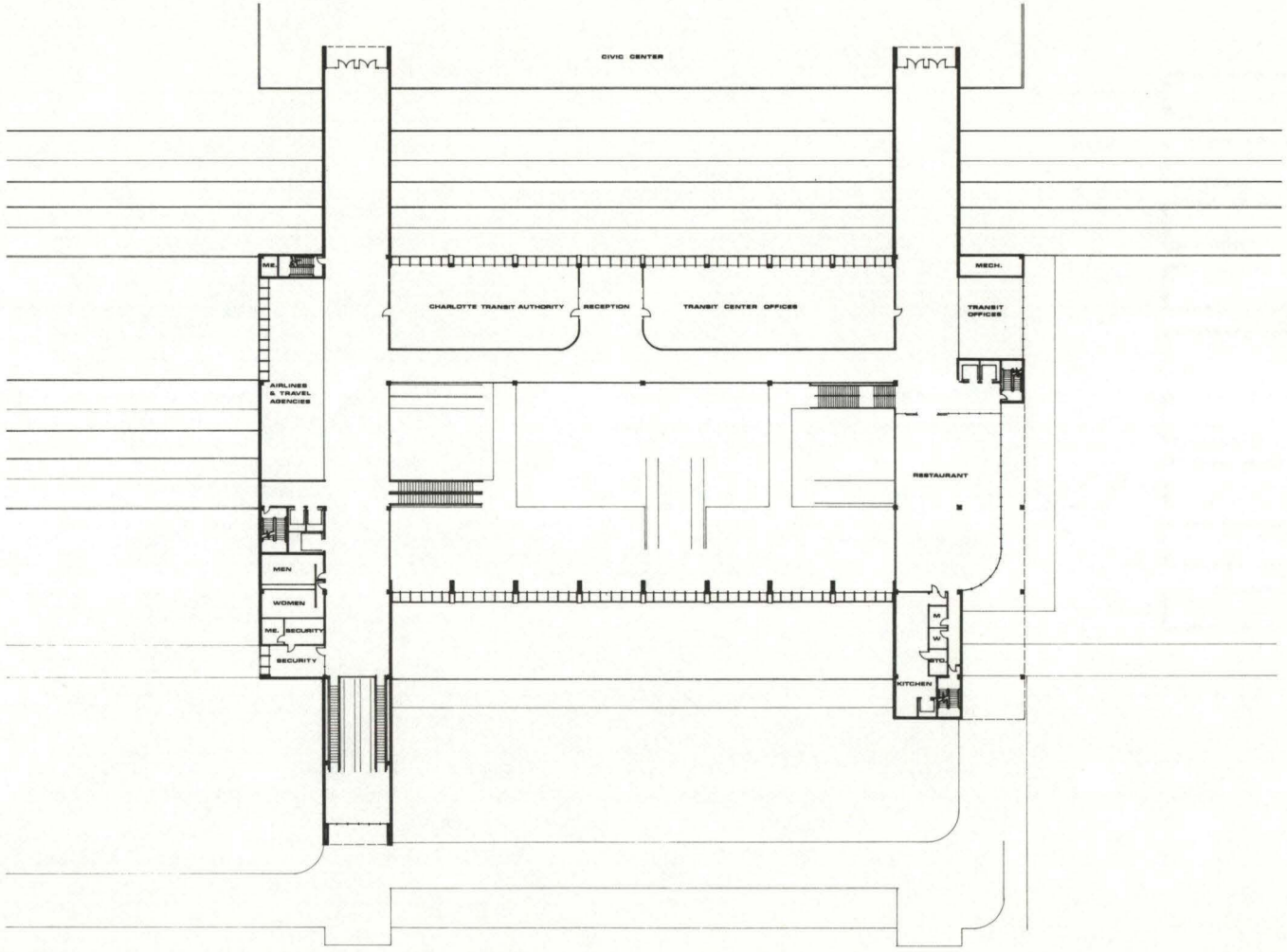

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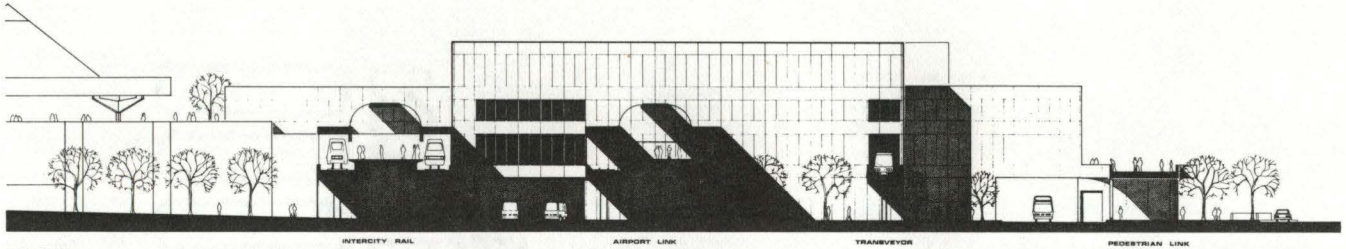
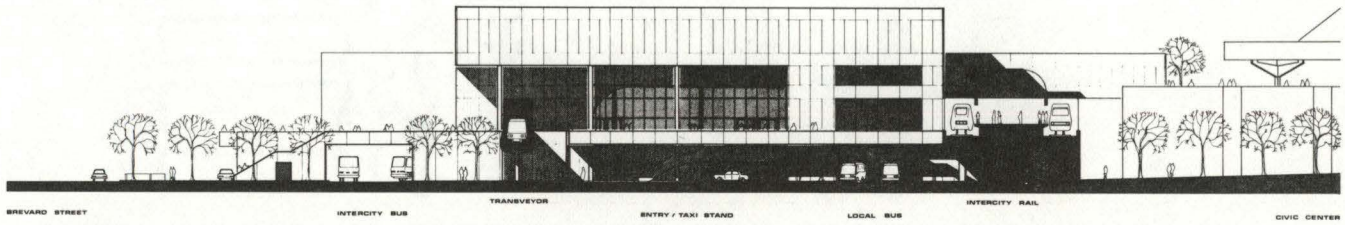
