copy 1

INTER-CITY BUS TERMINAL LOCATION CRITERIA

by

EDMOND REINIER CUYLITS
B.A., University of British Columbia, 1966

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

in the Faculty
of

GRADUATE STUDIES,
SCHOOL OF COMMUNITY AND REGIONAL PLANNING

We accept this thesis as conforming to the required standard.

THE UNIVERSITY OF BRITISH COLUMBIA

MAY, 1972

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Edmond R. Cuylits, B.A.

SCHOOL OF COMMUNITY AND REGIONAL PLANNING
FACULTY OF GRADUATE STUDIES

The University of British Columbia
Vancouver 8, Canada

Date May 1ST, 1972

ABSTRACT

Since the initial development of inter-city transport, fixed stopping places serving inter-city common carrier modes have become established. Such stopping places include locations with specialized structures or terminals that facilitate the interchange process and link the access or egress journey to the line haul mode. Traditionally inter-city bus terminals have been situated in the central business district of metropolitan areas. However, the expansion of urban areas and the dispersion of urban activities into these areas would suggest that the traditional location of the bus terminals is no longer optimal. This thesis poses this question in the hypothesis which states:

> The optimal location for an inter-city bus terminal in an urban metropolitan area is one at or near that metropolitan area's central business district.

In order to develop a definition for optimal location an examination is first made of inter-model competition and factors that affect demand. Time and cost are indicated in the literature to be of prime importance and their minimization encourages travel. As access and egress journeys form significant elements of the inter-city journey, the time and cost of these journey segments receive most of the attention in the literature surveyed. Measurements of these factors is discussed at length.

As the inter-city terminal is the interchange point which links the access or egress journey to the line haul mode,

a variation in the terminals' location will affect these journey segments. The optimal location is defined in terms of minimizing the access/egress journey times and cost in order to stimulate demand.

However, demand oriented locations may have high land acquisition and operating costs that would negate the benefit of such locations and for this reason this aspect must be considered in the location evaluation. Finally, consideration is given to the consequences of such location on the present and future urban environment. These three criteria - demand, cost and urban impacts must be included in the evaluation of terminal location.

It is concluded that a central location near the hub of the urban transit system is most desirable for main bus terminals. In the future, the importance of the central location will decline and a location on the transit system will become the most desirable. However, with the dispersion of urban patterns, it may be necessary to add suburban terminals which can best be located near major arterials and at points where suburban town centers should be encouraged.

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION	Page	1
1.1	The Stopping Place in Inter-City Travel	1
1.2	Inter-City Travel - A Definition	3
1.3	Terminal Location and Impact.	6
1.4	The Balance in Inter-City Transportation: A Perspective.	7
1.5	The Hypothesis	17
1.6	The Study Approach	18
CHAPTER TWO: THE BASIS OF ANALYSIS		23
2.1	Introduction	23
2.2	Early Bus Terminals	23
2.3	Location Optimization - The Gravity Principle	28
2.4	Passenger Characteristics	36
2.5	Passenger Origins and Destinations	39
2.6	Future Distribution of Trip Origins and Destinations	43
2.7	Line Haul Times	44
2.8	Supply of Transport Services - An Economic Consideration	46
2.9	Community Planning Considerations	49
2.10	The Ottawa Terminal Relocation - An Example.	51
2.11	Inter-city Terminal Location, A Summary	53
CHAPTER THREE: BUS TERMINAL LOCATION		58
3.1	Introduction	58
3.2	The Terminal in the Inter-city Bus System	58
3.3	Bus Terminal Use and Location	59
3.4	Access and Egress Journeys - Modal Choice	59
3.5	Implications of Future Demand on Terminal Location	63
3.6	The Line Haul Journey and the Bus Terminal	64
3.7	Inter-city Bus Costs	65
3.8	Community Planning and Bus Terminals	66
3.9	Summary	67
CHAPTER FOUR: DISCUSSION AND CONCLUSION		70

LIST OF TABLES

Table 1.1	Annual Inter-city Passenger Miles Logged in Canada	16
Table 1.2	Relative Role of Common Carrier Modes.	16
Table 2.1	Comparison of Business Trips Between New York City and Washington D.C.	33
Table 2.2	Usage of Inter-City Modes Between Philadelphia and Washington by Income Groups in Comparison with S.A.R.C. Data.	38
Table 2.3	Travel Purpose - % for City Pair	38
Table 2.4	Local Travel Modes for Inter-City Travellers in the Northeast Corridor	41
Table 2.5	Average Local Travel Times	41

LIST OF DIAGRAMS

Figure 1.1	The Inter-city Journey	Page	4
Figure 2.1	Cumilitive Distribution of Passenger Income on Inter-city Modes		36a

ACKNOWLEDGEMENTS

I wish to thank all those who assisted me in the preparation of this thesis. In particular I wish to indicate my appreciation to Mr. P. Roer and Mr. Wm. Rees for their advice concerning the organization of this paper. I would also wish to thank my employer, my parents, and my wife, for their patience and cooperation while this study was being prepared. Finally I wish to thank my typist, Mrs. Andrea Howell, for her willingness to work at all hours to complete the final document.

