TRANSIT: A TOOL FOR IMPROVING THE URBAN ENVIRONMENT

Thesis for the Degree of M.U.P.

MICHIGAN STATE UNIVERSITY

GEORGE THOMAS JOHANNESEN, JR.

1966

ABSTRACT

TRANSIT: A TOOL FOR IMPROVING THE URBAN ENVIRONMENT

by George Thomas Johannesen, Jr.

Transit is one of many important aspects of the total urban transportation system with ability to affect the urban environment in various ways. As such, it can be a valuable tool for implementing plans, although not an ultimate panacea by any means. For various reasons, though, it has received very little use as such a tool.

The exact characteristics of transit as a tool for environmental improvement vary according to the type of transit. If transit is to be an effective tool, it must be able to attract riders in sufficient numbers to affect the transportation situation. Although other factors are also important, the most important single factor affecting the attractiveness of transit is whether or not transit operates in a channel separate from automobile traffic. Such a separate channel greatly enhances transit attractiveness.

Transit can be used to manipulate the person-carrying capacity of a street system with a given vehicle-carrying capacity. Traffic equilibrium can make it difficult to deal successfully with traffic congestion; dealing with congestion can be facilitated by using transit and recognizing the workings of traffic equilibrium. Transit and land use strongly

affect each other, and transit can be used to affect the process of blight. Furthermore, transit can be used to affect social conditions and to facilitate planning in various other ways.

The main purpose of this paper is to facilitate the use of transit as a tool for environmental improvement by pointing out some of the ways in which it can be used as such. It considers the aspects described above and makes some generalized recommendations. With urban areas beset with so many problems today, they can little afford to let any planning tools lie under-utilized. Hence, it is to be hoped that transit will receive greater use as a tool for environmental improvement in the future.

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by

George Thomas Johannesen, Jr.

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER IN URBAN PLANNING

School of Urban Planning and Landscape Architecture

1966

ACKNOWLEDGMENTS

Various people and agencies have been helpful in providing me with background material which made it possible for me to write this paper. I express my appreciation to them and to the various people who have offered criticism and other help, not the least of whom were Mr. Carl Goldschmidt and other faculty members in the School of Urban Planning and Landscape Architecture.

TABLE OF CONTENTS

page

ACKNOWLEDGMENTS ii

LIST OF APPENDICES v

INTRODUCTION 1

Chapter

I. GENERAL CHARACTERISTICS OF THE URBAN TRANSPORTATION SYSTEM 4

The Total Urban Transportation System . . . 4

Present Characteristics of the Internal Passenger-transportation System 6

Urban Transportation Planning and Administration: Fragmentation and Unification 17

II. THE URBAN TRANSPORTATION SYSTEM: CAPACITY, TRAVEL PATTERNS, AND COSTS 23

The Ability of Transit to Alter Traffic Patterns and Capacity 23

Financing of Urban Transportation 39

III. TRAFFIC EQUILIBRIUM 47

Development of the Concept 47

Effects of Traffic Equilibrium on Traffic Congestion 49

Relationship of Traffic Equilibrium to Transit Peaking 54

Effects of Transit on Traffic Equilibrium 58

IV. TRANSIT AND LAND USE 62

Chapter		page

Relationship of Urban Transportation to Urban Spatial Design 62

Transit and Blight 70

V. TRANSIT AND SOCIAL ASPECTS OF TRANSPORTATION 81

Social Costs Resulting from Excessive Reliance on the Automobile for Urban Transportation 81

Ability of Transit to Ameliorate Social Aspects of Transportation 85

Social Patterns 87

VI. APPLICATIONS AND CONCLUSIONS 92

Transit as a Tool for Improving the Urban Environment 92

Conclusions 99

BIBLIOGRAPHY 102

LIST OF APPENDICES

Appendix		page
I.	System	105
II.	Sub-optimization	106

INTRODUCTION

Transportation is an aspect of the urban environment which has received considerable attention from planning agencies over the years. In fact, plans and studies concerned only with transportation have been made on many occasions.

Transit is one of many aspects of transportation which a planner must consider in formulating a transportation plan, but most transportation planning has been handicapped by the omission of some important factors pertaining to transit. While planners generally have recognized that transit plays a useful part in urban transportation and have suggested its use in their plans, provisions for transit in the plans and actual implementation of transit portions of the plans have both been on a hit-or-miss basis.

In most cases public transportation policy has been indifferent to transit while actively promoting automobile travel. This situation is reflected in the heavy highway orientation which appears in many of the agencies responsible for transportation plans and studies. Some planning agencies are even restricted to highway aspects of transportation when they deal with transportation planning,[1] although this is not typical. Hence, it is little wonder that such highway-oriented agencies

[1]Lyle C. Fitch and Associates. Urban Transportation and Public Policy. San Francisco: Chandler, 1964. p. 79.

give transit no more than a passing nod.

Compared to the research which has been done concerning highways, not much research has been done about transit, and usually the research which has been done is not publicized so well as highway research. Planning agencies which are not particularly highway-oriented are influenced by what is done by other agencies and by published results of research. When many of the other agencies are highway-oriented, then a certain amount of highway orientation seems normal. Since most planning agencies cannot be expected to be outstanding trail-blazers, it is little wonder that planning agencies in general have given so little attention to transit.

Consequently, the purpose of this paper is to point out some of the ways in which transit can be used as a tool for improving the environment. The planner should understand the relationship of transit to total urban transportation and to the total urban environment in order to make full use of transit as such a tool. It should be borne in mind that because transit is only one of many factors which a planner must consider, a course of action advocating a greater use of transit as the only means of improving transportation would merely exchange a new set of problems for the present set, for a greater use of transit cannot solve all transportation problems. Various means are pointed out herein whereby transit can be used to improve the environment, but transit must be used along with many other means of improvement if the environment actually is to be improved.

Changing technology may alter the relative attractiveness of transit and the automobile, and it may alter commuting time to the point that people may live even farther from their places of work than they do now, but it is unlikely to change markedly the needs for land for transportation rights-of-way, both for the automobile and for transit. Much speculation is involved in predicting such future changes, and it is beyond the scope of this paper to predict them. The likelihood of technological change must be recognized, though, and land-use plans should allow for such change without requiring alteration of the basic plan.

When urban transportation planning has considered transit and its relationship to transportation and the environment, it has generally been concerned mainly with various engineering and economic factors and their immediate effects. Many other factors, though, are just as important as the economic and engineering factors, even though they are not so readily quantified and have effects which are more long-range, e.g. street capacity, traffic equilibrium, land use, blight, social factors, and the like. Hence, many considerations important to those relationships are discussed herein.

CHAPTER I

GENERAL CHARACTERISTICS OF THE URBAN TRANSPORTATION SYSTEM

The Total Urban Transportation System

Transportation is a comprehensive system[1] of interrelated activities, the requirements of which are determined largely by land use, demographic and social characteristics, and consumer choices. Not only is transportation shaped by the characteristics of the area in which it is located, but it also helps to shape the development of the areas in which it is located. Since a metropolitan region's fabric of interdependent functions is formed by travel-generating daily activities located without reference to municipal boundaries, transportation planning today must be on a metropolitan scale.[2]

In any urban area the total transportation system is a subsystem of the North American transportation system, which in turn is a subsystem of the world transportation system. The urban transportation system includes freight and passenger subsystems. Included in the freight subsystem are ports and terminals and the means of moving freight by any of the following subsystems: road, rail, water, and air.

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[1]See definition of "system," Appendix I.

[2]John W. Dyckman. "Transportation in Cities," Scientific American. CCXIII (September 1965). 162-174. p. 164.

Included in the passenger subsystem are internal metropolitan-area transportation and external transportation, i.e. trips to or from points outside the metropolitan area or trips merely passing through. External transportation can take place on any of the sub-systems mentioned above for freight (road, rail, water, and air); it can be by common carrier on any of those subsystems and by private vehicle on all except the rail subsystem, which is restricted to common-carrier vehicles.

Because most urban transportation demand is for trips which begin and end within the metropolitan area,[1] the major concern of this paper is internal metropolitan-area transportation. Internal transportation usually takes place by one of the following means: private automobile, transit,[2] taxi, bicycle, or on foot. In most of North America trips by bicycle are few and relatively unimportant. Although many trips are made on foot and nearly all trips originate or terminate on foot, accommodation of pedestrian trips is very easily accomplished. Hence, consideration of pedestrian and bicycle trips is beyond the scope of this paper. The characteristics of taxi trips are essentially the same as those of trips by private automobile except for parking. Hence, the major concern of this paper will be internal transportation by private automobile and by transit.

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[1]Fitch, p. 1.

[2]Herein transit is defined as the usual types of transit vehicles and their variations: bus, trolleybus, streetcar, rapid transit, commuter train, incline, and ferry. It also includes various new and uncommon forms, such as hydrofoil water carft, moving belts, and exotic forms of rapid transit. Transit does not include the taxicab, for essentially its characteristics are those of the private automobile, except for parking.

Present Characteristics of the Internal Passenger-transportation System

Transit

Transit carries many person-trips with a minimum expenditure of resources. It carries passengers in relatively large units, i.e. the transit vehicles. In order that the passengers may know where transit can take them and where they can board a transit vehicle, transit operates in established corridors of movement, i.e. the same routing month after month. Transit can operate in the same channels with automobile traffic, or it can operate in separate transit channels. Transit service is greatly improved when separate channels are provided for it,[1] but such separate channels cannot be provided everywhere, for construction of such channels can be justified only if passenger-traffic densities are sufficiently high.

Transit is suited for operation on high-traffic-density routes and at times when traffic densities are high. Transit is suited also for people who cannot drive, who do not have an automobile at their disposal for any or all trips,[2] or who prefer not to drive. It is useful to automobile-owning families for some regular trips and for standby service when the automobile is disabled by the weather or mechanical troubles. In case of national defense emergencies, transit can become particularly important.[3]

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[1] Fitch, p. 145.

[2] i.e. captive riders.

[3] Developing Metropolitan Transportation Policies: A Guide for Local Leadership. New York: Committee for Economic Development, 1965. p. 28.

The characteristics of transit vary according to the type of transit involved. Transit can exist in such a variety of forms that it may be considered that continuums of transit types exist. Some of the major types are discussed below.

Bus: Busses operate as completely self-contained units, each subject only to the control of the driver. Most major and secondary streets and roads can serve as bus channels without alteration. Hence, the bus is suited for routes and times with low passenger-traffic density.

Because it is possible for the bus to leave the route at any point, bus routings can be made with infinite variety. However, the bus must adhere to a fixed route in order that the riders may find it. If the transit operating agency is willing to make many variations and changes in routes and scheduling, it then becomes possible to tailor the bus service to many particular, specialized transportation needs; but such variations complicate the service and the task of the would-be rider to understand it. If the rider does not readily understand what service is offered, he is likely to go by automobile instead of by transit. Furthermore, variations usually mean a longer time interval between busses (except along portions of the route on which no variation takes place), which usually means that the rider must consult a timetable if he wants to avoid an unduly long wait at the bus stop, thereby encouraging him to drive instead.

As noted above, busses lend themselves to routing and scheduling instability. In addition, the relatively small amounts of capital required for a bus company and the ease of transporting busses to new locations when sold tends to produce instability of management, as evidenced in frequent changes of ownership and policy and abandonments of service.[1]

A type of bus which deserves special mention is the trolleybus. The trolleybus is essentially the same as a bus except that it is powered by electricity carried by overhead wires. It can maneuver through several lanes in a street, but it cannot deviate from an established route except where the overhead wires are located. It has the advantages of quieter and smoother operation, faster acceleration (particularly when fully loaded), more economical operation on higher-density routes, and no exhaust to add to air-pollution levels. Since the trolleybus requires the installation of overhead wires, it is not suited for the very low-density bus routes and the many variations in route described above. It is, however, well suited to the many trunk routes served by busses in many large cities. Furthermore, because of its lack of exhaust, it is suited to operation in tunnels without elaborate ventilation systems.

Rail: Rail transit exists in a wide variety of types, which form essentially a continuum from one general type to another. They all have in common the requirement that track be laid to provide the channel in which to operate. That channel may be shared with automobiles (in a street) or with other rail service, or it may be used exclusively by rail transit.

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[1]Fitch, p. 42.

Because construction of such special channels can be justified only if passenger-traffic densities are sufficiently high to support a trunk line (even more so than in the case of the trolleybus), rail transit is not suited for routes with low passenger-traffic densities, and busses must be employed to complement rail transit by serving such low-density routes. Rail transit routes must be chosen with care because of the expense of constructing and relocating the track. Hence, rail systems are built only when the advantages make them worthwhile. A description of the advantages follows; it should be noted, however, that these advantages are all enhanced by higher passenger-traffic densities.

Although some rail transit is powered by other means, most rail transit is powered by electricity generated at central power stations. Such a source of power removes the need for ventilation of exhaust fumes, and electric rail transit is thereby enabled to operate in tunnels and other enclosed spaces without elaborate provisions for ventilation. The track is a distinct advantage, for the rails provide an almost foolproof automatic steering system which (1) permits very precise steering through narrow clearances and (2) enables many cars to be coupled together into a train as long as desired, with all cars following the same path through the tight clearances as easily as a single car. Hence, rail transit is particularly adapted to operation in enclosed spaces with tight clearances, such as tunnels.

Although busses are flexible in their own way concerning the individual vehicle, rail transit has flexibility which busses do not have. Rail transit is particularly flexible with reference to the following factors:

1. Size of unit. Rail transit cars can be coupled together and run as trains as large as desired with no difficulty (particularly if multiple-unit controls are used), owing to the steering system provided by the tracks. This permits operating economies to be realized through increasing the number of passengers carried per crewman, particularly during peak hours.

2. Adaptability to automation. The rails provide an automatic steering system and also provide a means whereby signals may be conveyed from control points to the transit vehicles and back.

3. Location of transit channel. Track for rail transit can be laid anywhere, and rail transit can operate anywhere, through a wide variety of conditions, e.g. in streets in traffic lanes, in streets on separate lanes, in median strips, beside streets, in tunnels, in open cuts, on elevated embankments, on elevated structures, through buildings, on the surface of the ground, on existing railroad right-of-way, and practically anywhere else. The rail transit channel can utilize any or all of the types of locations listed above in rapid succession, even all on one route if so desired.