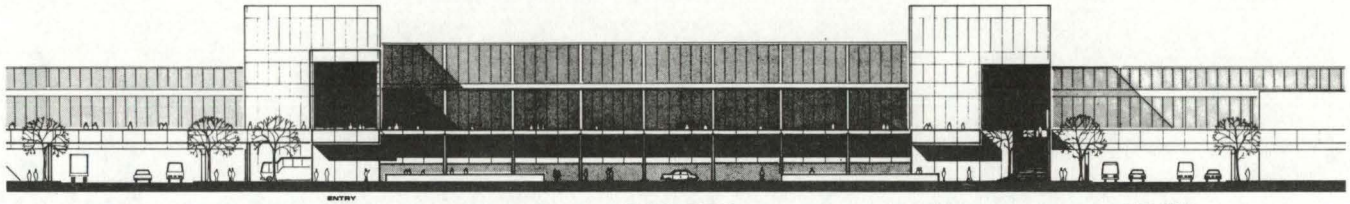


FOURTH STREET ELEVATION - S.W. 0 5 10 20 40



TRADE STREET ELEVATION - N.E. 0 5 10 20 40

ELEVATIONS



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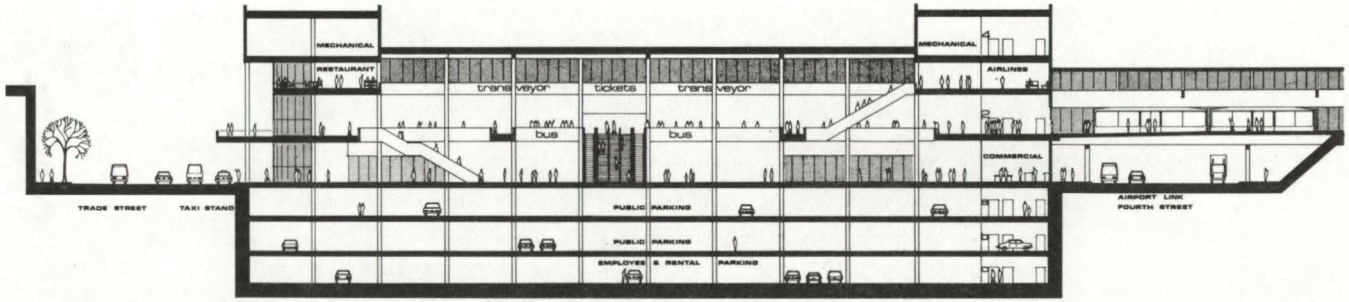

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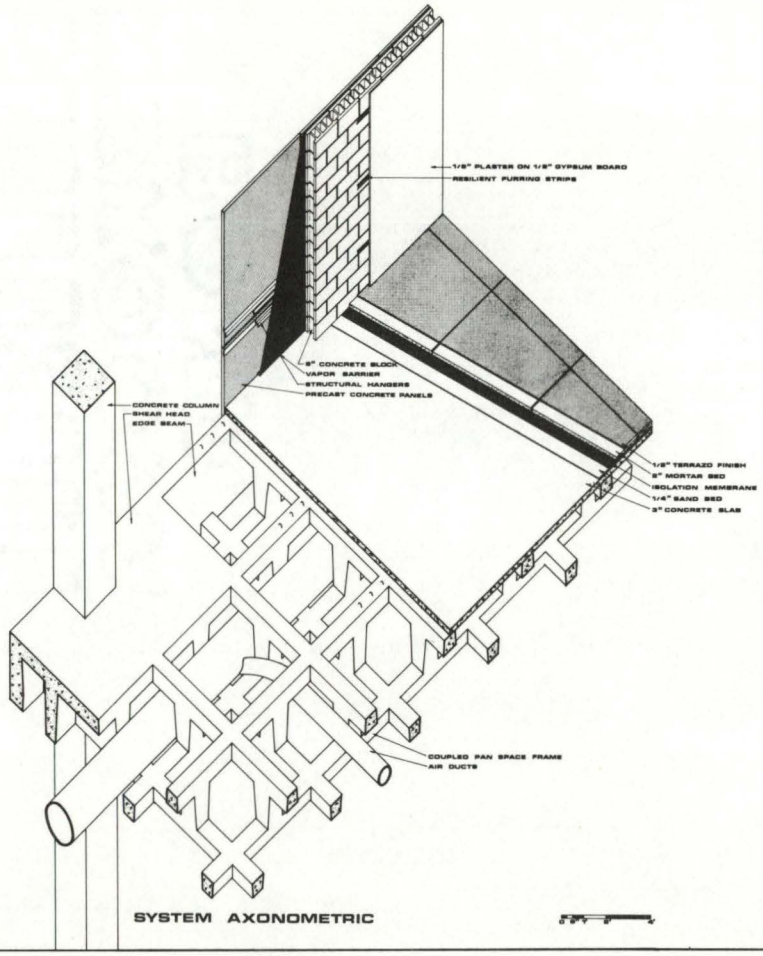
ELEVATIONS