E. R. Cuylits

CHAPTER ONE: INTRODUCTION.

1.1 The Stopping Place in Inter-city Travel.

With the development of inter-city public transport, fixed stopping places became established, where passengers could gather and board the inter-city vehicle. Early stopping places for such inter-city modes as the stage coach required no particular structures, as passenger pick up along the roadway was possible. In urbanized areas these points were well advertised and often located at cafes, taverns, or at the carrier's offices. The railway, with its more sophisticated technology required elaborate stopping places and frequently specific structures - terminals or stations - were built to permit access to the transport vehicles. Similarly, airports were developed. Thus, the single stopping place became a specialized structure housing the many and varied activities required for each transport technology.

For inter-city ground transport, the stopping points in the larger North American cities have traditionally been at a central location and many still have these central terminals for rail and bus modes. These central locations were considered central locations for rail terminals frequently resulted from the growth of cities around and a way from these facilities. These central locations were considered

optimal as urban public transport, which provided the main mode of transport in cities, frequently converged on the city center. However, increasing automobile ownership has diminished the dependency on local public modes and has permitted greater individual choice in residential location away from the transit routes. The resultant dispersal of urbanized areas into the countryside, while inter-city bus and rail terminals have tended to remain in the city centers, raises the question whether or not this traditional location is still optimal. This paper focuses its attention on this issue and will make specific reference to the terminal serving the inter-city bus system.

The question raised will be operationalized in this chapter. It is intended that the analysis made will suggest criteria for inter-city bus terminal location which can be of assistance to bus operators, planners, and of benefit to travellers.

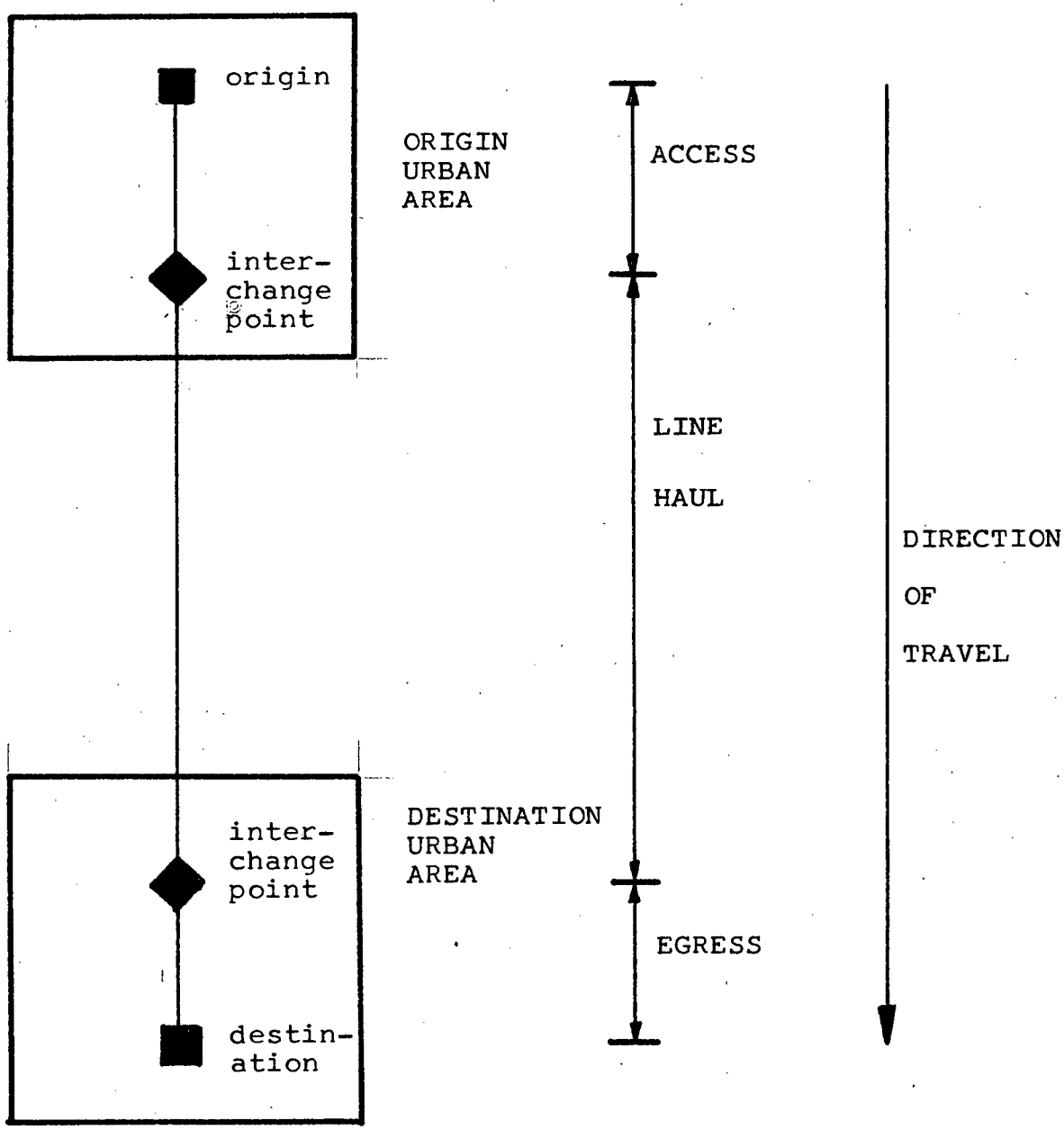
For the planner, these criteria can be of assistance in planning for new transportation terminals, urban development, and the location of new highways. For example, Toronto, Canada, is contemplating a major downtown redevelopment project called "Metro Center" which would include a comprehensive transportation terminal at its core. The project would include inter-city and commuter rail, local and inter-city bus, subway, and airline limousine terminals.[1] The criteria established can aid in the assessment of this project.