There is a term, "rapid transit," which deserves consideration. The term itself can apply to almost any type of transit which operates on a separate channel over part or all of its route and has its stops spaced fairly far apart (one half mile or more) over most of the separate-channel portion of its route; hence, it can apply to a system operated with busses or with rail cars. However, as the term generally is used, it refers to a particular type of rail transit with most of the following characteristics:

1. Electric power.
2. Multiple-unit operation. The trains are composed of one or more self-propelled cars.
3. Frequent operation. The rider does not need a timetable, except at very lightly traveled hours, e.g. between midnight and 6:00 A.M.
4. High-level platforms and automatic doors. The platforms are at the level of the train floor. The doors generally are all controlled from a central control for the whole train.
5. Fare collection off the train. Fare collection is accomplished at the stations, except during lightly traveled times such as nights and Sundays, when it may be done on the train.

If some of these characteristics are missing from a given rail transit system, it is usually defined as a particular type of rapid transit or as something other than rapid transit. Rapid transit as described above can be called "heavy-duty rapid transit" when there is a need to distinguish it from other types.

Rapid transit can be considered to be at the center of the rail-transit continuum with streetcars at one end and commuter trains at the other. The definition of a commuter train usually allows for a wide range of variation, but some of the characteristics are as follows:

Although rapid transit is highly focused on the central business district, commuter trains are even more highly focused on it. Commuter trains draw their customers mainly from upper-income groups of people who work in the central business district and who live farther out than the outer edge of rapid-transit service. Commuter trains usually operate sufficiently infrequently to require the rider to consult a timetable, and fare collection is usually accomplished on the train with the rider buying a ticket before boarding.

Some rail transit systems are located on the continuum between commuter trains and rapid transit, e.g. the Illinois Central commuter service in Chicago, which is now in the process of becoming more like rapid transit and less like a commuter railroad.

At the other end of the continuum is the streetcar, an electric rail car operating in the streets for all or most of its route. It provides service essentially the same as that of a bus except for the disadvantage of being unable to maneuver in traffic and the advantage of being readily adaptable to operating in a variety of separate channels. Many present and past streetcar systems have had some of the system on separate channels, generally called private right-of-way. Of the streetcar systems operating in the United States and Canada today, all but one operate some or all routes on separate channels.

When a streetcar operates on a separate channel, it begins to have some of the qualities of rapid transit. Hence, it is then located on the rail-transit continuum between rapid transit and streetcars. If such rail transit has a major portion of its route in separate channels, it is generally called "light rapid transit" or a "limited tram" or "limited tramline."

A limited tramline is probably the most flexible type of rail transit, being as well adapted as heavy-duty rapid transit to all types of grade-separated separate channels and also being particularly well adapted to operation in streets and in at-grade separate channels. Furthermore, a limited tramline can be converted to heavy-duty rapid transit quite easily when conditions warrant. While heavy-duty rapid transit requires many feeder busses except in areas of extremely high density (e.g. Manhattan), the limited tramline can do much or all of its own feeding by operating in uncongested streets on the outer portions of its routes, with several routes feeding into one high-speed separate channel for the trip downtown. In this respect, the limited tramline has the same advantage which bus rapid transit has, i.e. one-seat service from many residential areas to the central business district with no transfer.[1] Of course, in order to serve low-density

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[1]Henry D. Quinby. "Major Urban Corridor Facilities: A New Concept," Traffic Quarterly. XVI (April 1962). 242-259.

residential areas optimally, automobiles and busses should be used as feeders to some extent.

There are still other types of rail transit, some of which are lumped together under the term, "monorail." As far as the planner is concerned, monorail has about the same service characteristics as other forms of rail transit, so no elaboration is in order here, other than to say the following: Few monorails exist today, and serious rapid-transit proposals today generally do not consider monorail beyond the preliminary stage because various technological aspects of monorail make it generally inferior to and more expensive than ordinary rail transit for most rapid-transit applications.[1] Fitch concludes, "In summary, there is no indication that monorail can do anything that conventional rail cannot do as well or better."[2]

Other Transit: Other types of transit, e.g. ferries, moving belts, and various exotic forms, are uncommon. Special consideration of them is beyond the scope of this paper.

Automobile

Automobiles carry person-trips with a maximum of flexibility in small units, i.e. the individual automobile. Automobiles can go anywhere on the street system without having

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[1] "Consulting Engineers Make Final Recommendations on Basic Design of BARTD Rapid Transit System," Rapid Transit: An Information Digest from the San Francisco Bay Area Rapid Transit District. VI (September-October 1963). 3-4. See also Donald S. Berry, George W. Blomme, Paul W. Shuldiner, and John Hugh Jones. The Technology of Urban Transportation. Evanston: Northwestern University Press, 1963. pp. 85-87.

[2] Fitch, p. 201.

to be bound to established routes, such as bus routes. The precise routing of an automobile can be chosen on the spur of the moment if the driver changes his mind. Automobiles are inefficient for high traffic-density routes because they take up too much road space per person-trip. Hence, a street system becomes congested at relatively low person-trip levels when all or most trips are made by automobile. Furthermore, automobiles consume a larger amount of resources for parts and fuel per person-mile delivered than does transit.

Automobiles are suited for trips with any of the following characteristics:

1. The trip has an odd desire line[1] shared by only a few other people or is made at an odd time.
2. The trip requires goods to be moved.
3. The trip requires many stops at many different places located at greater than walking distances from each other.
4. The trip involves someone who is sick or physically handicapped so that he cannot walk or should not be exposed to the public.

Current Roles of Transit and Automobile

Transit: With increasing use of the automobile for all types of trips, transit has gradually come to be used for more specialized types of trips. Today transit is used mainly for the following types of trips: captive riders, central business

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[1] A desire line is an imaginary straight line drawn from the point of origin to the point of destination. Ordinarily, one must take a route which deviates from the desire line to some extent.

district trips, and work and school trips. Although some people prefer not to drive, in most cases the transit service is so poor today that it attracts very few of these people, for transit offers them no real alternative to driving. Transit trips by people who prefer not to drive usually are central business district trips or work trips.

The scope of the role of transit is broader in the larger metropolitan areas than in the smaller ones, although there are variations in this. Furthermore, trips by transit occur with very high peaks and very low levels in off-peak times, mainly due to the importance of work trips and central business district trips, both of which exhibit high peaking tendencies.

Automobile: Trips by automobile today include all kinds of trips, but in particular the following types:

1. Social-recreational trips.
2. Peripheral trips, i.e. trips not to and from the core.
3. Small-town and rural trips.
4. Non-central-business-district shopping trips.
5. Non-central-business-district work trips. This category includes reverse commuting, i.e. a work trip wherein home and work are in the same general sector radiating from the core, but home is closer to the core than work is.
6. Trips by the physically handicapped who are unable to walk.
7. Long-distance trips by people from out-of-town who are passing through, perhaps stopping to attend to some personal business.
8. Trips by people who feel the need for a psychological

boost and can get it by driving, e.g. the prestige which one can feel by being seen in a fancy automobile, the ability to extend one's personality by driving an automobile, and the like.

The scope of the role of the automobile is broader in the smaller metropolitan areas than in the larger ones. Although peaking occurs in automobile use, peak-hour levels are restrained by the capacity of the street system,[1] and off-peak levels are relatively high, partially because of social-recreational trips. Hence, the degree of peaking in automobile use is low compared to peaking in transit use. It should be noted that at popular recreation times, e.g. weekends, peaks occur in automobile traffic going to and from popular recreation places.

Urban Transportation Planning and Administration: Fragmentation and Unification

Many public agencies and some private agencies deal with urban transportation planning, administration, financing, construction, and operation. These agencies usually are poorly co-ordinated, if they are co-ordinated at all. Lyle C. Fitch described the situation as follows:

> Urban transportation probably suffers more from the fragmentation of the American administrative system than any other urban service. . . . Present fragmentation of planning and administration of urban transportation along modal and jurisdictional lines precludes consideration of metropolitan transportation as an integral and open system. Metropolitan areas have

[1] See Chapter Three herein.

> leapfrogged jurisdictional boundaries. And even within jurisdictions, responsibilities for transportation are divided among manifold functional units.[1]

The fragmentation of urban transportation planning and administration can be categorized as follows:

1. Spatial fragmentation: e.g. state agencies, county agencies, municipalities and municipal agencies, and special-purpose districts.

2. Functional fragmentation: e.g. road construction, road administration, rail, water, air, transit, special-purpose districts, and regulatory commissions.

These agencies naturally have varying orientations, for each agency usually develops a specialized point of view. Generally these agencies, and particularly the special-purpose districts and other functional agencies, are not interested in transportation matters outside their own special concern. Frequently these agencies have conflicting interests and engage in empire-building to further themselves, to the detriment of the other parts of the transportation system and to the detriment of the public in general. Generally the highway agencies have been much better supplied with funds than the transit agencies, and public policy has frequently responded to the well-funded highway agencies by decisions favoring them, to the detriment of transit.[2]

There has been a tendency recently toward partial unification

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[1]Fitch, p. 16.

[2]Fitch, p. 36.

of transportation planning in metropolitan areas through comprehensive metropolitan planning agencies, metropolitan transportation studies, and the like, but administration of metropolitan transportation generally has remained as unco-ordinated as ever. When co-ordination exists, its scope is limited to a small number of agencies for certain purposes. Sometimes one function has spatial unification throughout the metropolitan area, but virtually no co-ordination with other functions. Ordinarily, if a degree of spatial unification is achieved, then functional unification is missing; and if functional unification is achieved, then spatial unification is missing.

Although it might be desirable to achieve complete unification in metropolitan transportation planning, administration, and operation, it has been politically unfeasible so far and would be difficult to make workable. Hence, what is considered below is a generalized consideration of a workable, feasible partial unification.

If the unification is to be really effective, it must be at a metropolitan level of government. If the central city is located centrally in its county and the county contains most of the metropolitan area, the county can be the spatial unit for the metropolitan level of government, and metropolitan functions can be placed at the county level, either gradually or all at once, e.g. Pittsburgh, Cleveland, Los Angeles, and Seattle. Otherwise, a metropolitan government requires a new spatial unit, which usually requires action by the state government. If a metropolitan government is not made, then whatever metropolitan agency is created will have to deal with municipalities and other smaller units, a situation which, although not the most desirable, would be considerable improvement over the present situation.

The following type of organization provides an example of the type of partial unification which could be achieved under a metropolitan government:

Metropolitan Transportation Department

Staff Divisions: Planning, External Liaison, Internal Liaison, and the like.

Line Divisions:

1. Metropolitan Transit Operating Division: to operate all transit service in the metropolitan area, with possible exceptions for various reasons. There will be inter-city busses and trains not operated by the Metropolitan Transit Operating Division, and there may be other exceptions if it is in the public interest to have separately operating transit in the metropolitan area.
2. Regulatory Division: to regulate any transit operating agencies other than the Metropolitan Transit Operating Division operating in the metropolitan area, e.g. commuter railroads and independent (private and municipal) bus companies.
3. Port Division: airports, water port, truck terminals, bus terminals, and railroad freight and passenger stations.

4. Highway Division: expressways, arterial streets, bridges, tunnels, parking facilities, and the like.
5. Other Divisions: as needed, if needed.

The Metropolitan Transportation Department will have to deal with state and federal agencies and regulatory commissions. One of the most important functions of the Metropolitan Transportation Department will be to be concerned with the overall transportation situation in the metropolitan area and not to be swayed by generously funded state and federal agencies engaged in a bit of empire building. Furthermore, the Metropolitan Transportation Department will have to deal with other metropolitan agencies, municipal agencies within the metropolitan area, private agencies within the metropolitan area, and agencies in neighboring areas. Many questions concerning the Metropolitan Transportation Department will have to be decided in light of local conditions. For example, it depends on local conditions whether or not the Metropolitan Transit Operating Division should take over all other transit operating agencies in the area.

If no metropolitan government is feasible, then a comprehensive metropolitan planning agency can be used to provide co-ordination among the various agencies involved with transportation. Each case will vary according to local conditions.

This chapter has shown the general functions of transit and the automobile in urban transportation and has shown the general setting and problems incident thereto. Both the automobile and transit have important roles to play in urban transportation, and if either the automobile or transit is prevented from providing its service fully, it will hurt the whole urban transportation system and the whole metropolitan area. Both the automobile and transit should be encouraged to reach their potential in the types of service in which they excel; they should be encouraged to complement each other, not to compete with each other. When this is done, it will benefit all the metropolitan area and its residents.

CHAPTER II

THE URBAN TRANSPORTATION SYSTEM: CAPACITY, TRAVEL PATTERNS, AND COSTS

The Ability of Transit to Alter Traffic Patterns and Capacity

Expanded Role for the Automobile and Reduced Role for Transit

In total person-trips there is a modal split between the private automobile and transit, with a small remainder of person-trips made by other means, e.g. pedestrian and taxi. As discussed in Chapter One herein, the capacity of transit to carry people is much greater than the capacity of automobiles to do so. If a transportation system of a given size exists with person-trips shared between automobiles and transit according to a certain ratio, then if the system is altered to place greater reliance on automobiles and a correspondingly lessened reliance on transit, the result will be reduced person-carrying capacity for the system.

Since most urban transportation systems have excess capacity except at peak hours, reduced capacity will generally not have an adverse effect on off-peak transportation from a strictly economic and engineering standpoint, but is will create sizeable problems at peak hours, though, by aggravating traffic congestion.[1]

[1] Traffic congestion is a condition which exists when traffic volume exceeds the number which a traffic artery can accommodate with a free traffic flow. When traffic congestion exists, traffic cannot move freely. It may move slowly or it may come to a temporary standstill.

Reduced Role for the Automobile and Expanded Role for Transit

Conversely, if a lesser reliance is placed on the automobile and a greater reliance is placed on transit, the result will be greater capacity for the given transportation system. Greater peak-hour capacity will permit a higher peak with the same level of congestion. In the larger metropolitan areas peak-hour travel demand is so high, though, that markedly lessened peak-hour congestion of private vehicles will not occur because the process of traffic equilibrium will keep traffic volumes at congestion levels, no matter how much the transportation system is expanded to accommodate more vehicles -- unless the system is expanded on a monumental scale, a scale sufficient to accommodate all now-captive transit riders by automobile.[1]

Thus, transit can increase the person-carrying capacity of a transportation system per unit of space,[2] thereby reducing land requirements and economic and social costs needed to provide facilities to accommodate the volume of person-trips made in the transportation system.