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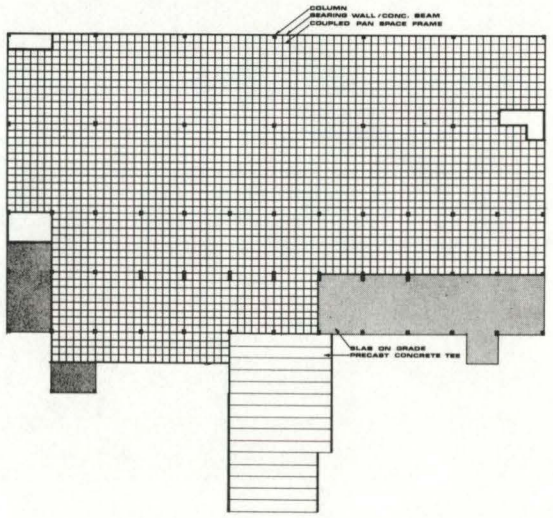

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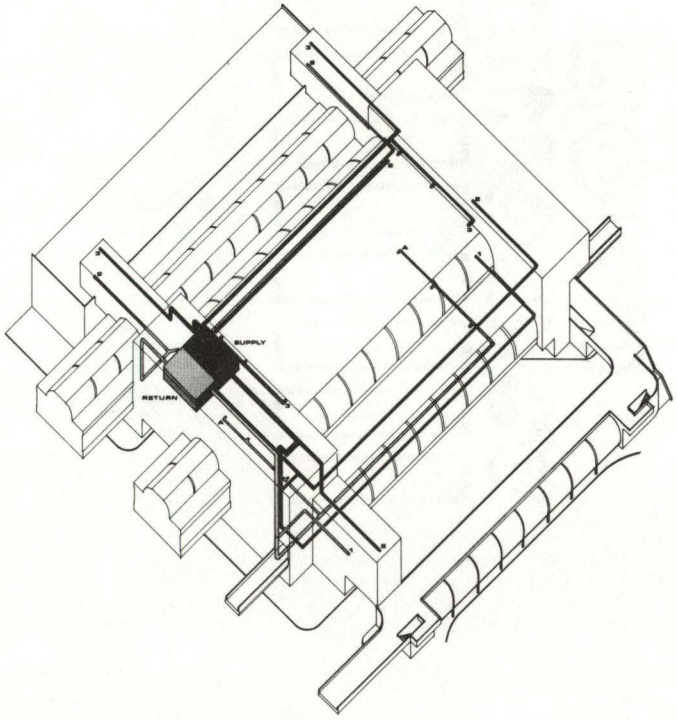