1.2. Inter-city Travel - A Definition.

In its primitive stages, inter-city travel can be more accurately defined as inter-community travel that takes place between communities separated by sparsely settled or rural areas. This definition, however, is not applicable in modern North America where many regions have become extensively urbanized and individual communities have physically, (but not necessarily politically) merged to form large urban conglomerations. A more accurate definition of modern inter-city travel is one which refers to inter-metropolitan travel only and does not include travel between various communities within the metropolitan area. This would exclude commuter traffic which has its origins and destinations within the same metropolitan area.

Once having established inter-city travel as the movement between metropolitan areas, the inter-city journey itself can be analyzed as one having three basic segments: the access journey from the point of origin to the main inter-city mode; the line haul journey on the inter-city mode; and the egress journey from this mode to the ultimate destination. Frequently, the first and last segments of the journey occur within metropolitan areas. The points where these various journey segments meet and where transfer is made, can be considered the interchange or transfer point. Figure one schematically portrays the typical inter-city journey.

FIGURE ONE: THE INTER-CITY JOURNEY.



The location of the interchange point and the length of the access or egress journey can vary widely, depending on the type of mode used and the location of the ultimate origin or destination. When the automobile is the line haul mode, the access or egress portion of the journey is frequently very short as an automobile can usually be "parked" close to the origin or destination. Frequently, the access or egress journey is made by the most personal mode available, one's own feet. The point where the car is parked can technically be considered as the interchange point.

With common carriers, however, the interchange point is often at a particular set location and the access or egress journey will vary in length, depending on the location of the ultimate origin or destination. These journey segments can, therefore, be of considerable distance and may involve the use of local transport modes other than walking. If required, these journey segments could be separated into subsections with secondary interchange points.

The location of the interchange point for some inter-city modes can be variable (e.g. roadside stopping places for buses) within the urban setting. Also, several points may exist within the one urbanized area serving the same mode (e.g. a mode having both central and suburban stations). Usually at least one of the points has a specialized structure or terminal capable of handling large volumes of passengers and facilitate interchange.

1.3. Terminal Location and Impact.

As was indicated above, the point of interchange for common carriers is usually at a set location and this location can have an impact on the inter-city journey segments. For example, if origins and destinations remain constant and the interchange point is relocated, line haul and access/egress journey segments may be lenghthened or shortened, causing travel times and/or costs to alter. Using the concepts of comparative time and cost performance of each mode, these shifts can result in the realignment of the use of each mode. This concept will be discussed more fully in chapter two, but it can be stated at this point that if overall costs and travel times for travellers are reduced by the change in particular mode's terminal location, increased patronage on that mode can be expected. Many of the studies of the Boston to Washington transportation corridor (the Northeast Corridor) have applied themselves to this concept and will be referred to in the following chapter.