Treatment of Peak-hour Traffic

Even when all other urban transportation difficulties are solved, peak-hour traffic remains a problem and must be given special consideration here. Transit can handle peaks

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[1]See Chapter Three herein.

[2]Fitch, p. 14.

in person-travel without much (if any) increase in the vehicle capacity of the streets, while peaks in person-travel handled by private vehicle require a very great increase in roadway capacity. This concept can be expressed through using the following model. The model can be used for any street system or any portion thereof, ranging in size from a one-block stretch of one street (or a portion of an expressway between two consecutive interchanges) to the whole street system of a metropolitan area. The smaller the portion of the street system considered in the model, the more precise the results will be; conversely, if a large portion of the street system is considered with a single application of the model, the results will be very generalized.

The model considers neither walking trips nor truck traffic; it is concerned only with person-trips by automobile and by transit. Since it does not consider storage of vehicles, trips by taxi are equivalent to trips by private automobile.

Although the type of capacity employed in the model is usually "practical capacity" or a variant thereof, any type of capacity may be used. However, the type of capacity chosen for use in the model will determine the type of results which the model will give.[1]

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[1]Three major types of capacity generally used are defined in: Brian V. Martin; Frederick W. Memmott, III; and Alexander J. Bone. Principles and Techniques of Predicting Future Demand for Urban Transportation. Cambridge : Massachusetts Institute of Technology Press, 1961, 1965. p. 208.

Transit vehicles are converted to equivalent automobiles (in terms of the vehicle capacity of the street system) by use of a conversion factor.

Symbols used in the model follow.

c = capacity of the street system in equivalent automobiles per hour.

v = traffic volume in equivalent automobiles per hour, i.e. the volume needed for carrying the number of person-trips in question by the modal split envisaged.

If the transportation system is to operate properly, v must be less than or equal to c. The following constants and conversion factors must be determined for the transportation system. Since they depend largely on the size of vehicles used, they are relatively constant from one city to another throughout the United States.

Constants:

a = average number of persons per automobile driving and riding in each trip

t = average number of riders per transit vehicle in each trip

Conversion factors:

b = number of automobiles equivalent to a bus in terms of the vehicle capacity of the street system, i.e. the value of a bus in equivalent automobiles

s = average number of transit riders per equivalent automobile, i.e. number of transit riders per transit vehicle in terms of equivalent automobiles.

Note that: $s = t/b$

Along with the preceding constants and conversion factors, the model employs the following variables:

n = total volume of person-trips in person-trips per hour

x = number of person-trips by automobile in person-trips per hour

$(n - x)$ = number of person-trips by transit in person-trips per hour

The model consists of the following equation, wherein v must be less than or equal to c.

$$v = \frac{(n - x)}{s} + \frac{x}{a}$$

The equation can be transposed as follows:

$$x = \frac{a(sv - n)}{s-a}$$

$$(n - x) = \frac{s(n - av)}{s-a}$$

Once a, b, and t are determined, if n and c are given, then x and (n - x) can be manipulated so that v will be less than or equal to c (unless the system cannot handle that volume of person-trips even when they are all by transit).

As given so far, the model applies only to a transportation system wherein all transit service operates in the same channels with automobile traffic. If the transportation system includes transit operating in separate channels, then the model must be modified to the following:

$$v = \frac{(n - x - q)}{s} + \frac{x}{a}$$

q = number of person-trips by separate-channel transit.

$(n - x - q)$ = number of person-trips by transit operating in the same channels with automobiles.

Hence, if a certain number of peak-hour person-trips are allocated to private automobiles and a certain number to transit, a given volume of person-trips can be accommodated by a given street capacity. If the street capacity is given, almost any volume of person-trips up to the maximum possible can be accommodated if the ratio of trips by transit to trips by automobile can be controlled. If person-trips are shifted from automobile to transit, the volume which can be carried in a given street capacity will be increased.[1] If person-trips are shifted from transit to automobile, either the volume carried in a given street capacity will be decreased or traffic congestion will be made worse. Hence, a given street vehicle capacity can carry almost any number of person-trips under the maximum possible if the desired mix of peak-hour person-trips by transit and by automobile, i.e. modal split, is obtained.

Implementation Difficulties

However, if the desired goal is an absence of congestion, the modal split at present consists of more person-trips than desired made by automobile and fewer person-trips than desired made by transit, and present transportation policies offer little hope of shifting sufficient person-trips from automobile to transit to reach a desired mix of trips between

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[1]Or the same volume could be carried in a lessened amount of street congestion, but this possibility is not likely to occur during peak hours because of traffic equilibrium.

transit and the automobile. The reason for such a situation is that under present conditions the automobile has certain personal advantages over transit which cause more than the desired number of persons to decide to make their trips by automobile. Hence, if the transportation system is committed to individual freedom of choice of mode of travel, transit must be made sufficiently attractive that the desired percentage of peak-hour person-trips will be made by transit. Otherwise, the desired mix of trips will not be achieved, for too great a number of trips will continue to be made by automobile.

Because the ability to attract riders to transit is necessary in order to shift them from automobile to transit, we must consider the reasons why riders whose trips are suited to transit are not now attracted to transit in adequate numbers and the means whereby they may be attracted. The tendency toward the above-mentioned too-great percentage of person-trips made by automobile results from wholly inadequate transit service unable to compete with the automobile in speed, convenience, comfort, and prestige.

Some of the reasons why transit is generally so inadequate today can be demonstrated by the following example: in most situations transit service is provided by a bus operating in the same lane of roadway with automobiles and stopping repeatedly to receive and discharge passengers. If automobile traffic is slow because of congestion, the bus will be slow. If the bus must stop to receive and discharge passengers, then the bus will be even slower than the automobiles. In most cases the bus is slowed further by having to wait for a break in traffic in order to squeeze back into the stream of traffic after having pulled out of the traffic stream for a stop.

The bus passenger's situation in such a case is quite frustrating and most unpleasant, especially if he is standing, as is often the case in peak-hour bus trips. With such an unpleasant ride by bus, the person who makes a peak-hour trip is thereby encouraged to make his trip by automobile if at all possible. By automobile the trip is faster, more comfortable, and generally more pleasant.[1] Hence, no matter what the transit service is like, the peak-hour trip by automobile offers a rather high level of service with a number of amenity factors. In order to attract the desired number of peak-hour person-trips to transit, then transit must be attractive enough to compete with the automobile and its high level of attraction.

Factors which Affect the Ridership Appeal of Transit

Factors which affect the attractiveness of transit can be classified as follows:

I. Convenience

- A. Speed
  - 1. Operating channel separate from automobile traffic
  - 2. Frequency of service
- B. Location of routes and stops
- C. Manner of collecting payment

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[1]Werner W. Schroeder. Metropolitan Transit Research Study. Chicago: Chicago Transit Authority, 1954-56. pp. 53-55.

1. Means of collection

2. Revenue sources

II. Comfort

A. Absence of crowding

B. Availability of seats and degree of comfort in their design

C. Smoothness of ride

D. Noise level

E. Air-conditioning

III. Prestige

IV. Cost

Although speed is classified here as a sub-factor of convenience, it is so important that frequently it is classified as an independent factor. It seems to the author, though, that it is better to say that the factor with the greatest power to attract riders to transit is convenience; the sub-factor with the greatest attracting power is speed. In order to have adequate speed, transit must travel over a channel separated from automobile-traffic channels, thereby unaffected by traffic congestion. When so separated from automobile traffic, transit is able to offset the slowing effects of having to stop to receive and discharge passengers through not having to stop with automobile traffic. Although the separate channel can be separate lanes for busses, it usually is a railway of some sort. Because a separate channel involves extra initial expenditure, relatively high passenger-traffic densities are required in order to make construction of the separate channel feasible.

Another sub-factor of convenience which affects speed is frequency of service, commonly known as headway. Since waiting time is part of travel time, if the interval between transit vehicles is kept at a minimum, travel time is also kept at a minimum to the extent that waiting time enters into it. Frequent service requires a high passenger-traffic density.

Convenient location is another sub-factor of convenience which affects travel time. Consequently, the locations of the separate channels and of transit routes in general are important. If they are poorly placed, they will not attract passengers in the volumes for which they have the potential to attract otherwise. While price levels seem to have little effect on the attracting power of transit,[1] the manner in which the fares are collected strongly affects convenience. Payment for transit is usually about as inconvenient and painful as possible, usually coming in small dribbles requiring small change. In contrast, payment for the automobile is about as painless as possible, with large amounts paid infrequently, usually not directly tied to a trip, except for tolls and parking charges. Some progress has been made in transit payment procedures,[2] but so far it has been woefully inadequate in most cases.

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[1] Leon N. Moses and Harold F. Williamson. "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation." Journal of Political Economy. LXXI (June 1963), 247-264. See also Schroeder, pp. 77-85.

[2] Monthly commutation tickets are available by mail on some commuter railroads, and credit-card types of payment systems are planned for some rapid-transit and commuter-railroad systems. See: "Automatic Fare Collection," Now Under Construction: Rapid Transit for the Bay Area. San Francisco: Bay Area Rapid Transit District, 1963.

The factor which is secondary to convenience in attracting riders to transit is comfort. Sub-factors in comfort are absence of crowding, available and comfortable seats, smooth and quiet ride, air-conditioning, and the like.[1] When transit is non-air-conditioned and crowded with standees during the peak hours, the peak-hour traveler is thereby encouraged to drive his automobile if he can stand to battle the traffic. If the transit vehicle is a bus, as is usually the case, peak-hour travel is especially uncomfortable and unattractive, for the bus pulls repeatedly over to the curb, tilting at an ungainly angle because its right wheels are in the gutter, and then pulls sluggishly out into traffic again when a break in traffic occurs. Furthermore, the bus is crowded with standees and is inadequately ventilated, while exhaust fumes enter through the windows at the stops. Since such an unpleasant trip is also slower than the same trip by automobile, it is little wonder that many transit riders switch to the automobile when they first get a chance.

The factor third in importance is prestige. Prestige is dependent on human attitudes, and human attitudes toward transit are strongly dependent on the quality of service provided, generally as measured by the convenience and comfort factors described above. In most places transit suffers from a lack of prestige usually resulting from long-continued patterns of inconvenient and uncomfortable transit service.

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[1]Schroeder, p. 54.

In these places most people ride transit only when they have very little alternative. Transit can have prestige, though, e.g. Toronto, where even the wealthiest people ride the subway, often brought to the station in a chauffered limousine.

A factor of lesser importance is cost, which seems to affect mainly people of lower-income groups. As mentioned above, price levels seem to have relatively little influence on the attractiveness of transit, although lower fares do increase ridership slightly and higher fares reduce it somewhat.

Means of Increasing Transit Attractiveness

Possible ways to increase transit attractiveness are to provide the following:

1. Preferential treatment of transit in traffic. This may be accomplished by: preferential access to freeway on-ramps,[1] preferential right-of-way in rejoining a stream of traffic, or preferential right-of-way in intersections. Preferential treatment makes transit more attractive by increasing its speed, but its use has been quite limited so far because of difficulty in implementing it on a large scale.

2. Separate channels for transit vehicles. Separate channels separate transit from automobile traffic by providing either reserved lanes or streets from which automobiles are barred, or separate private right-of-way as presently used extensively

[1] J. R. Meyer, J. F. Kain, and M. Wohl. The Urban Transportation Problem. Cambridge; Harvard University Press, 1965. pp. 322-324. See also Fitch, p. 208.

for all forms of rail transit and used in certain locations for busses. By separating transit from automobile traffic, separate channels permit a greater increase in transit speed than does preferential treatment and are, therefore, more important as a means of enhancing transit attractiveness. In fact, separate channels are the most effective single means of enhancing transit attractiveness.[1]

3. Additional seats -- in order to reduce the number of standees to a minimum. Additional seats usually are provided by adding more vehicles to the route. With busses this means adding more bus runs to the route. With rail transit it can mean adding more runs or adding cars to existing runs or a combination of both.

4. Additional comfort factors (air-conditioning, more comfortable seats, smoother ride, and the like). An important comfort factor is some provision to avoid the tilting which occurs when a bus loads at the curb of a typical street wherein the right wheels are in or near the gutter. Means of avoiding such tilting include: island (safety-zone) loading, separate bus lanes physically separated from the other traffic lanes, level bus loading zones, compensating lateral suspension system (e.g. torsion bars), or replacement of busses by rail transit. The extent to which any of those means can be taken is quite limited.

5. More convenient service by re-routing where desirable. The

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[1]Fitch, p. 145.

most desirable type of routing is to provide direct service over the shortest possible route, but frequently densities of development are insufficient to support such a route unless feeder service is added. The alternative to feeder service is a longer and less direct route, which will be able to serve more territory along the way. Some situations are better served by a direct trunk route and feeder routes along the way. Other situations are served better by through one-seat service. Rail transit usually requires feeders as follows: heavy-duty rapid transit requires an extensive feeder service; light rapid transit can provide direct one-seat service to many areas, but it works best with a small feeder service.

6. Promotion. No matter what improvements are made in transit, they will not have full effectiveness if promotion is inadequate. Transit today has largely inadequate publicity, which is likely a factor contributing to the present low level of transit service and patronage. Promotion, however, is far from being everything, though, and it would be pointless to expend much effort to promote bad service.[1] However, it is common for existing service to have totally inadequate promotion, to the extent that most potential riders have no idea about the transit service in their areas.[2] Hence, some promotional effort is needed merely to maintain the status quo, and minor

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[1]Lewis M. Schneider. Marketing Urban Mass Transit. Boston: Harvard Business School, 1965. pp. 176-177.

[2]Schneider, pp. 180-181.

improvements should be fully utilized for their promotional value.