STRUCTURAL



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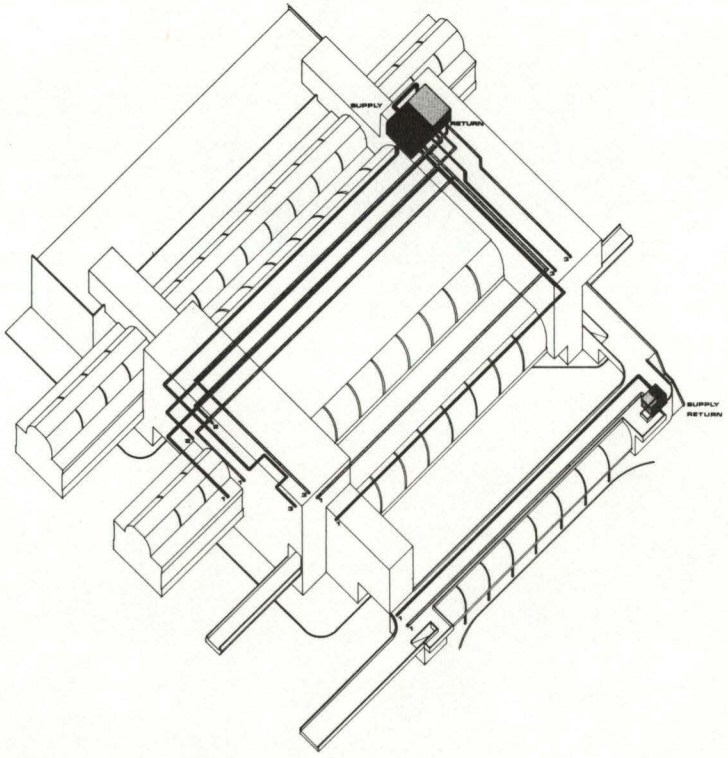

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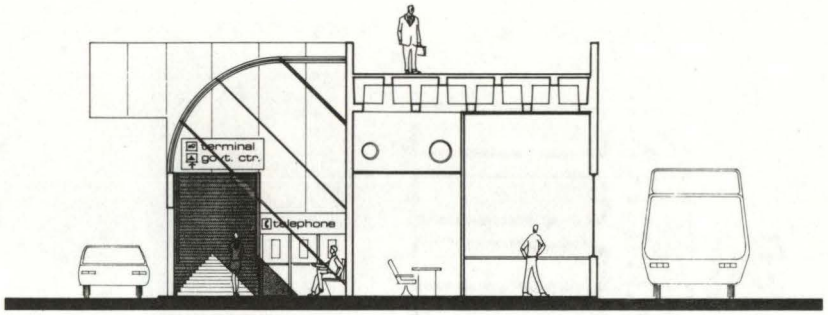