A similar effect could be anticipated if urban patterns (including the location of origins/destinations) shift while the terminal location remains constant. For example, the spread of cities has lengthened the average distance to the city center and have frequently resulted in significant increases in the access and egress portions of the inter-city journey via common carrier.[2] Thus it could be argued that there is a point where the access and egress portions become so large in terms of time and cost, that travellers will shift their choice to a mode whose performance characteristics have become more desirable.

Should a particular carrier wish to retain this patronage, it may be necessary to relocate the terminal or to provide additional terminals where interchange can take place.

Terminals have particular impacts on urban structure that are usually not included in the evaluation of the transportation network. This impact can be on local transportation patterns, the distribution of land values, and land uses within the city. Gaekenheimer discussed an extreme example of such a set of impacts by considering a single interchange point to serve all common carrier inter-city modes. Should such a single terminal be established, Gaekenheimer argued, it would necessitate the reconcentration of access systems within the city "in such a manner as to make land prices, density of occupancy, and the need for radial access most difficult problems which might well be insolvable at the urban level".[3] One of his conclusions is that the impacts of terminal location (or locations) on the urban structure should not be neglected.

To conclude, the suggested approach to the evaluation of terminal location is the evaluation of impact on the transportation system balance resulting from shifts in access and egress journeys and the impact on the urban environment in which the terminal is located.

1.4. The Balance in Inter-City Transportation: A Perspective.

The balance among the various inter-city transport modes has varied with the development of new technology and the

ability of the North American public to afford personal transport modes. In order to indicate the nature of the present balance and the role of terminal location in this balance of brief description of recent trends in inter-city travel will indicate the changing use patterns.

After the early stage coaches yielded to the faster and more comfortable train, the railways were the dominant mode for travel for many decades in the late 19th and early 20th centuries. However, it can be suggested that since the turn of the century, the railways have failed to make the improvements needed to permit them to continue its dominant position in inter-city travel. For medium and long haul distance travel, railway speeds have not improved significantly since 1920 and it is claimed that little effort has been made to improve the comfort and convenience of this mode to passengers.[4] The major decline of railway passenger service is clearly evident in the passenger statistics (which will be discussed below) and the considerable cutbacks in scheduled train service. The U.S. railroads listed 421 passenger trains in their 1969 schedule, a drop of over 19,000 trains since 1929.[5] As a last resort, the United States government introduced a network of subsidized passenger services, called AMTRACK, which freed the railways from part of the claimed losses incurred by unprofitable passenger operations. The AMTRACK network has a basic inter-city grid of sixteen routes. According to U.S. Transportation Secretary, John Volpe, the system will require only half the current number of trains while reducing service by only 15%.[6]

The future of inter-city railway passenger operations using existing technology does not appear bright. The high capital investments required and the cost squeeze effect of rising labour demands and increasing inter-modal competition suggest that the railway will only continue to operate extensive passenger networks under subsidized programs such as the AMTRACK system. This is evidenced by the number of petitions filed for abandonment and the speed with which the railways accepted AMTRACK[7].

Research and demonstration projects presently underway in the Northeast Corridor are suggesting a future for inter-city rail transport which is limited to medium distance travel (200 to 600 miles)[8]. The Metroliner, introduced under such a demonstration program, operates on the Washington to New York run and did cost the Penn-Central Railway $45 million and the U.S. Department of Transportation $11 million to develop[9]. A similar demonstration program is the Turbo-train operation between Boston and New York. It should be noted that these new services required not only new rolling stock but also extensive improvements to the rights of way.[10]

Some new technologies suggested for high speed ground transportation are related to existing rail techniques but involve highly sophisticated right of way technology. Such systems would operate at speeds in excess of 160 miles per hour and could utilize such motive power as the linear induction motor. Another suggested type of vehicle has been

the tracked hover train or air cushioned vehicle.[11] Costs for these new systems are expected to be considerably higher than for conventional techniques and will be feasable in high density travel corridors only.

Historically, "the first major challenge to the railroad passenger train" occurred in the 1920's when the interurban - an outgrowth of the urban street railway - reached its peak.[12] At its greatest extent, in this peak period, the interurban provided fast and frequent service to many communities along a network of 15,000 route miles in the U.S. alone. In Canada, extensive networks existed around some of the major urban areas including Toronto, Winnipeg, and Vancouver. In 1926, the interurban accounted for 11.7% of the total inter-city passenger miles completed by common carriers in the United States; over 72% was handled by the railroads; while the remainder was completed by a new mode of transport, the motor bus.[13]

As the bus was able to share the right of way with the automobile, the development of inter-city highways permitted the expansion of bus routes. It was during the 1920's that many of the governments began to fund highway construction to accommodate the increasing number of privately owned automobiles.[14] Such companies as Grey Coach Lines of Toronto reported that it took full advantage of the new highways to provide new services.[15]

In the early years the bus was considered an exciting novelty and it frequently attracted much ridership for this

reason.[16] However, the value of the bus with its flexibility was quickly recognized and transport operators such as the Toronto Transit Commission saw the bus as the "logical answer to the capital expenditure necessary for the rail services."[17] One of the first regularly scheduled bus services in Canada was established by the T.T.C. on September 20th, 1921.