In formulating a promotion campaign for transit it will be necessary to utilize advertising techniques which have been demonstrated to be effective through experience with advertising for other products. The rational appeals used in past transit advertising have largely been ineffective, just as rational appeals generally have been ineffective in other advertising. Hence, the results of depth research must be utilized to produce an effective emotional appeal complete with an appropriate amount of hoopla and ballyhoo.

If well-paid advertising agencies can sell injurious and habit-forming items such as tobacco products and alcoholic beverages, they can certainly sell transit. The problem in the past has been that transit operating agencies have not been willing to pay for good advertising, and when a fairly good promotional campaign has been made, it has been an isolated campaign of limited duration and has not been tied into a program of continuing promotion. One reason for the lack in promotion is that transit operating agencies are too much product-oriented and not sufficiently market-oriented.[1]

The value of promotion can be demonstrated rather spectacularly through the example of the Skokie Swift, a highly successful new rapid-transit route operated by the Chicago Transit Authority. From its inception, the Skokie Swift has offered high speed, frequent service, and a convenient parking

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[1]Schneider, pp. 80-81, 180-181.

lot for park-and-ride, but what has really made it such a resounding success is a well managed, very generously funded promotional campaign which started promoting the Swift several months before service even started.[1] The result of such a promotional campaign has been nothing short of spectacular. It shows what can be done when a very attractive transit service is given excellent promotion.

The value of promotion has been demonstrated less spectacularly in other instances, for example (1) Santa Monica, California, where the transit operating agency has carried on a continued promotional campaign for many years, and (2) the Alameda-Contra Costa Transit District in Oakland-Berkeley, California, which has carried on a promotional campaign ever since it came into being around 1960 and has experienced a gradual rise in ridership over the years, while other transit operating agencies in the Bay Area generally have experienced a slight decrease in ridership during the same time.[2]

In order to increase the attractiveness of transit sufficiently that transit will handle as much peak-hour traffic as desired, it may be necessary to construct an elaborate rapid-transit system from scratch, as in the San Francisco Bay Area, or it may be sufficient to upgrade

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[1] Skokie Swift Progress Report (various issues). Chicago: Chicago Transit Authority, 1964-1966.

[2] Anthony R. Sloan. "The Marketing Effort of A.C. Transit," Traffic Quarterly, XIX (October 1965), 594-608. pp. 602-603.

existing transit systems, but in nearly every case a number of improvements will be necessary.

Financing of Urban Transportation

Taxes

Some parts of the urban transportation system are financed through public action with funds obtained from a variety of sources, e.g. real property taxes, special assessments, vehicle-weight taxes, weight-distance taxes, motor-fuel taxes, and the like. Types of public financing such as these separate the revenue collection from the actual trip-making. The advantages of such separation include lower cost of collection, greater convenience both to the payer and to the payee through payment of larger amounts at less frequent intervals, and a broader base of support because everyone pays, whether or not he makes direct use of the facilities. For example, the users of the Kennedy Expressway in Chicago pay only one-third of its capital cost and nothing toward its operation and maintenance.[1]

As a result, each individual decision whether or not to make a short automobile trip is not particularly an economic decision as the individual person sees it, and indeed, it has little direct effect on his overall economic situation; he pays his taxes painlessly when he buys motor fuel and at other times. Hence, he has no particular discouragement

[1]Ruth and Edward Brecher, "Getting to Work and Back, Part 2," Consumer Reports, XXX (March 1965). 128-133. pp. 129, 133.

against making the trip in order to avoid paying out the cost of the trip, for he hardly notices that he pays for it, whether it is a peak-hour trip or an off-peak trip.

Constraints on Peak-hour Travel

Financing through taxes and special assessments generally works without difficulty, but it offers no economic constraints on peak-hour travel. Hence, as such financing procedures presently operate, they do not operate to help improve peak-hour travel conditions. Although peak-hour traffic is quite expensive to accommodate, whether by transit or by automobile, it is considerably less expensive to society when handled by transit than when handled by automobile. Hence, if financing can be arranged to encourage peak-hour transit use and to discourage peak-hour automobile use, then financing can help to accommodate peak-hour traffic.

The usual methods proposed for arranging financing to help improve peak-hour travel conditions are (1) to place economic constraints on peak-hour automobile traffic and to institute means of transit financing which will make it possible to provide a level of transit service which will attract sufficient riders that the desired modal split (as discussed in terms of the model) will be achieved. The usual proposal for placing economic constraints on peak-hour automobile traffic is to put tolls onto certain trafficways during rush hours. The feasibility of tolls, though, is made doubtful by the problems which tolls create, particularly

(1) the cost of collection and (2) the general public hostility to tolls, particularly those on tax-supported roads. Furthermore, there is some question as to the deterrent value of a toll because the average peak-hour motorist considers cost of transportation to be a minor issue in determining his mode of travel. If he cared about saving money, he would go by transit in the first place (if his trip is of a type suited to transit). Hence, tolls do not offer a satisfactory system of constraints on peak-hour automobile traffic, and not much change in the present system of financing streets and roads is likely. A system of positive incentives to do something other than make a trip by automobile during the peak hours could be considered to be a system of indirect constraints, and it has a much better chance of being effective than a system of direct constraints has. These positive incentives for controlling peak-hour travel include manipulating the modal split through upgrading transit and spreading out the peak through staggered working hours, which have the effect of a better relative pricing system.

Financing of Transit

As discussed in Chapter One, the role of transit today has become one wherein its main functions are (1) to enable the transportation system to accommodate the necessary number of peak-hour person-trips by providing a certain percentage of them and (2) to serve those who cannot, should not, cannot afford to, or do not wish to drive.

Having lost much of its off-peak base traffic volume to the automobile, transit has been forced to curtail off-peak service in order to reduce costs. The off-peak ridership that remains is discouraged from going by transit because the off-peak rider must wait longer for a transit vehicle once he reaches the boarding point. Hence, an existing downward trend in off-peak riding has been reinforced by a spiral effect from the feedback between reduced service and would-be riders discouraged away from transit. The net result of the reduction in off-peak riding levels is to raise the levels of the peaks still higher with reference to the base period.

Peak-hour service is the most expensive kind to provide, and as transit becomes more and more a peak-hour operation, it becomes more and more expensive to operate per passenger carried. The high expense of operating with high peaks and a low base level of off-peak operation stems from two types of expense: labor and capital.

<u>Capital</u>: The amount of equipment needed for operation is determined by the amount required for peak-hour operation. All equipment which is unused during off-peak times (e.g. rolling stock) or which is used at only a fraction of capacity during off-peak times (e.g. way and structures) raises operating costs by tying down capital without giving adequate return on it. More equipment must be bought, while the amount of return is not increased. In fact, it may not be possible to cover the cost of the added equipment; the deficit may have to be met from another source, such as equipment which is fully

utilized and which recovers its own cost and brings a return. Much transit equipment is utilized about twenty hours per week for peak-hour service and lies idle at other times.

Labor: Peak-hour operation requires more employees to operate the vehicles (and to staff the cashiers' windows, where applicable). Although the transit operating agency would like to hire peak-hour employees for three or four hours in each of the two peak periods, the employees generally want to work a full eight-hour day in one piece, just like anyone else. Hence, the transit operating agency cannot attract sufficient personnel unless it hires them for workdays in one piece, and unions usually require that the employees be paid for eight hours even if they work less than that length of time. Hence, labor costs are, in effect, excessively high because productivity is low.

Hence, the transit operating agencies have been caught in a financial squeeze from which fare-box revenues have not been able to extricate them. The transit operating agencies have tried to make ends meet; they have raised fares repeatedly and tried to cut costs where possible, but the squeeze has continued unabated. Since peak traffic carried by transit saves the public very large sums which would otherwise have to be spent for increasing peak-hour vehicle capacity of streets, proposals have been made that part or all of the costs of providing transit service be provided by some of the indirect means used for maintaining streets and roads. Vested interests often oppose such proposals in the hopes that they can further their own interests through sub-optimization[1] of the road portion of the transportation system if present policies of neglecting transit are continued. Often, though, the opposition from vested interests has validity, because proposals for public financing of part of the costs of transit frequently are merely patches on top of an existing patchwork of financial operations which finance the transportation system.

Public assistance to transit has existed in some forms for a long time, notably in public construction of subways and other facilities.[2] When the city owns or builds transit facilities, it may charge rent, though. For example, while the Chicago Transit Authority pays rent to the City of Chicago for the use of the subways,[3] in New York the city pays the capital costs of the subway system: new cars, new track, new tunnels, and the like.[4] Hence, the New York City Transit Authority only has to recover operating costs from the farebox.

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[1]See definition of "sub-optimization," Appendix II.

[2]The Independent subway system in New York was financed by the city, as are new subways today. Both the Broad Street Subway in Philadelphia and Chicago's subways were built by their respective cities and are owned by them. See: Chicago's Mass Transportation System. Chicago: Chicago Transit Authority, 1959. pp. 7-8.

[3]The rent is $20,871,000 per year for a period of about thirty years. See: Chicago's Mass Transportation System. p. 8.

[4]New Horizons for Chicago Metropolitan Area. Chicago: Chicago Transit Authority, 1958. p. 9.

Many of the problems of financing transit result from a piecemeal treatment of transportation, which extends to financing. If transportation funds were pooled and then put to work where the needs are the greatest, then these problems would be eased. Various political machinations[1] could still take place with unified financing of transportation, but the potential for improvement under unification is greater than the potential without it, and with unification the net result will be improvement to one degree or another.

As discussed in Chapter One, the theoretical optimal system would be to finance urban transportation on a unified basis. Such a system, however, is probably not politically feasible. Hence, a desirable goal is to unify to a degree which is politically feasible, being sure that sufficient funds are available for adequate transit service as desired. This may involve use of motor-vehicle revenues, a very touchy issue with some very powerful vested interest groups. The use of certain motor-vehicle revenues can be made politically feasible by use of a rationale therefor which will obtain sufficient support, e.g. the use of money from tolls collected on the San Francisco-Oakland Bay Bridge to help finance the Transbay Tube of the Bay Area Rapid Transit District system.[2] Without

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[1]For example, the situation wherein the streets and roads in one part of a municipality are better maintained than elsewhere in it, or wherein one part is systematically neglected.

[2]The Composite Report: Bay Area Rapid Transit, May 1962. San Francisco: Parsons Brinckerhoff-Tudor-Bechtel, 1962. pp. 40, 46-48. See also Fitch, p. 87.

an adequate rationale, any program for using motor-vehicle revenues for transit improvements will be politically unfeasible.

This chapter has shown how transit can affect a transportation system and why transit generally is not permitted to reach a level even approaching its maximum effectiveness. Transit has the potential to affect a transportation system markedly in its capacity, its ability to accommodate peaks, its travel patterns, and its costs. Yet at present, transit is unable to reach a level of effectiveness even remotely approaching its potential because it has received only inadequate attention. Fragmented administration of the transportation system has brought sub-optimization of the transportation system with transit one of the neglected subsystems. Hence, the resulting situation is one of transit systems with financial resources inadequate to provide a level of service capable of having any noteworthy effects on the transportation system. With increased attention and financing, transit will be able to reach the general level of its potential to affect the urban transportation system and to take its place alongside the other subsystems serving the transportation system.

CHAPTER III

TRAFFIC EQUILIBRIUM

Development of the Concept

Traffic equilibrium is a concept which has received consideration only recently. It was developed after many traffic plans did not work out as anticipated.

At one time it was generally thought that peak-hour traffic congestion could be properly handled by a policy of determining the peak-hour vehicle flows, calculating the quantity of additional road facilities necessary to accommodate those flows, adding in certain growth factors according to predicted growth patterns, and building those facilities. As this policy was employed repeatedly in many locations, it was noticed that consistently the desired results were not obtained, even though population growth had occurred as predicted. Instead of handling the congestion as anticipated, the new facilities generally were soon flooded with more vehicles than ever and were just about as badly congested as the old system had been before the new facilities were built.

For quite a while, these events were interpreted as a sign that not enough new facilities had been built. Hence, it was advocated that more facilities be built so that a point could soon be reached wherein traffic would not continue to increase as soon as a new facility was opened. As time went on, though, and as the old pattern of continued congestion kept repeating itself as each new facility was opened, people began to wonder why and to wonder whether or not they had a correct concept of the situation.

Eventually the concept of equilibrium was applied to traffic congestion, thereby bringing forth the concept of traffic equilibrium. Just who originated the concept is not known, although it seems likely that many people thought of it independently at about the same time.[1] In 1962 Anthony Downs published an article in which he stated the concept succinctly concerning urban commuter expressways in a somewhat humorous vein patterned after Parkinson's Law.[2] The author of the article called it "Downs's Law of Peak-hour Traffic Congestion," Parkinson's Second Law adapted to traffic: "On urban commuter expressways, peak-hour traffic congestion rises to meet maximum capacity."[3]

An equilibrium level of peak-hour traffic congestion is obtained because: (1) Traffic congestion discourages automobile trips, while the lack of congestion encourages them. (2) Hence, increased congestion deters automobile trips, while

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[1]Without having read Downs's article, the author formulated a concept of traffic equilibrium independently in early 1963; it is reasonable to assume that other people have likewise formulated the concept independently.

[2]C. Northcote Parkinson, The Law and the Profits. Boston: Houghton Mifflin Company, 1960.

[3]Anthony Downs. "The Law of Peak-hour Expressway Congestion," Traffic Quarterly, XVI (July 1962). 393-409. p. 393.

reduced congestion encourages them; and additional trips are added to or subtracted from the total by the presence or absence of congestion until a condition of equilibrium is reached.

Effects of Traffic Equilibrium on Traffic Congestion

Reduced Peak-hour Congestion

At peak hours there is a very large potential demand for travel, much of which would go by automobile if it could. The potential demand is so great that it may as well be considered as unlimited in large metropolitan areas. Under the potential demand, whenever congestion is lessened slightly, more automobile trips are made. The reason for such a phenomenon is that reduced congestion converts automobile trips from potential to actual trips in sufficient numbers that congestion is increased to a level approximately the same as the old level.

Consequently, whenever a new traffic facility is opened, congestion drops for a short period, i.e. several days or weeks, until people adjust to it by making more peak-hour automobile trips. As people adjust, the level of congestion rises until it reaches an equilibrium level again, wherein congestion deters a number of drivers sufficient to prevent any further net increase in their numbers.