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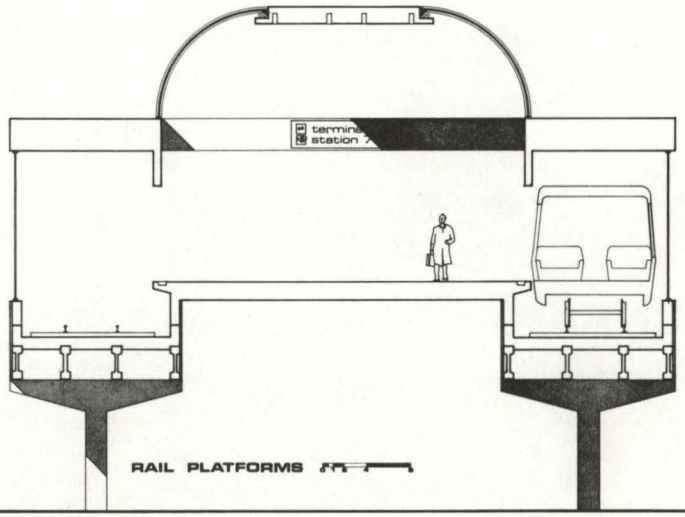

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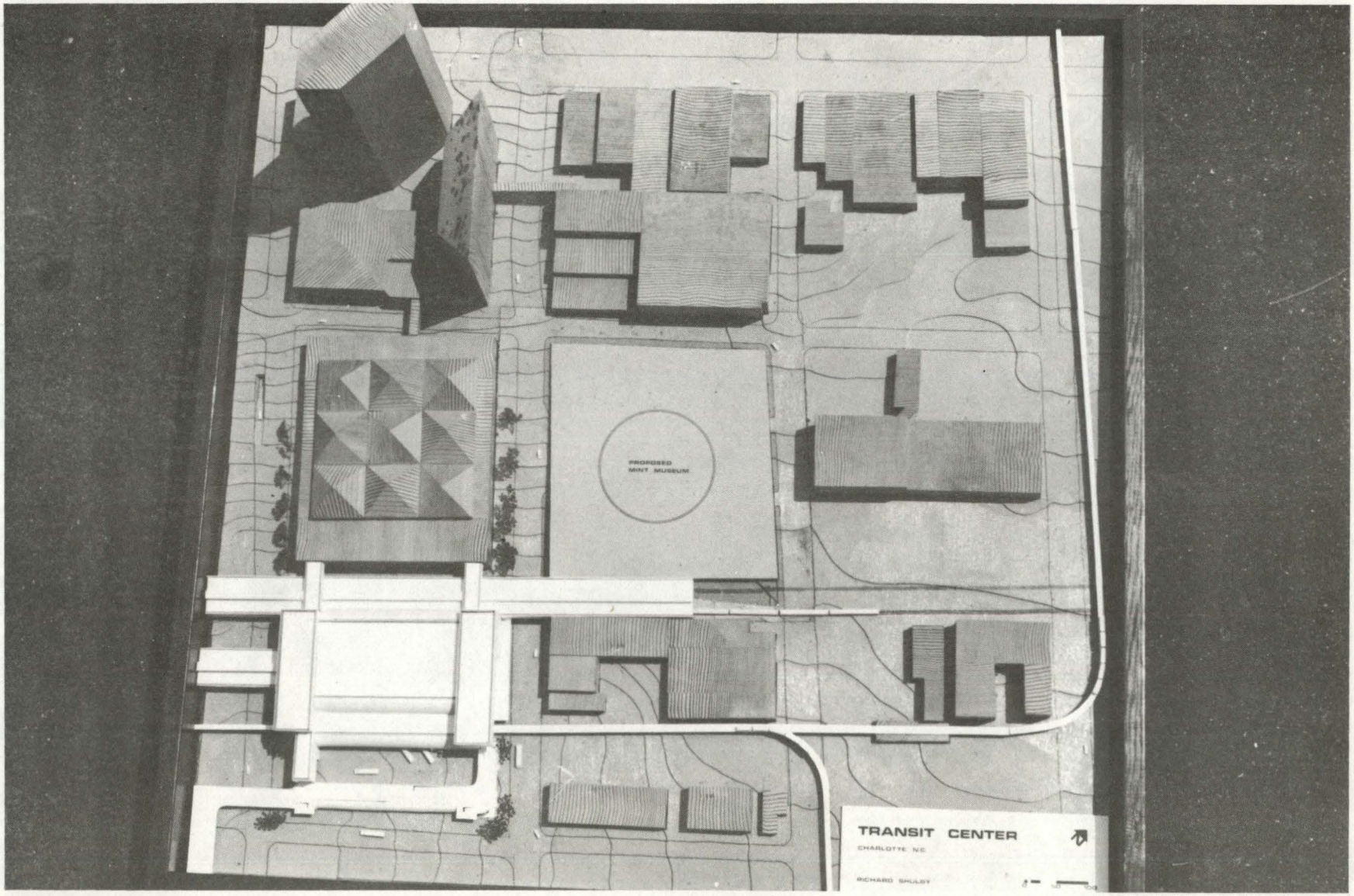
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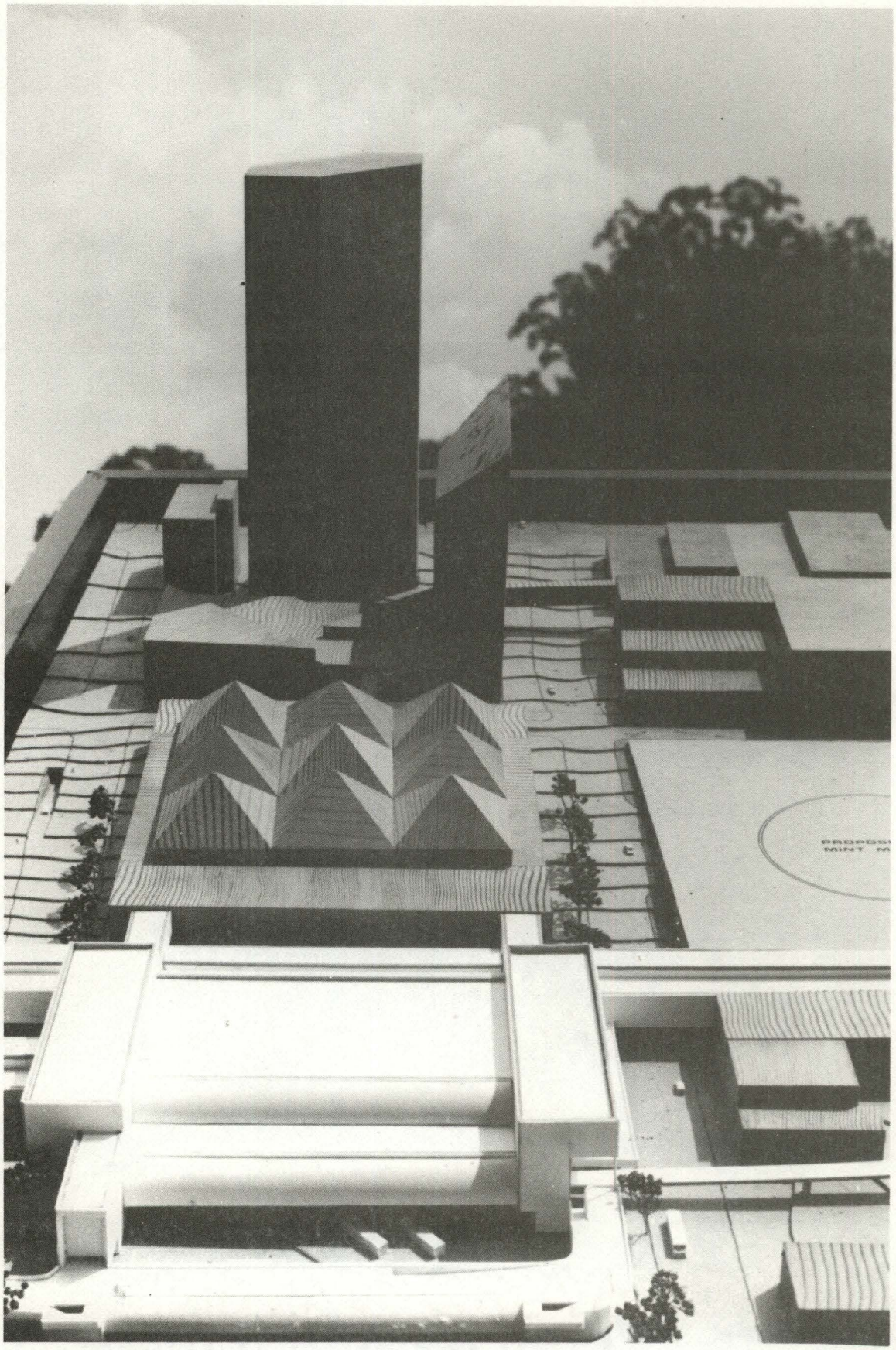

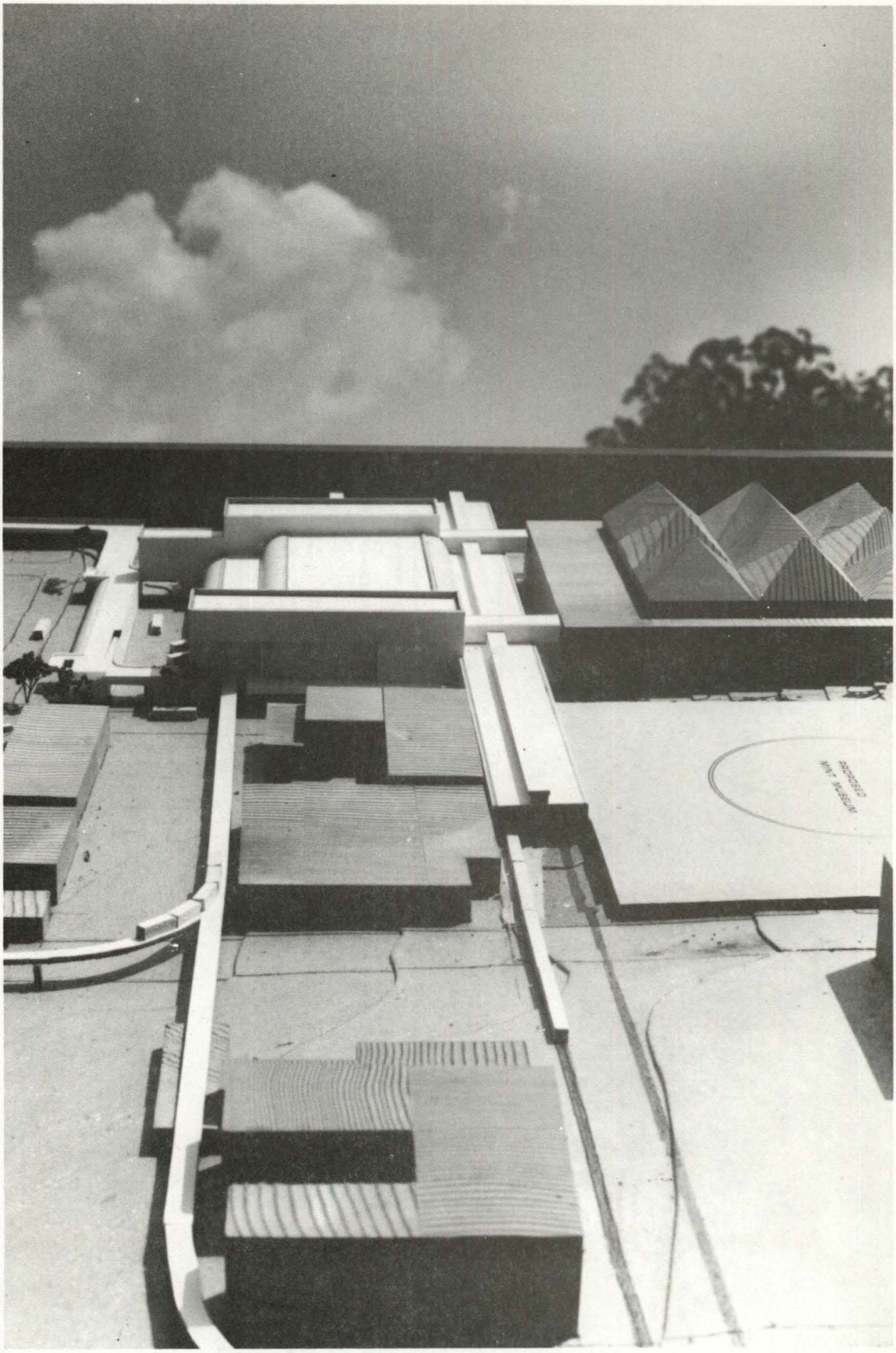