Although less comfortable, than the interurbans, the inter-city bus provided strong competition with its low fares.

> "During the 1920's, inter-city bus fares averaged 2.25 cents per mile, with allow of 1.8 cents, while the interurban charged between 2.4 and 3.0 cents per mile. The fixed investment in track and electrical fixtures plus associated maintenance gave the interurban an average marginal cost structure higher than buses at the low passenger densities they carried."[18]

For this reason, the T.T.C. established Grey Coach Lines in 1927. The bus system replaced many of the interurban routes and initiated long distance runs as well. In the first year of operation, the main inter-city route to Niagara Falls carried approximately 280,000 passengers.[19] By 1929, Grey Coach services had taken advantage of the expanding highway network and a large fleet of motor buses had been purchased.

This development in and around Toronto was typical of

the changes in inter-city surface transport throughout North America. Bus lines expanded their routes, improved the quality of their fleet, and attracted passengers from the interurban. Perhaps the greatest single improvement in bus service occured when the Greyhound Corporation designed its "Scenicruiser" almost thirty years ago. This vehicle had a smoother and more comfortable ride than any of its predecessors, and cruising speed of sixty-eight miles per hour.[20] Recently Greyhound introduced its new M.C.6 and M.C.7 "Supercruisers" which have improved air conditioning, seating and twice as much luggage and parcel space.[21] The latter reflects the rapid growth of the package express business.

The long run future of inter-city bus transport appears to be moderately optimistic. Although inter-city bus patronage has levelled at the moment, the operators are confident the bus will remain a significant element in the inter-city transport system. This optimism is based on such factors as the low fixed capital investment required where buses operate on ready-made rights of way. The bus system has the lowest break even point of all the common carriers.[22] Such operators as Mr. D. P. Anton of Grey Coach Lines feel that:

> "No other passenger carrying mode is more flexible in its ability to meet public demand than is the inter-city passenger bus industry."[23]

Buses are able to pick up and discharge passengers at the centers of population, and at most points along a route travelled. In effect, the inter-city bus resembles the stage coach mentioned

in the introduction, in its flexible routing, low fixed costs, and its ability to carry both passengers and express freight. To illustrate the flexibility and economy of the carrier, "one may note the promptness with which bus service takes up the slack in areas where railways find it necessary to discontinue passenger train service."[24]

Bus operators are presently promoting travel on their vehicles over intermediate distances. This appears to be the trip distance where buses can compete effectively with other forms of transport. Greyhound recently announced plans to actively promote its non-stop service on runs of 200 to 300 miles. The company claims it can provide travel times comparable to rail in vehicles that are as comfortable as the standard railway coach. Furthermore, it feels the service can be offered at much lower fares than is possible with any other common carriers.[25]

The third major inter-city common carrier is the air mode. This mode has been cited as one of the major causes of the decline of inter-city rail transport. In Canada, early air passenger services were operated by many small firms scattered throughout the country. The interesting aspect of these services is that they did not grow rapidly in the heavily populated areas. Rather they initially served areas not yet penetrated by roads and railways.[26]

The establishment of Trans Canada Airlines by the Canadian Government in 1937 provided the beginning of long

distance inter-city service in Canada. However, the company did not develop into a major carrier of passengers, mail, and freight until the second world war.[27] The growth of T.C.A. during the war parallelled the development of air services in many western countries. Since the second world war, passenger traffic on airlines has grown sharply and congestion problems in some of the more heavily travelled areas have developed. The attractiveness of this mode has been partially attributed to the fast service over long distances and at relatively low fares. The latter is possible by the "very large number of seat miles that the high speed vehicle is able to fly per day."[28]

The speed of air transport ensures its role in inter-city travel over longer distances. However, for intermediate and shorter distances, the traditional fixed wing aircraft will experience increasing competition from advanced ground transport technology as air congestion and ground access problems become more acute. Research into new types of vehicles such as short or vertical take-off aircraft may result in an expansion of air travel for shorter distances if economic and technical difficulties can be surmounted. The use of super-sonic aircraft for the longer inter-city distances still appears to be remote as many environmental and economic problems still have to be solved.

By far the most ubiquitous mode is the private automobile. The growth of this mode has been spectacular and well documented elsewhere. The Systems Analysis Research Corporation (S.A.R.C.) suggests that the automobile is in such

great demand because its relative costs have not increased as rapidly as the cost of living.