Increased Peak-hour Congestion

Conversely, when traffic congestion increases, some peak-hour trips which can be shifted to other times or to less congested destinations are so shifted; other trips are just not made; still others are not even considered; and if transit travel is not markedly slower than automobile travel or is not otherwise markedly inferior in attractiveness, some trips will be shifted from automobile to transit. Trips shifted from automobile to transit generally are shifted in greatest number to transit which operates in a channel separate from automobile traffic and is therefore free from delays caused by traffic congestion.

Comparison of Peak Hours to Off-peak Times

The types of trips important to traffic equilibrium and traffic congestion can be classified as follows; potential automobile trips, potential transit trips, actual automobile trips, and actual transit trips. Traffic congestion is produced by actual trips, of course, but potential trips determine whether a given measure will have any notable favorable effect on traffic congestion. Actual and potential transit trips are not given much concern herein because additional transit trips are rather easily accommodated in an existing street system, as explained in Chapter Two herein. Although a street system can easily accommodate additional transit trips, the transit operating agency may not be able to do so. This is the case particularly with additional peak-hour transit trips, for such trips place a strain on the already limited financial resources of transit operating agencies. Such trips are the most expensive type of trip for the transit operating agency to provide, for they require additional vehicles and employees. Hence, if transit is expected to take even heavier peak-hour loads than it does at present, it must have some financial assistance, probably from public funds. Public financial assistance to transit to permit it to take additional peak-hour riders is in the public interest because it would cost the public even more to accommodate the additional peak-hour person-trips by automobile.

In the peak hours potential automobile trips exceed actual automobile trips, whereas in off-peak times potential trips approximately equal actual trips. Such a situation exists because potential peak-hour trips greatly exceed potential off-peak trips; and if actual trips exceed street capacity, congestion results, and further increases in the number of actual trips are sharply restrained until additional drivers are deterred in sufficient number to prevent further increase in their number, at which point equilibrium is reached. Because the potential volume of off-peak trips is usually below street capacity, there is no congestion to deter off-peak trips, and all potential trips can become actual trips in most cases.

When potential and actual automobile trips are far below street capacity, even the potential trips are encouraged to increase. At certain times of day (e.g. the wee hours of the morning) hardly any increase occurs thereby, but at other times of day (e.g. midday and early evening) the increase in potential and actual off-peak automobile trips encouraged by excess street capacity is quite noticeable. Hence, traffic equilibrium operates even in the absence of congestion by encouraging additional off-peak automobile trips in proportion to the amount of excess in street capacity, except when special factors (e.g. majority sleeping hours) prevent it.

Whereas in off-peak times (1) actual trips are usually accommodated without congestion and (2) actual trips usually equal potential trips, in peak hours the potential number of automobile trips greatly exceeds street capacity, usually by many times over. Hence, the potential number of automobile trips cannot be accommodated by the street system, and actual trips must be controlled by some means. If they are not controlled by some other means, they will be controlled by congestion, which will establish an equilibrium level, as described above.

Traffic Equilibrium and Construction of New Facilities

New facilities, e.g. expressways, which increase the vehicle-carrying capacity of the street system alter the traffic patterns in the street system and the traffic volumes at which equilibrium is reached. For example, expressways frequently bring a lower level of peak-hour congestion on the thoroughfares which they parallel.[1] But although the peak-hour equilibrium level is altered, congestion remains essentially the same, for the potential automobile trips still greatly exceed street capacity, and many new automobile trips are attracted by the lessened congestion initially brought about by the new facility. Hence, peak-hour traffic congestion remains with

[1] Meyer, Kain, and Wohl. p. 361.

delays as noticeable as ever, but with larger traffic volumes and with the worst bottlenecks probably shifted.

Hence, the following conclusions can be made:

1. In fairly large metropolitan areas on any radial expressway peak-hour traffic volumes will almost always be at congestion levels, and although expressways may reduce overall commuting time, they will be clogged with traffic congestion every day during the peak hours.

2. Hence, in such areas it is impossible to build expressways with the capacity to carry peak-hour traffic without traffic congestion for the reasons stated above.

3. Since expressways cannot be designed with sufficient capacity to eliminate peak-hour traffic congestion, goals other than elimination of peak-hour congestion must be used in determining the capacity of each expressway. Traffic unhampered by congestion during off-peak hours can be a reasonable goal replacing impractical goals concerning elimination of peak-hour congestion.

4. In some conditions a new expressway may cause peak-hour traffic congestion to become actually worse than before the new expressway opened. This ordinarily occurs only where a sizeable per cent of the person-trips are made by separate-channel transit and nothing is done to improve separate-channel transit service when the expressway opens.

5. If traffic congestion is to be kept under control,[1] any expressway planning and construction program must be part of

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[1](A) prevented from worsening and (B) lessened at certain critical points.

an overall program which includes planning and construction of improvements in transit as well as comprehensive land-use patterns.[1] If this is not done, trouble can result, for as Mr. Downs says, "In particular, marked improvement of roads without any improvement in segregated-track transit may cause automobile traffic to get worse instead of better."[2]

6. Separate-channel transit has the capacity to alleviate peak-hour conditions, in fact a greater capacity to do so than expressways generally have. Hence, separate-channel transit must be built and existing separate-channel systems improved as the core of a program to alleviate peak-hour congestion.

Relationship of Traffic Equilibrium to Transit Peaking

At peak hours the potential automobile trips which do not become actual automobile trips can be: (1) diverted to other times or destinations, (2) just not made at all, or (3) converted into actual transit trips. It should be noted that some trips because of their nature can be made only be automobile and cannot be converted to actual transit trips. The more attractive the transit service is, the more trips will be diverted into actual transit trips. Transit also receives actual transit trips which have very little or no potential of going by automobile: captive riders and people who prefer not to drive.

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[1]Downs, pp. 408-409.

[2]Downs, p. 409.

Hence, transit receives both (1) transit trips with little or no potential for becoming automobile trips and (2) potential peak-hour automobile trips diverted to transit by traffic congestion resulting from street capacity insufficient to accommodate them. The number of each type of trip which transit receives is partially dependent on the attractiveness of the transit service. Transit trips of the former type occur in peaks, the highest volumes generally coinciding with rush-hour travel. Transit trips of the latter type occur only when potential automobile trips exceed street capacity, ordinarily only during peak hours, for when the potential number of automobile trips is less than street capacity, congestion is nonexistent, and all potential automobile trips can become actual automobile trips. Hence, transit trips occur with rather high peaks compared to off-peak volumes, for during off-peak times trips only of the former type occur, and those only in small numbers.

Transit peaking is considerably greater than the peaking in automobile traffic because of the operation of traffic equilibrium as follows: (1) Traffic congestion prevents automobile peaks from reaching their potential heights, while diverting potential automobile trips to actual transit trips. This reduces peak-hour automobile traffic volumes, while increasing peak-hour transit volumes. (2) Excess street capacity over potential automobile trips encourages additional automobile trips and diversion of actual transit trips to actual automobile trips over time. Hence, this helps to maintain and increase off-peak automobile traffic levels, while reducing the number of off-peak transit trips.

The tendency toward transit peaking is increased when street capacity is increased, e.g. by construction of an expressway. When street capacity is increased, street capacity exceeds off-peak potential automobile trips by greater volumes than previously. The greater the excess capacity, the greater the encouragement of additional automobile trips. Although transit vehicles generally run at greater speeds in off-peak times as a result of excess capacity, their attractiveness is not sufficiently enhanced by the excess capacity to compete effectively with the automobile for most off-peak trips. In fact, the excess capacity works to divert actual transit trips to actual automobile trips. Hence, off-peak transit volumes decline.

Increased street capacity lowers the peak-hour transit volume slightly by reducing the excess of potential automobile trips over street capacity slightly, but it increases transit peaking because peaking is measured by comparing peak levels with off-peak levels, and off-peak transit volumes suffer a much greater reduction from increased street capacity than do peak-hour transit volumes. Hence, when street capacity is increased, transit peaking becomes greater.

Transit peaking causes operating costs to be higher than they would be otherwise; and the greater the peaking, the higher the operating costs. Unless a deficit can be tolerated, costs must be cut when transit peaking increases. Usually the only available means for cutting costs are to reduce service and to reduce the quality of service, for other possible means of cutting costs ordinarily have already been utilized to their maximum.

Cuts in service reduce the attractiveness of transit and tend to discourage transit riding in general still further. Cuts in service can encourage ill will toward the transit operating agency, thereby making it more difficult to get public support for measures to help the operating agency when it asks for help. Consequently, transit peaking can cause a series of events with a feedback which causes a downward spiral of reduced transit service, reduced transit riding, raised transit fares, and public demand for additional increases in street capacity. Then the additional increases in street capacity will give more feedback by causing greater transit peaking. Such spirals result in eventual abandonments of transit service in many places, greater amounts of land and money devoted to transportation and storage of vehicles than would have been needed if such a spiral had been prevented in the first place, increased air pollution, and the like.

When the principle of traffic equilibrium is properly understood, it can be applied to actual situations to help to attain whatever results are desired. Hence, if a spiral such as was described above is considered undesirable, the concept of traffic equilibrium can be employed to develop measures to prevent such a spiral from taking place or to keep it limited in scope.

Effects of Transit on Traffic Equilibrium

Traffic equilibrium operates independently and inexorably, whether it is desired or not, no matter how many trips are made by transit and how many by automobile. However, other factors, e.g. the modal split between transit and automobile, still affect traffic conditions, although the actual effects result through the operation of traffic equilibrium as well. Hence, through an understanding of traffic equilibrium and how it works, transit can be utilized to affect traffic conditions through traffic equilibrium and through the ability of transit to alter the person-carrying capacity of the street system, as explained in Chapter Two herein.

If transit is made sufficiently attractive to attract nearly all the potential automobile trips which can be converted to actual transit trips instead of actual automobile trips, it can permit a given street system to accommodate many more person-trips than is generally now the case. The most important means of enhancing transit attractiveness is transit operation in separate channels, which when instituted, removes transit vehicles from automobile traffic, allowing the automobile traffic to flow more smoothly as a result; but even more important, the transit vehicles in the separate channels are not impeded by traffic congestion in the automobile channels. For transit to have much effect on traffic through the operation of traffic equilibrium, it must have a separate channel in which to operate so that it need not compete with automobiles for operating space. Because separate-channel transit offers speed and an alternative to traffic congestion, it can attract large numbers of riders away from paralleling thoroughfares.

As potential automobile trips (including some which have been actual automobile trips) are converted into actual transit trips, more person-trips are carried by transit, and more space is available in the street system to carry more actual automobile trips. Traffic equilibrium then operates in this situation as follows: As former automobile drivers and passengers are attracted to the separate-channel transit, additional space becomes available on the paralleling thoroughfares, just as when a new expressway opens. Then as the thoroughfares become less congested at peak hours, more automobile trips are induced over them. Hence, through the operation of traffic equilibrium street traffic congestion remains at about the same level as before, although the duration of the peak may be shortened somewhat. The major difference that separate-channel transit makes is that more person-trips are now accommodated by the transportation system, and fewer person-trips are now deterred by congestion, for many of those which can be converted to transit trips are so converted and more space is left available for person-trips which can occur only as automobile trips for various reasons. Hence, the greater the number of riders attracted to the separate-channel transit, the greater will be the number of new automobile trips which can be accommodated over the paralleling thoroughfares without increasing the vehicle capacity of the thoroughfares.

In the process the transit riders will be able to proceed unimpeded by traffic congestion, whereas if an expressway had been built instead, it would have been congested at peak hours while carrying a much lower number of person-trips than that which the separate-channel transit can carry comfortably.

Hence, with separate-channel transit many more people are permitted to make trips at peak hours, and of those who make the trip, large numbers are able to make it via congestion-free means, i.e. separate-channel transit. Except for people who must make the trip by automobile, separate-channel transit makes it possible for people who make peak-hour trips to have a real choice between going by automobile and going by transit. Some people whose trips can take place by transit will still choose to go by automobile, but the only people still forced to buck peak-hour traffic congestion will be those for whom the nature of their trip requires that they use an automobile. In contrast, a trip by transit today is generally so grossly inferior to a trip by automobile that in most cases no one has a real choice between going by automobile or by transit.

In most respects the effect of a transit channel is much the same as that of a new expressway, but the transit channel can increase effective street capacity much more than a new expressway can, while much less land and money are required for the transit channel than for the expressway. Because of their much greater ability than that of expressways to increase street capacity, transit channels can have a marked effect on the peak-hour traffic on paralleling thoroughfares, although as described above, the peak traffic volumes will remain about the same, even though the distribution of types of trips among the vehicles on those thoroughfares would be different.

In this chapter we have seen that the concept of traffic equilibrium helps one to understand some of the phenomena of traffic patterns which he would not understand properly otherwise. With a proper understanding of traffic patterns, measures can be taken to alleviate problems which exist therein. Hence, the concept of traffic equilibrium must be utilized in planning for transportation if that planning is to reach a level of effectiveness approaching its potential.

CHAPTER IV

TRANSIT AND LAND USE

Relationship of Urban Transportation to Urban Spatial Design

It is generally accepted that land use and transportation are interrelated. Transit can affect transportation in various ways, as shown in Chapters Two and Three herein. Hence, transit can affect the relationship between transportation and land use. Likewise, transportation and spatial design are interrelated, and transit can have considerable influence on that relationship. Transit can affect urban spatial design and be affected by it in some of the following ways.

Transit is related to the density of urban development. Since high passenger-traffic densities are required for fast and frequent service, high densities of urban development encourage good transit service, while low densities discourage it. And conversely, lack of good transit service tends to encourage low-density development, while good transit service can stimulate high-density development.

Rapid-transit Land Booms

The ability of good transit service to stimulate urban development has been demonstrated in cases wherein new rapid-transit lines have been opened. Such new rapid-transit lines have stimulated construction booms and the concomitant increase in property values along their routes. Particularly notable classic examples of such construction booms have been the Queens Boulevard line of the Independent Subway in New York City and the Yonge Street Subway in Toronto. Both these subways stimulated a sharp increase in property values along the route; and a building boom of upper-income high-rise apartment buildings and other structures followed the rise in property values.