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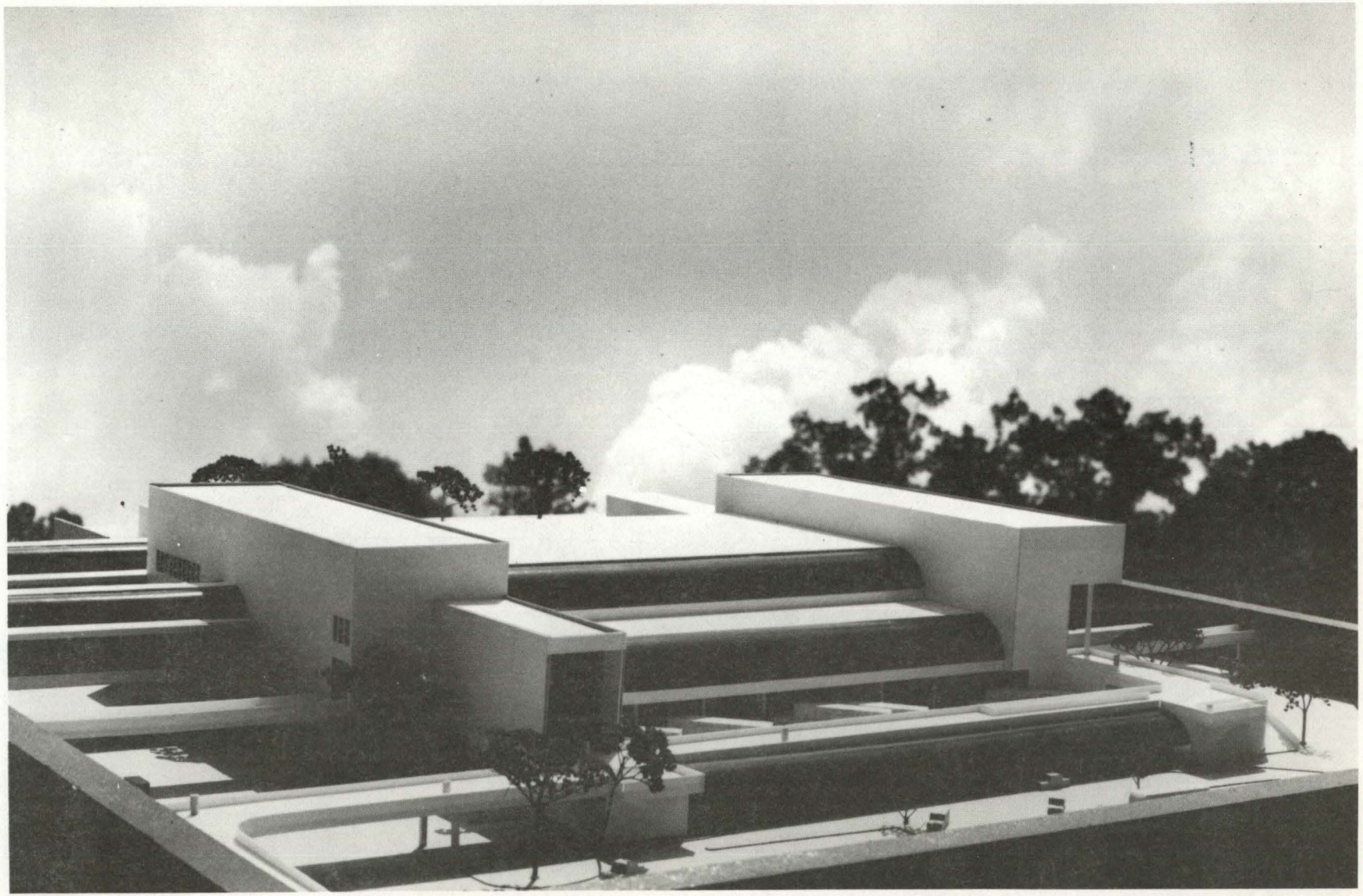

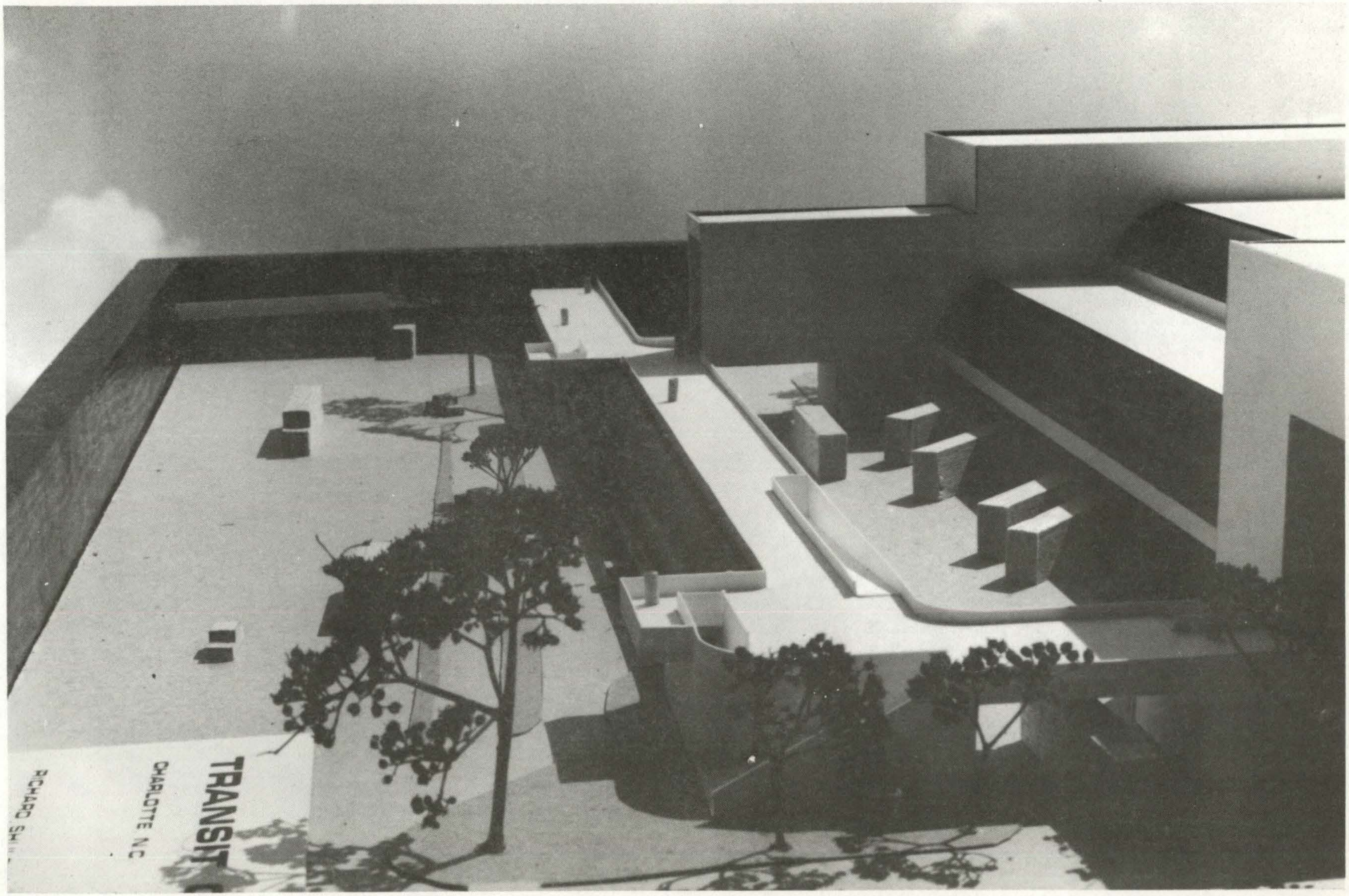
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