> "The cost of owning and driving a car have not, in the aggregate, gone up as fast as the general cost of living nor have they mounted as fast as real family income... Auto costs have increased at a lower rate than other modes since 1948...It is not surprising that car usage continues to gain."[29]

The S.A.R.C. report indicates that as facilities are further improved with new inter-city highways, these costs will further decline. This would make the automobile available to an increasing proportion of the public.

Over shorter distances the automobile is frequently the fastest mode as the vehicle is usually available when needed and little time is lost in gaining access to it. This view is confirmed by studies such as those completed by National Analysts Inc. concerning travel in the Northeast Corridor, and by Boorer and Davey concerning demand for V/STOL aircraft.[30,31] However, in areas where inter-city freeways are well established, travel distances by automobile can be substantial. Beimborn suggests that time limitations coupled with trip costs are critical determinants of automobile use. The study maintains that common carriers can only be expected to be competitive when:

> "The combination of good terminal locations and low inter-city times and costs have an advantage over the direct route, schedule free automobile."[32]

The growing use of the automobile can best be indicated

by the statistics available concerning inter-city travel in Canada. In the period between 1949 and 1968, the number of inter-city passenger miles logged in this country has increased by 56 billion passenger miles - giving an annual increase of 2.9 billion miles. Of this total growth, the automobile has accounted for 86%, the remainder being attributable to the common carrier - air, bus, and rail. The growth is shown in table 1.1 below.

TABLE 1.1 ANNUAL INTER-CITY PASSENGER MILES LOGGED IN CANADA
(In Billions of Miles)

	1949	1968
AUTOMOBILES	21.42	70.10
COMMON CARRIERS	6.97	11.12
-Air	.39	4.20
-Bus	3.39	4.41
-Rail	3.19	2.51
TOTAL	28.39	81.22

Sources: Dr. H. L. Purdy, U.B.C.
Dominion Bureau of Statistics (Statistics Canada)

If the mileage completed on common carriers can be considered separately, then the spectacular growth of the air sector can be readily observed. Table 1.2 below gives the comparative figures for the same period as above.

TABLE 1.2 RELATIVE ROLE OF COMMON CARRIER MODES.
(% of Total Common Carrier Inter-city Passenger Miles.)

	1949	1968
AIR	5.6	37.7
BUS	48.7	39.7
RAIL	45.7	22.6

Source: Dr. H. L. Purdy, U.B.C.

The two tables show that the railways have not only suffered a relative decline but also an absolute one. The other ground mode, the inter-city bus, experienced a relative decline but increased its total passenger mileage logged annually by 1.02 billion miles.

In summary, the statistics show that there has been a definite shift in the usage of modes available for inter-city transport. It appears that the performance characteristics of the automobile in terms of time and cost and the airplane have attracted the largest increases. It is the comparative performances of all modes and their technological improvements that will greatly affect the future balance of traffic among various modes, including the private automobile and the inter-city bus.

1.5 The Hypothesis

Despite the dominance of the automobile and the airplane, the statistics indicate the inter-city bus is an important transporter of inter-city passengers, and as it has been described as one of the more flexible modes, a study of bus terminal location can provide a useful example for all inter-city transport. Relocation can occur with comparative ease and the fact that a significant sector of the travelling public will be affected, makes the bus terminal an interesting element of the terminal system for study.

It can be shown that the traditional location of the bus terminal is in or near the central point of an urban area. This location persists in most North American cities but a recent shift in Montreal of a major bus terminal away from the city center would suggest that this location could no longer be optimal. The relocation in this instance was largely a private decision by the operator and a case is made for a non-CBD location.

To test the validity of the traditional location, a hypothesis can be formulated to state that this location is still optimal. Stated briefly:

> The optimal location for an inter-city bus terminal in an urban metropolitan area is one at or near that metropolitan area's central business district.

The meaning of optimal will be developed in chapter two.

1.6 The Study Approach

This chapter has established the nature and context of the problem to be explored. It has defined the role of the inter-city passenger terminal in terms of its effects on the inter-city journey and the balance among the various modes serving the same linkages. The data presented concerning the growth of inter-city travel and the development of various modes places the inter-city bus (the mode to be studied) in its context of the total system. The concept of 'balance' among the various modes and the competition for passengers has suggested the importance of time and cost in the ability of a mode to attract a portion of the total travel market and can be

used to analyze the effects of various terminal locations. This chapter has indicated that externalities of urban impacts should be considered and that an evaluation of terminal location should also be made in terms of urban planning policies. For purposes of evaluation, the example of the bus terminal is used.