There has been some question concerning the actual significance of the rise in land values along the route, though, for

> even though land values rise along a new transportation route, the increase may not constitute a new increment to the city's total land values, relative to what otherwise would have occurred. There is some question, for example, as to whether the enhancement of values along Yonge Street in Toronto constituted a net addition to total property values in Toronto, or whether it represented the concentration in one area of property-value increases which might have occurred elsewhere, or would have been spread over a wider area if the rail-transit line had not been built. Was the transit line a catalyst which made possible the realization of potential values that would not otherwise have developed, or did it simply produce a reallocation and concentration of values in one particular section?[1]

A shift in the spatial distribution of property values has been noted in another instance: When the subways were built in New York, people who formerly had had to live on the Lower East Side of Manhattan were enabled to live in the other boroughs. At that time land values in the other boroughs increased, while land values on the Lower East Side declined

[1]Fitch, p. 114.

as the population densities declined. Hence, the increase in property values in Toronto may be merely a shift from other locations, or it may be a net addition to total property values over what would exist if the subway had not been built. In considering this question the planner must have his values and goals concerning the urban spatial pattern well in mind.

In addition to the examples mentioned above, there are a number of more recent examples. The land boom along the Yonge Street Subway caught many people by surprise, but in doing so, it created such a sensation that it was publicized more widely than it might have been otherwise. Hence, both in Toronto and elsewhere people sat up and took notice of the experience with the Yonge Street Subway,[1] and they have expected such land booms in conjunction with more recent rapid-transit construction.

For example, people knew what to expect with the recently opened Bloor-Danforth Subway in Toronto. Once the route was chosen for the east-west subway, property values along the route began to climb. Once construction on the subway started, property values skyrocketed, and a building boom began. The building boom along the Bloor-Danforth Subway is now in full swing; and the building boom along the Yonge Street Subway is still continuing, although at a slackened pace.[2]

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[1]One of many articles which has mentioned the land boom along Yonge Street is, "Toronto: How One City is Working Out Mass Transit," U.S. News and World Report. LVI (June 22, 1964). 68-69.

[2]"Toronto's Unfinished Subway Already Generates New Money," Financial Post. LIX (March 20, 1965). 18.

Likewise, Montreal is experiencing a land boom along the routes of its new subway system scheduled to open sometime in 1966 or 1967.[1] Montreal's plans for its subway include developing the land over the subway stations and in other parcels acquired by the city for subway construction.[2]

In the San Francisco Bay Area and in the Camden, New Jersey, area, property values are increasing along the rapid-transit lines now under construction, and people consider the location of the new rapid-transit lines and stations when buying property there. Furthermore, in recognition of the changes in land-use patterns brought about by transit, the Skokie Swift demonstration project included many studies concerning land use in the area served.

Use of Transit to Stimulate Land Development

Transit can be used to stimulate new urban development. In the past the usual procedure was to extend a transit route out into a new area when it was first opened for development. Usually this involved merely extending existing routes or instituting feeder bus service, but occasionally it involved instituting a very elaborate service such as the Shaker Heights Rapid Transit, a light rapid transit service.

As time went on and the automobile came into wider use, the practice of extending transit service into developing areas

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[1]"Rapid Transit Pays for Itself in Many Ways," Financial Post. LIX (March 20, 1965). 17-18.

[2]2,000,000 People in Your Own Basement: Building Rights over Metro Sites. Montreal: City of Montreal. Undated (1965?).

to help stimulate development was generally discontinued, and the pattern became one of developing new neighborhoods with no thought concerning transit service. Once an area was developed, if the transit operating agency saw fit to extend service to the new area, the developer was pleased, but if no such service was extended, he usually had no particular complaints.

Since no transit service operated to the area when the people moved in, they had to get along without transit service from the beginning, although some or many of them may have complained about the lack of transit service. Hence, if the transit operating agency instituted transit service once all the residents had moved into the neighborhood, it found that although the people had asked for the service, very few of them actually rode it very often, for they had adapted their living habits to enable them to get along without transit; so when transit service was instituted, passenger volumes were low. Thr result of such a situation was that transit service to the area either was discontinued or was continued at a level of infrequent service, perhaps only during rush hours, or perhaps hourly with no service evenings, Sundays, and holidays. With service so infrequent, it is little wonder that usually the only people who rode transit from such new neighborhoods were those who could not go by automobile on that trip for one reason or another.

In recent years the situation described above has been nearly universal, for governmental financing policies since the end of World War II have encouraged low-density residential construction on the periphery of urban areas, while giving virtually no encouragement to transit. Low-density peripheral residential areas are rather difficult to serve with transit, and when transit service is not extended to an area until nearly all the houses are occupied, it becomes nearly impossible to provide transit service other than the minimal amounts described above. Perhaps the reason for a lack of transit service in developing areas could be ascribed to inferior transit management, but in most cases the transit operating agencies have been placed in such a financial squeeze that there has been virtually no other alternative. Operating new routes through developing neighborhoods means temporary financial losses for the transit operating agency, and most agencies are in too precarious a financial position to take a temporary loss such as that. As a result, once a neighborhood has reached the density necessary to support a transit route, its travel patterns will be well established by automobile, and transit cannot break into the market effectively.[1]

Considerable feedback exists in the process described above, for a shift from transit to the automobile encourages additional low-density peripheral development, with commercial and industrial establishments joining the residences there. Hence, a shift to the automobile and a dispersion of urban functions reinforce each other. The result is the sprawling

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[1] Fitch, p. 42.

development which is widespread today.

In the future it is likely that urban growth will continue at a rapid pace. If present trends are continued, our open space will be taken for urban uses at an alarming rate, and it will be difficult to preserve sufficient open space. If we are to retain sufficient open space for recreation, esthetics, agriculture, and the like, we must utilize our land more carefully and efficiently, i.e. developing at higher densities with more ordered patterns. Such development will require provision for transit service at sufficiently high levels to be attractive enough to attract nearly all trips suited to transit. Such development will have to provide for separate channels for transit where useful and for extensions of transit routes into new areas when they are first opened to prospective buyers or tenants. In order to utilize transit in such a manner to affect urban spatial design, it will be necessary to provide public assistance to make transit service possible in new areas and to provide the separate channels for transit. This can be provided through a number of ways, e.g. (1) direct expenditure, or (2) an addition to the subdivision regulations requiring that the developer pay a share of the cost of providing the separate transit channel to serve his subdivision and that he pay for providing an adequate level of transit service until the dwellings are occupied. Precisely how it is provided is beyond the scope of this paper.

<u>Transportation and Variations in Spatial Design</u>

Spatial design may be varied in order to achieve various transportation goals. On the surface it seems logical that traffic congestion can be lessened by dispersing urban development at lower densities; it seems that congestion will be lessened thereby because peak-hour trips are spread out over a larger area, and no large concentrations of activity exist, those concentrations which do exist being limited in size and separated from each other by distance.

However, traffic congestion will occur with such a dispersed pattern, just as with a more concentrated pattern, for such a spreading out requires that the places of residence be farther from the people's various destinations, e.g. work, shopping, recreation. Consequently, in order to make use of a variety of destinations, people will make more and longer trips, for they will not be satisfied with the small-town scope of choice of types of jobs and services which they can get within a short distance from their homes. Furthermore, such a pattern would make traffic congestion more difficult to deal with because it is more difficult to provide adequate transit service to low-density areas. Hence, more and longer trips would be made on the arterial streets, and a larger portion of the trips would be made by automobile. In the end, such an attempt is self-defeating. In addition, such a pattern is more difficult and expensive to serve with other utilities and services: water, sewer, electricity, gas, refuse collection, and police and fire protection. Hence, if the goal is to alleviate or eliminate traffic congestion, opportunities for success are considerably greater with a concentrated, high-density spatial pattern than with a dispersed, low-density pattern.

Because of the nature of urban spatial design and our social customs, the travel patterns in our urban areas have daily high peak periods. Attempts have been made to spread out the peaks over a longer period of time, but without much success. In order to bring many people together where they can have easy face-to-face contact, there must be major nuclei. If there are major nuclei, there will be a peak-hour traffic pattern which will have a unidirectional character if one nucleus greatly dominates all the others as a place of employment. Transit and urban spatial design can be utilized to lessen the adverse impact of peak-hour traffic volumes.

Transit permits major urban centers, i.e. major nuclei such as central business districts, to exist by permitting the economy in land necessary for such concentration of functions by requiring only a small amount of land for transportation compared to that required by the automobile.

Transit and Blight

Technological Considerations and Blight

All transportation facilities produce annoyances, e.g. noise, vibration, dirt, and exhaust, whether the facility is a road or expressway, a rail facility, a waterway, or air transportation.

Transportation facilities located above grade block the view and depending upon the design, can block out some light from places beside them. Transportation facilities on bridges and bridge-like structures make more noise than otherwise through the reverberations of the bridge, unless means are taken to dampen the reverberations. Bridges and bridge-like structures over streets block out light on the street below. If the structure is merely a bridge crossing the street, the portion of the street affected is minimal, but if it is an elevated structure following the street for some distance, it can have a distinct blighting influence. The degree of the blighting influence will depend on the noise level and the esthetic design of the structure.

Such elevated structures over streets have been built for rail rapid transit and other rail lines in past decades. But the knowledge gained in the past about the blighting influence of such structures has frequently been discarded recently when it has come to building expressways, for many elevated expressways which have been built are just as blighting an influence on the surrounding area as the elevated rail lines which were built several decades earlier.

In New York, Boston, and Philadelphia numerous elevated rapid-transit lines were built many decades ago. Most of these were built over streets and apparently caused considerable blighting of the areas through which they went. Considerable public opposition to elevated rapid transit developed thereby; some of the elevateds have been torn down as a result, some replaced by subways and some not replaced at all.

In contrast, in Chicago most of the elevated rapid-transit lines were built over alleys and over special rights-of-way. In this manner only a very small portion of the Chicago elevated system was built over streets. Usually the elevated rapid-transit lines in Chicago are located about half a block from a major thoroughfare. Hence, these elevated lines provide the advantages of serving the thoroughfare without being a blighting influence to it.

These elevateds spoken of in the East and in Chicago were built around the time of the turn of the century without any sound-dampening provisions and with old types of construction methods requiring a very ponderous structure. Since that time many new types of construction have become available utilizing high-strength materials which require smaller and fewer supporting columns. Furthermore, sound-deadening materials can easily be incorporated both in the cars and in the elevated structures built today. It should be noted that some of the Chicago elevated lines are built on elevated embankments instead of elevated bridge-like structures. The embankments embody one important item of sound-deadening construction: ballasted track. All recent construction of elevated portions of the Chicago system employs a concrete structure with ballasted track, thereby incorporating the advantages of the embankment without obstructing movement beneath it to the extent that an embankment does.

In observing the neighborhoods through which the elevated lines pass in Chicago, the author has noted no particular blight associated with the elevated lines. Generally where elevated lines pass through blighted areas, the areas have become blighted independently of the elevated lines. The author's observations indicate that there is only one place in Chicago where there might be some question as to whether an elevated line was a factor contributing to blight in the area, and that place involves a line which runs over a street.[1]

Hence, the author has concluded the following:

1. Elevated rapid transit can be a blighting influence, but it is only one of many such influences, and a relatively minor one at that.

2. Elevateds provide a blighting influence only when they are located over streets.

3. The degree of their blighting influence depends on the noise level and the esthetic design of the elevated structure.

4. The blighting influence can be negated by other factors. If the other factors are sufficiently strong, they can upgrade an area where an elevated operates over a street.

An example of blighting influence negated by other factors is found on Chicago's Loop, the elevated line over streets in the central business district. On most of the Loop the general conditions of the streets under the elevated reflect the conditions of the surrounding area. This becomes particularly apparent on Wabash Avenue between Adams and Lake Streets, where

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[1]Lake Street in the general vicinity of Cicero Avenue (4800 West).

it is a major shopping street located between the main shopping street (State Street) and the fashionable facade (Michigan Avenue) overlooking the lakefront park. Wabash Avenue has four traffic lanes and wide sidewalks. Over the two middle traffic lanes is located a two-track elevated structure. The elevated structure permits light to reach the sidewalks and the outer portions of the street with little or no obstruction. In recent years the girders and columns of the elevated structure have been painted a light color to enhance its appearance, and small pots of plastic flowers have been hung from the lampposts. Some new rapid-transit cars have been placed in service on the Loop. They have lowered the noise level somewhat. Many fashionable stores are located on Wabash Avenue, and in general the atmosphere of Wabash Avenue is pleasant and far from anything resembling blight. Admittedly, the elevated structure could be more pleasant-looking than it is, and it could be reconstructed with sound-dampening provisions, but no blighting influence is evident with the situation as it is now. Instead, the elevated structure seems to help to give a distinctive character and atmosphere to Wabash Avenue.

It should be noted that rapid transit built on the surface of the ground or in an open cut apparently has no blighting influence. The most notable example demonstrating this factor is Toronto's Yonge Street Subway north of Bloor Street, which is on the surface and in open cut. If anything, the land boom along the subway has stimulated more construction of high-income, high-rise apartment buildings and other fancy buildings along the surface and open-cut sections than along the underground sections.

Blight and the Presence or Absence of Transit Service

Good transit is an amenity factor which, along with other factors, can counteract blight. This aspect of transit is demonstrated in the following examples.

Toronto: Any tendency toward blight near the subway routes in Toronto has been reversed by the construction booms along the subway routes.

Castle Shannon: Castle Shannon is a small community about six miles directly south of downtown Pittsburgh. Until about 1954 Castle Shannon was a blighted ex-coal-mining town. Between 1954 and 1963 Castle Shannon became a pleasant middle-class center in a suburban area of middle-class and upper-middle-class development. While the planner spends much time considering blight, its causes, and the means to prevent it, he rarely encounters a situation where the reverse of blight occurs. Yet, this is exactly what happened in Castle Shannon.

From 1945 to 1954 much middle-class and upper-middle-class residential development oriented toward downtown Pittsburgh took place in the area to the south. Development occurred in all directions from Castle Shannon, but it always avoided Castle Shannon and was always separated from Castle Shannon by some space, an unplanned "greenbelt," as it were.