In the second chapter, an analysis of some of the literature on the subject will be made. The literature regarding early terminals suggests the criteria considered for their location which can provide the basis for a theoretical examination. This examination is based on more recent research. This chapter will conclude with a summary of urban impacts on location and the location impacts of the environment of earlier terminals.

The information presented in chapter two will be developed into analysis criteria and a test of the hypothesis will be made on data existing for some eastern Canadian cities. A conclusion will be presented in the last chapter, chapter four.

FOOTNOTES - CHAPTER I

1. S. M. Andrews, "Metro Centre", Urban Renewal and Low Income Housing, Volume 5:2, 1969, p.2.

2. L. K. Sillcox, "Railway's Role in Speed, Service, and Safety", High Speed Ground Transportation Journal, Vol. II, No. 1, January, 1968, p. 206.

3. R. A. Gaekenheimer, "High Speed Transit in Urban Areas", High Speed Ground Transportation Journal, Vol. I, No. 1, January, 1967, p.30.

4. "Railpax Passenger Trains Will be in Service in Six Months", Railway Age, Oct. 26, 1970, p.14.

5. "U. S. Plans Sixteen Route Grid", Vancouver Sun, Dec. 1, 1970, p.63.

6. Loc. cit.

7. A Canadian example is the petition to the Canadian Transport Commission in 1970 for the abandonment of passenger services on C.P.R. routes.

8. G. D. Friedlander, "Railway vs. Highway", I.E.E.E. Spectrum, September, 1967, p.69.

9. Loc. cit.

10. A Canadian project was the short-lived "Turbo-train" experiment between Toronto and Montreal.

11. P. J. Detmold, T. E. Parkinson, G. A. Clark, Aspects of Intercity Passenger Transport, Paper presented to Canadian Good Roads Association, Montreal, 1970.

12. G. W. Hilton and J. F. Due, The Electric Interurban Railways in America, Stanford, California, Stanford University Press, 1960. p.41.

13. D. N. Dewees, "The Decline of American Street Railways", Traffic Quarterly, Vol. 24, No. 4, p.569.

14. Wabco, A Study of Evolutionary Urban Transportation, Vol. II, Clearinghouse, PB178-268.

15. Toronto Transportation Commission, Transit in Toronto, Toronto, 1969, p.19.

16. Toronto Transportation Commission, Wheels of Progress, Toronto, 1944, p. 70.

17. T.T.C., Wheels of Progress, p.36.

18. D. H. Dewees, op. cit., p. 568.

19. T.T.C. Transit in Toronto, p.18.

20. B. W. Firth, Evolutionary Development of the Public Transport System, Society of Automotive Engineers, Paper No. 696124, January, 1969.

21. Greyhound Inc., Greyhound Annual Report, 1969.

22. D. Scrafton and S. van Steinburgh, The Inter-City Motor Coach Industry in Canada, Ministry of Transport, Canada, April 1970, p.114.

23. Ibid., p. 113.

24. Ibid., p. 114.

25. "Fighting a Doggy Image", Time Magazine, No. 2, 1970, p. 59.

26. A. E. W. Salt, Imperial Air Routes, London, John Murray, 1930, p. 193.

27. C. A. Ashley, The First Twenty-Five Years: A Study of Trans-Canada Airlines, Toronto, MacMillan, 1963.

28. M. Miller, "High Speed Ground Transportation Research and Development," High Speed Ground Transportation Journal, Vol. I, No. 1, January, 1967, p. 16.

29. Systems Analysis Research Corporation (S.A.R.C.), Demand for Inter City Passenger Travel in the Washington - Boston Corridor, Clearinghouse, PB 166-884, p. III-4.

30. National Analysts Incorporated, The Needs and Desires of Travellers in the Northeast Corridor, Philadelphia, Pa., 1970.

31. N. W. Boorer and B. J. Davey, "Characteristics and Problems Associated with V/STOL Operations", Aircraft Engineering (London), Vol. 41, No. 3, March 1969, p. 19.

32. E. A. Beimborn, "Terminal Access and the Choice of Intercity Modes", Transportation Engineering Journal, August, 1969 p. 472.

CHAPTER TWO: THE BASIS OF ANALYSIS.

2.1 Introduction.

This chapter reviews some of the information available concerning terminal location and discussion of earlier bus terminals and the reasons for their location. This is followed by a look at the literature concerning the balance of demand in inter-city transportation and the impact of the urban environment in which it originates or terminates. The chapter concludes with an evaluation of the earlier terminals using the criteria developed out of this review of the literature.