Around 1954 about all the vacant land which was easily accessible to downtown Pittsburgh in the area to the south was developed except for Castle Shannon and the "greenbelt" surrounding it. Once additional readily accessible vacant land was no longer available in the area, residential development began to encroach on Castle Shannon's "greenbelt." In a few years new residential development enveloped Castle Shannon, and middle-income people moved into the town itself, rehabilitating the structures there as they came. By 1963 the transformation was essentially complete; Castle Shannon had become "de-blighted."

In the Pittsburgh area separate-channel transit has existed in many directions on various routes. In all directions except for directly south, separate-channel transit was provided by commuter train, while to the south the separate-channel transit was provided by streetcars on private right-of-way. The difference in type of service resulted from formidable terrain barriers to the south which prevented commuter service from being provided there. Eventually Pittsburgh Railways Company built elaborate private right-of-way streetcar routes over trestles and through a tunnel to reach the area to the south. The historical relationships of these two types of separate-channel transit in the Pittsburgh area follow the national trend: Commuter service started long before the private-right-of-way streetcar routes to the south were built, and the commuter service has since been abandoned except for infrequent service on one route.

Castle Shannon is located directly to the south on a high-speed trolley route which is entirely on private right-of-way except for its loop downtown. During the time when

Pittsburgh commuter service was considerable, the high-speed trolley line to Castle Shannon was nothing outstanding in comparison. But once the commuter service was all but abandoned, the transit service to Castle Shannon became superior to all other transit service in the Pittsburgh area except for a route through an already built-up area paralleling the route to Castle Shannon.[1]

Peripheral development in some parts of the Pittsburgh area has not been particularly oriented toward the downtown area, but the development of the area directly to the south has been quite downtown-oriented. Hence, good transit has been particularly attractive for residential development in the area to the south.

Because of the general virtual abandonment of commuter service, the only separate-channel transit with frequent service remaining in the Pittsburgh area by 1950 was that provided by the high-speed trolleys to the south. Hence, by the 1950's Castle Shannon had superior transit service and was surrounded by middle-class and upper-middle-class downtown-oriented residential development. Therefore, Castle Shannon had a very desirable location; once demand for the location became sufficient, its blighted character was no longer able

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[1]The high-speed trolley route continues a mile beyond Castle Shannon, where it splits into two routes, Shannon-Drake and Shannon-Library, which continue about three and five miles beyond the junction respectively, both of them through post-1945 upper-middle-class residential development from Castle Shannon to their terminals. The paralleling private-right-of-way streetcar route is #42/38-Mt. Lebanon via Beechview; it operates in streets in two relatively short sections.

to repel development, and the development "de-blighted" Castle Shannon.

Just as the factor of having superior transit can counteract blighting factors, the lack of adequate transit can be a blighting factor as in the following example.

Watts: Watts is a section of Los Angeles which gained nationwide notoriety in 1965 because of a protracted spell of highly destructive rioting bordering on anarchy. Watts is a non-white slum area which has been blighted for many years, in which despair finally welled up sufficiently to spark the 1965 rioting. Most of the residents of Watts are too poor to own automobiles, a factor which rather seriously restricts the area in which they can move about, for transit service in the Los Angeles area has gradually deteriorated to the point that the transit service available to Watts is probably the worst transit available to any big-city slum in the United States. At one time there were high-speed private-right-of-way trolley routes serving the area. Fortunately for the residents of Watts, the high-speed trolley route which was retained the longest was the one which connected Long Beach and downtown Los Angeles via Watts, but unfortunately, that route was abandoned in 1961, and the bus service which replaced it is considerably inferior as far as service to Watts is concerned.

The Governor's Commission investigating the Watts riots stated the following in their report:

> Our investigation has brought into clear focus the fact that the inadequate and costly public transportation currently existing throughout the Los Angeles area seriously restricts the residents of

> the disadvantaged areas such as south central Los Angeles. This lack of adequate transportation handicaps them in seeking and holding jobs, attending schools, shopping, and in fulfilling other needs. It has had a major influence in creating a sense of isolation, with its resultant frustrations, among the residents of south central Los Angeles, particularly the Watts area.[1]

The context in which the Watts transit situation exists is described by Norman Beckman as follows:

> The Commission found that the coverage and frequency of bus service in the Watts area, although comparable to the service throughout Los Angeles, was both inadequate and costly. Research uncovered the fact that Los Angeles is the only major metropolitan area in the United States that does not either directly or indirectly subsidize the operating losses of its public transportation. A major recommendation in the December 1965 report of the Governor's Commission is that the existing small transportation companies in the area be consolidated under the existing rapid transit district in the area and that a public subsidy be given to the transit district to provide a satisfactory bus transportation system throughout the entire metropolitan area.[2]

Hence, although the lack of adequate transit service is not sufficiently strong as a blighting factor to be the main cause of blight, it can definitely be a contributing factor, serving to make blight worse where it already exists and helping to make minor amounts of blight appear where it would not otherwise be noticeable.

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[1] Violence in the City -- An End or a Beginning? Sacramento: California Governor's Commission on the Los Angeles Riots. December 2, 1965. p. 65.

[2] Norman Beckman. "Impact of the Transportation Planning Process," Traffic Quarterly. XX (April 1966). 159-173. pp. 162-163.

This chapter has shown some of the relationships of transit to land use. In doing so, it has shown how transit can be a useful tool to the planner in achieving desired land-use patterns, obtaining an orderly development of new urban land, and combatting blight.

CHAPTER V

TRANSIT AND SOCIAL ASPECTS OF TRANSPORTATION

Social Costs Resulting from Excessive Reliance on the Automobile for Urban Transportation

It is frequently said that our urban transportation systems rely excessively upon the automobile for functions which would be better handled with a greater reliance on transit. Such an excessive reliance on the automobile presents a number of problems, of which some are discussed below.

Urban automobile traffic suffers from a high and rising rate of accidents. Automobile travel has a higher accident rate than any other mode of transportation, and the urban automobile accident rate has risen much more rapidly in recent years than the rate for other automobile travel.[1] The high automobile accident rate results partially from the great number of individual vehicles, mostly driven by amateurs, some of whom do not keep their vehicles in satisfactory operating condition, and some of whom should not be driving at that time in the first place for one reason or another, e.g. fatigue, influence of drugs (particularly alcohol), general driving incompetence, or physical or mental disorders.[2]

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[1]"Keep Moving Please," Journal of American Insurance. XL (May 1964), 18-19.

[2]George M. Smerk. Urban Transportation: The Federal Role. Bloomington: Indiana University Press, 1965. p. 184.

The automobile accident situation is compounded because many people who should not be permitted to drive are allowed to have driver's licenses because it would work considerable hardship on them if they were not permitted to drive. The great hardship frequently stems from the deterioration of transit which has taken place as a result of the excessive reliance on the automobile whereby the automobile has become the only way of getting around in many areas.[1]

The deterioration of transit service mentioned above hurts non-drivers, who constitute approximately one-third of the population, and encourages increased amounts of driving by encouraging all who can drive to do so whether or not they really want to. As mentioned above, it also increases accident hazards by encouraging driver-licensing agencies to be very lenient with licensing requirements.[2]

Excessive reliance on the automobile and an attitude of concern only for accommodating the automobile have frequently resulted in careless expressway construction policies. Of course, excessive reliance on the automobile does not necessarily bring such careless policies, but the situation does lend itself to such policies. Careless freeway construction policies give rise to social problems such as those described below.

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[1]Ruth and Edward Brecher. "Getting to Work and Back, Part 1," Consumer Reports. XXX (February 1965). 56-65. p. 60.

[2]Brecher (Part 1). p. 60.

Public and semi-public properties not normally available for sale frequently have been condemned for expressway rights-of-way at less than the full cost of replacing the values to the general welfare destroyed by such condemnation. As a result, eminent domain has sometimes resulted in a less valuable use replacing a more valuable use.[1] A common error is to treat land which is already publicly owned as costless, e.g. park land. As a result, parks and historic landmarks frequently have been made victims of freeway construction.[2]

Freeway construction policies have frequently chosen routes which cut up neighborhoods and routes which require the uprooting of many people. The social costs of such routing policies can be considered to be virtually incalculable, as shown in the following example: A transportation plan for Washington, D.C. with a heavy emphasis on highways would have required displacing 33,000 people, within the District of Columbia alone, or one out of every twenty-two residents of the District, whereas an alternative plan to accommodate the same travel demand -- but with greater emphasis on rapid transit -- would require the displacement of only 5400 people. Furthermore, many of the 33,000 people who would have been displaced would have been from low-income groups, particularly low-income Non-whites, for whom housing is already in short supply. Fortunately, the plan requiring the displacement of 5400 people is the one

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[1] Developing Metropolitan Transportation Policies. pp. 43-44.

[2] Brecher (Part 1), p. 61. See also Fitch, p. 120.

which was recommended by the National Capital Transportation Agency.[1]

Air pollution, generally recognized as a health hazard, is a problem of considerable magnitude in many cities. A sizeable portion of the air pollution present in large cities comes from motor-vehicle exhausts, e.g. roughly 40% in New York City and 65-70% in Los Angeles.[2] Although motor vehicles are necessary, and therefore their exhausts, the quantity of motor-vehicle exhaust put into the air has been increased considerably by excessive reliance on the automobile for urban transportation. Some work has been done to develop devices to reduce the content of air-polluting agents in the exhaust, and it is to be expected that such devices will be improved in the future, but it seems unlikely that all air-polluting agents can be eliminated from motor-vehicle exhaust. Hence, as urban areas grow and the number of person-trips therein increases, if the per cent of trips accommodated by automobile remains constant, then anti-pollution devices likely will merely keep pollution levels from increasing, rather than reducing pollution levels.

Traffic congestion, particularly at peak hours, is one of the more readily noticeable aspects of our urban areas and is generally recognized as a social problem of considerable importance. For many people work-trip travel times have

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[1] Recommendations for Transportation in the National Capital Region. Washington: National Capital Transportation Agency. 1962. pp. 23-24. See also Brecher (Part 1), p. 60.

[2] Fitch, p. 15.

increased sufficiently to cancel the time freed by shorter working hours.[1] Whether or not work-trip travel times have been lengthened, though, traffic congestion makes such travel times longer than they would be otherwise and thereby adds to the social costs of transportation. The cost can be measured in terms of the commuter's time at so much money per hour, but many other factors do not lend themselves to quantification. For example, in effect, congestion cheats a family out of time together and renders the breadwinner worn out and cross from battling traffic when he arrives home.[2] Furthermore, congestion increases accident frequency and severity. As measured in monetary value of the damage caused, the sharpest recent increases in accident rates have occurred in heavily congested urban areas.[3] Hence, congestion is more than just an inconvenience; it presents a threat to physical safety and to intra-family harmony.

Ability of Transit to Ameliorate Social Aspects of Transportation

As described in previous chapters herein, in most cases traffic can be handled more expeditiously with transit than without it. Transit can provide a means for dealing with congestion; it can help to end an excessive reliance on the

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[1]Fitch, p. 11.

[2]Brecher (Part 1), p. 61.

[3]"Keep Moving Please," p. 18.

automobile by providing an alternative to congestion, separate-channel transit. By providing such an alternative to congestion, transit can provide the motorist with a real choice of mode of transportation, and in some cases it may even provide a choice of types of transit.

As more people live closer to each other, more possibilities of conflict arise, and more regulations are needed. In similar fashion, freedom of traveling must be regulated if life in urbanized areas is to be made livable.[1] By providing a more orderly flow of vehicles and a more efficient use of transportation resources, transit can provide the degree of regulation needed in urban transportation. A greater use of transit can reduce accidents, increase safety, and reduce automobile insurance costs; and it can provide independence for non-drivers, thereby removing pressure on licensing officials to permit people who should not be allowed to drive to have driver's licenses.

Transit can reduce travel times if used judiciously in providing an alternative to traffic congestion, whether by separate channels or by other means. Hence, it can enhance pleasantness of life in general by placing less tension on family breadwinners as they make their journeys to and from work.

Transit can permit a lowering of financial costs of transportation without lessening comfort and convenience, both for society in general and for the individual families in that society. For example, transit can make it possible for families to live conveniently with one automobile, while they require two

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[1]Smerk, p. 193.

automobiles at present, thereby reducing the families' living costs and leaving them with a greater amount of their resources available for spending on items other than transportation. It should be borne in mind, however, that transit will be unsuccessful in accomplishing any of the actions discussed above unless it is made sufficiently attractive to compete effectively with the automobile.

Social Patterns

Habit and prestige are important social patterns which must be given consideration in transportation planning if that planning is to attain its potential effectiveness.

Habit

As creatures of habit, once people choose a mode of transportation, they generally will not change unless compelling reasons for the change exist. If one mode is markedly superior to another mode, people will choose the superior mode and will soon have well-established habits concerning use of it. In like manner, if there is only one mode available, then when another one is introduced, people will not change in any great numbers unless the new mode is much more desirable than the previously existing mode.

These principles apply in choosing between automobile and transit. When transit generally has been greatly inferior to the automobile, it is little wonder that practically all people who have had a choice have chosen the automobile, leaving transit mainly with captive riders. The people who have now chosen the automobile will not change back to transit in any great numbers when minor improvements are made in transit, for in most cases the automobile is so far superior to transit that minor improvements to transit hardly alter the comparative position. For these people to be convinced that they should change to transit, striking improvements in transit must be made to make transit as attractive as the automobile, or even more attractive.

Because the situation wherein transit has generally been grossly inferior to the automobile has lasted for such a long time, a whole new generation has grown up, many of whom have hardly ever ridden transit and some of whom have never ridden it. It may very well be that it will be more difficult to get people who have never ridden transit regularly to change to transit than it will be to get those who once rode it regularly to change back to transit.

Prestige

Urban areas exhibit numerous spatial social patterns, one of the most important of which is housing location. Patterns of housing location usually exhibit some degree of economic segregation and may also exhibit some racial segregation as well. Because of housing-location patterns involving economic status, various patterns in the use of transportation exist; and because the basis of choice of transportation mode also varies according to the above factors, various patterns of transit use result. Some of the factors involved in choice of mode include travel time and pleasantness of the trip. Frequently the choice of mode is between the automobile and plebeian transit, but many cases also exist of a choice between prestigious transit and plebeian transit.

Certain transit services can be considered prestigious because of the people who ride them or because of the segregation of the economic classes who ride them. Such a selection of clientele usually results from economically segregated housing-location patterns. Examples of such prestigious transit include the following:

1. Shaker Heights Rapid Transit. The Shaker Rapid connects Shaker Heights, an upper-income suburb, with downtown Cleveland. The riders of the Shaker Rapid are nearly all upper-income people, except for household servants, who are reverse commuters, riding outbound in the morning and inbound in the afternoon, when very few residents of Shaker Heights ride in those directions. Hence, although lower-income people do ride the Shaker Rapid, they generally are separated from the upper-income people.

2. Commuter railroads in general. Generally commuter railroads serve outlying upper-income areas and make virtually no attempt to serve close-in areas, e.g. Chicago's North Shore suburbs served by the Milwaukee Division of the Chicago and North Western Railway. When lower-income people live in the areas closer to the core and the upper-income people live in the outlying suburban areas, as is usually the case, commuter trains provide economically segregated transit with any lower-class riders being mainly household servants who are separated

from the upper-income riders by the time and direction in which they travel, as with the Shaker Rapid.[1]

Certain transit services can be considered prestigious not so much because of the people who ride them, but because of the speed and pleasantness of the service provided. For example, although the Skokie Swift provides a separation of economic classes of riders much as the above examples do, its power of attraction of riders is its high speed, the pleasantness afforded by a non-stop ride, and its convenience for park-and-ride trips.

For situations where the automobile is the prestigious mode and the only transit that exists is plebeian, the reason for the prestige of the automobile may stem from any or all of the following reasons:

1. The desire not to travel with lower-income people.
2. The desire for superior comfort and greater general pleasantness, which the automobile trip provides.
3. The desire to use the automobile as a status symbol even if it has no particular advantage over the available transit otherwise.

This last reason is based on the public images of the various modes of transportation. Public images are very important in determining the amount of prestige which a given mode of transportation will receive. Furthermore, it should be noted that the factors which give prestige to prestigious forms of

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[1] Meyer, Kain, and Wohl, p. 363.

transit give a public image which helps them to perpetuate their prestigious character.

This chapter has explored some of the social aspects of transportation and their relationship to transit. It has shown how social factors and transportation can affect each other, with an eye to providing the planner with an understanding of factors which should be considered in formulation of a transportation plan.

CHAPTER VI

APPLICATIONS AND CONCLUSIONS

Transit As a Tool for Improving the Urban Environment

As discussed in the previous chapters, transit can be used to enhance the character of an urban area. It can enhance social values by influencing urban spatial design and by making an urban area generally a more pleasant place in which to live. In like manner, transit can be used to preserve urban values and the character of the city by counteracting adverse factors affecting the city.

The present urban transportation situation is fraught with many problems of various causes. A comprehensive approach is needed to solve these problems and thereby to improve the urban environment. One of many necessary approaches is to consider transit as a needed part of the transportation system, an urban utility comparable in importance to water and sewer systems.

Transit can be considered and employed in implementing a transportation plan in many ways, some of which were discussed in the previous chapters. In order to be effective, transit must be sufficiently attractive to get ridership volumes large enough to affect the transportation system. In order to be attractive, it must be financed like other utilities with some of the financing coming from public funds and only part of it coming from user charges.

Traffic equilibrium is a concept which helps one understand the behavior of traffic volumes as related to road-system capacity. Traffic congestion can be dealt with better than otherwise when traffic equilibrium is considered, and while it could theoretically be dealt with without transit, it is nearly always considerably easier to employ transit in allowing for traffic equilibrium while dealing with traffic congestion.

Transit has the ability to alter traffic patterns and capacity, as do other subsystems of the transportation system. As such, it can affect traffic congestion levels as mentioned above, and it is strongly interrelated with land use. Urban spatial design affects transit and, in turn, is affected by it.

The relationship between transit and land use is strongly affected by many factors, some of which are the following. The form of urban spatial design envisioned in plans and the provisions for locations of transit channels therein determine in large measure the actual relationship between transit and land use for that area. If transit channels are reserved, as with dedications for streets and easements for utilities, then separate-channel transit can be instituted when the time comes for it. The decision whether or not to extend transit into newly developing areas and the timing of that extension determine in large measure the amount of transit riding generated in that area, and therefore, the specific relationship of transit and land use there. Transit is related to the process of blight and deterioration: while some transit facilities have a blighting influence, others work to counteract the blighting influences which come from other sources.

As with other parts of the transportation system, transit is related to the social aspects of the environment. Transit and social conditions affect each other in numerous ways. Transit has an effect on the social costs involved with transportation and on social patterns in general, and in turn, transit is affected by social factors such as habit and prestige.

In order to act as described above, though, transit must provide service sufficiently attractive to get riders in numbers great enough to affect transportation patterns. In order to be sufficiently attractive, transit must be kept up-to-date. For example, the automobile manufacturers spend a great deal of money and effort in tailoring their products to the market. If transit is not similarly kept up-to-date, it will fall behind the times and will not appeal to the market sufficiently well; eventually it will become obsolete.

Transit Obsolescence

Unfortunately, though, transit generally has been neglected with no effort expended to keep it up-to-date. Hence, many transit services have become obsolete over the years, and for many of them obsolescence has eventually resulted in abandonment with either an inferior replacement or no replacement at all.

Partially because of its general obsolescence, the value of transit as a tool for enhancing urban character has not been fully recognized, and transit has generally been given very little attention in plans for urban areas. The plans which have mentioned provisions for transit have nearly all neglected working out the means for implementing their suggestions about transit. Furthermore, the lack of attention to transit in plans has allowed transit services to remain obsolete; and as a result of its general obsolescence, the effects of transit on urban areas in recent years have been mainly by chance.

When transit is not kept up-to-date, it naturally becomes obsolete and destined for abandonment unless changed radically. Frequently an essential service, even a separate-channel service, is neglected, allowed to become obsolete, and abandoned after a long decline. In such cases it is not uncommon to find a new up-to-date rapid-transit service being proposed and built along the same general route and frequently using the same right-of-way, e.g. the San Francisco Bay Area Rapid Transit District on the right-of-way of the Sacramento Northern Railway and the Skokie Swift on the right-of-way of the North Shore Line.

The form of transit which has most frequently become obsolete in the United States today is the commuter railroad. Various reasons are responsible, including some not generally applicable to other forms of transit:

1. Age. Commuter railroads usually operate on rights-of-way which were acquired before any other mechanically powered transit existed. Consequently, their routes and terminals frequently are more poorly located for today's needs than are those of other forms of transit.

2. Operating technology. The operating technology of commuter railroads frequently is obsolete. Many reasons can be given for that obsolescence: it can be ascribed to inadequate management, but such an evaluation omits some important factors, for commuter railroads generally are in a position which discourages aggressive, imaginative management.

The courses of action available for obsolete transit include abandonment, long-continued gradual improvement, radical improvement, and various combinations. Frequently, gradual improvement starts out with a program of public support to keep the transit service operating until a definite plan of improvement is worked out.

One of the more suitable means of providing adequate improvement to commuter railroads is to convert them to modern rapid-transit lines. Provisions for construction of the new rapid-transit line can be made before the commuter railroad is abandoned. Then construction can start almost immediately after abandonment, e.g. the Massachusetts Bay Transportation Authority's Highland Branch.

Some examples of the courses of action taken by various commuter railroads follow:

1. Abandonment without replacement

    most commuter lines

        e.g. most Pittsburgh commuter lines

            Chicago Aurora and Elgin

2. Abandonment with replacement

Sacramento Northern and Southern Pacific --replaced by San Francisco Bay Area Rapid Transit District

North Shore Line -- replaced by Skokie Swift

3. Radical improvement

Boston and Albany's Newton Highlands Branch -- converted to light rapid transit (Massachusetts Bay Transportation Authority's Highland Branch)

Pennsylvania-Reading Seashore Lines -- converted to heavy-duty rapid transit (Delaware River Port Authority)

4. Gradual improvement

Illinois Central -- by aggressive, imaginative management

Chicago and North Western -- by aggressive, imaginative management

Philadelphia commuter lines -- by public support

Long Island -- by public ownership

Transportation Policy

Objectives: If transit is to be kept up-to-date, transportation policy must give it adequate consideration, but merely transferring transit from neglected to favored status is not enough, for then the transit system would become out-of-joint in other ways. It is necessary to have transportation policy with objectives which consider all aspects of urban transportation, such as the following set of objectives.

1. Urban areas should organize on a metropolitan level in order to deal with transportation problems, most of which are region-wide in scope.

2. Experimentation should be employed to develop improved operational and administrative procedures and improved urban transportation systems.

3. Public and private urban transportation should be put onto a more nearly equal footing concerning decisions of investment and consumer choice in order (a) to give transportation users a choice among transportation alternatives which reflects true social costs and (b) to make decisions concerning investment in additional transportation facilities which likewise are based on full costs.

4. Many existing transit facilities are in danger of abandonment because of financial difficulties. Once metropolitan-area transportation planning is instituted, many of these transit facilities can serve an important function in spite of their present under-utilization. Hence, it is important to prevent the premature abandonment of these facilities, for it is easier to upgrade an existing facility than to replace it once it has been abandoned. Furthermore, many existing transit facilities may be brought up-to-date with various relatively small efforts which apply modern techniques, and the prospects are bright for the development of much new transit technology.[1]

Transit Financing: Financial provisions for maintaining and improving transit facilities, however, constitute what is probably the weakest link in the procedures for financing

[1]Fitch, p. 5.

urban transportation. Consequently, special attention will have to be given to it if transit facilities are to receive financing sufficient to bring them to adequate levels and keep them there. Many possible means of financing transit exist; one which shows some promise is to utilize the income and wealth of urban areas by inducing expanded state and local financial efforts through offering federal funds to be matched locally, as is presently done for highway construction.

Conclusions

Whereas planners frequently have spoken in favor of providing for transit in their plans, the existing situation has made implementing such provisions very difficult. As a result, very little has been done with transit. Hence, in order to utilize transit, the planner must see to it that transit is sufficiently attractive that it can accomplish something. Some of the important means of enhancing transit attractiveness have been discussed in previous chapters and are mentioned below.

Automobile use is underpriced in most congested urban centers. When such is the case, the only financial way to realize fully the potential economies of transit is to provide correspondingly low fares with public support. With sufficient public support it becomes easier to achieve the improvements in transit necessary to make it attractive.[1]

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[1]Fitch, p. 5.

Transit service must be kept up-to-date with a continuing program of improving service and tailoring it to the travel desires of the public: Such a program may involve radical changes such as the conversion of a commuter railroad to a rapid-transit line, or it may involve simple changes such as rescheduling a bus route. Land-use plans should include provisions for right-of-way for transit channels over which transit routes may be extended when desired. Transit routes should be extended into new areas as they are developed; in this respect transit should be treated as a utility, such as water and sewers.

The most important single consideration in the type of transit service offered is to provide a separate channel over some or all of the route. Of the types of separate-channel transit available, the type which probably is optimally adapted to widespread application is light rapid transit constructed for easy conversion into heavy-duty rapid transit when desired. Light rapid transit offers flexibility in type of routing, flexibility in size of vehicle (hence, the crew-to-passenger ratio), one-seat routing serving a broad area, little need for feeders, and easy conversion to heavy-duty rapid transit.

It should be noted, however, that a cultural bias exists favoring big and ultimate solutions over intermediate solutions such as light rapid transit. Hence, although light rapid transit may be the form of transit best adapted to a given area, the system chosen for that area may be one of a heavy-duty system of very few routes and many feeder busses.

Once attractive transit service is established, the planner then can utilize transit as he sees fit. If he recognizes and utilizes the principle of traffic equilibrium, transit can be an important tool for utilizing traffic equilibrium in his favor in dealing effectively with traffic congestion.

In fact, as has been shown herein, although the use of transit will not solve all urban transportation problems, the prospects for the use of transit in planning are virtually limitless, for the planner can use transit not only for transportation-oriented purposes such as enhancing street capacity and providing an alternative to traffic congestion, but also for broader purposes such as preserving social values and preserving and enhancing the character of the city.

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APPENDIX I

SYSTEM

A system is a group of two or more items (objects, ideas, or principles) united by some form of regular interaction or interdependence, comprising an organized or coherent whole. The items within the group are called "subsystems," subsystems are also groups of sub-items, called "sub-subsystems." Hence, subsystems are systems in themselves, and a whole hierarchy of systems and subsystems exists.

Stewart Marquis has described an approach to understanding human communities of all types as follows:

> The systems approach suggests that a community is a complex of interacting elements, and that it can be described and understood in terms of the characteristics of its components and subsystems and the ways in which they interact.[1]

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[1]Stewart Marquis. A Systems Approach to Communities, Community Centers, and Planning Areas. East Lansing: Institute for Community Development and Services, Michigan State University. 1963. p. 7.

APPENDIX II

SUB-OPTIMIZATION

"Sub-optimization" means giving attention and improvements to one or more subsystems in a system, while neglecting the other subsystems. The result is that while the favored subsystems operate reasonably well, the whole system becomes somewhat out of joint and does not operate so well as it would if the attention and improvements were given to the whole system and all of its subsystems. The reason for such poorer operation of the whole system is: The neglected subsystems are not able to function optimally; hence, the whole system suffers.

When all subsystems are given "equal consideration" (i.e. equitable treatment which is not necessarily the same, as in the example below), the operation of the whole system is optimized. In determining what constitutes equal consideration for all subsystems, though, value judgements must be made, for subsystems vary in size, function, and scope. Hence, equal treatment will not be exactly the same treatment. Since treatment of each subsystem will not be exactly the same, it would be possible to quantify the various treatments according to various methods, which could give almost any results which were desired, e.g. results which gave the impression that one subsystem was being especially favored, even though the policy of "equal consideration" was being applied equitably.

Equal treatment can best be exemplified by the actions of parents of two or more children toward their children. Each child is treated according to his own individual needs; if one child needs more of one thing than another, he will get it as a proper application of an "equal-treatment" policy. For example, if one child is chronically ill, he will receive much more economic outlay than the other child who is reasonably healthy, but in such a case both children will still be receiving "equal treatment."