2.2 Early Bus Terminals.

As was previously indicated, early bus terminals were frequently found in or near city centers. It is suggested below that this location resulted from a recognition by most terminal developers of the importance of passenger origins and destinations. If the bus was to be competitive to the inter-urban railway it was felt the access/egress segments of the journey was required to be minimal.

As mentioned in the introductory chapter, the early bus systems were similar to the interurbans in that they basically connected rural areas to some central city. It was shown at the 1917 Ninth Annual Conference on City Planning held at Kansas City that most of the passengers using these modes had destinations in the concentrated central business districts which were characteristic of early North American cities. A speaker at that conference discussed a destination survey conducted on interurban lines entering Kansas City. This early survey asked the basic questions: "Where do passengers want to go?" and "Why are they travelling?" and revealed that over 80% of the passengers had destinations close to the retail business district of Kansas City.[1]

The questions asked in this survey indicate the close correlation between trip purpose and the choice of destination. This was indicated in a comment made by F.L. Mogen of Greyhound Lines of Canada. He states:

> "Before the days of so many private cars, people from rural areas came to town to shop, see their doctors, etc., and all the main shopping areas were in the core of the city."[2]

This concentration of activities in the core which is described by such urban geographers as Charles Colby, permitted most of the activities to be within walking distance of each other.[3] For this reason, a central terminal serving inter-city bus travellers permitted most of the final destinations to be reached on foot. Where destinations were not in the city center, the local transit network, which focussed on the city core, provided ready access to most parts of the city. Even though central bus terminal locations lengthened line haul travel times

as buses had to negotiate city streets into the core, it is estimated that total travel times were minimal, as lengthy access journeys could be avoided by passengers having central destinations. Thus, "bus depots were considered necessarily located in the heart of the downtown area for the convenience of those coming in from rural areas."[4]

Once having accepted the need for a downtown location, the literature concerns itself with the microscale of location, including factors relating to land economics, congestion, and terminal operating revenues. The concern for congestion has been suggested as the initial reason for the establishment of bus terminals and originates from early loading practice. The earliest terminals were, in effect, street loading facilities at designated drug stores, hotels, cafes, or carrier offices where passengers could gather before loading.[5] Parked buses at these points added to the congestion and city ordinances were devised in many cities to prohibit this practice in downtown areas. As the bus operators recognized a need for a downtown terminal location, off street facilities quickly developed. For example, the bus terminal at Knoxville Tennessee, constructed during the 1920's is claimed to be a direct consequence of such an ordinance.[6]

The importance attributed to congestion caused by parked buses is reflected in a submission to Boston City Council in 1925 which requested a permit to operate buses in and out of that city. The vice-president of the Boston and Maine Railroad told the council:

> "If we engage in the bus business to and from Boston, we shall not ask for the privilege of occupying city streets, adding to the already serious congestion. Instead, we shall plan to provide an adequate terminal off the street."[7]

Parked buses on public streets was a condition that could not be tolerated.[8]

The previously mentioned city planning conference approached the problem of congestion from a general urban quality viewpoint and suggested:

> "The way to determine where an inter-urban station should be located should be based on its effect on the congestion of traffic within the city itself, and if its location at a certain place would cause congestion in our streets, then we do not want it at that particular place."[9]

In this case, congestion is a factor in determining location.

The role of land economics was of great concern to terminal developers and operators. As the core was usually compact, any location for a terminal that was within walking distance of a large portion of that core was considered satisfactory to the majority of passengers. As "main street" locations were expensive, a near main street location having the just mentioned requirements was often considered desirable.

> "A site convenient to, but not on, a main street has definite advantages. First costs and taxes can be reduced. There should be no decrease in business; locations 'just around the corner' should make little difference to city patrons."[10]

Examples of such 'just around the corner' locations can still be found in most smaller communities (e.g. Hope and Vernon B.C.), and in many larger cities. For example, the bus terminal constructed in 1931 in Toronto, at Bay and Dundas streets,

was close to the main street (Yonge St.) but not on it.[11] A more recent example is Chicago's Greyhound terminal built in the early 1950's at the edge of the loop.

The rentability of terminal space was an additional economic factor in terminal location. This is especially true for smaller terminals where bus ticket revenues and bus related income could not support the terminal and additional rental space had to be provided. Most terminal designs predating the second world war provide evidence of this fact and include restaurants/coffee bars, shoe shines, book stalls, etc. A post war example is the Greyhound terminal in Chicago which has loading areas below street level, "thus clearing the way for maximum exploitation of the valuable areas at street level."[12] A location on a major through street or as close to the center as economically possible would result in higher rental income from this space in terminals.

In summary, early bus terminal location was usually determined by individual operators who recognized the importance of passenger destinations. As most of these destinations were in the city core, central or near central location for terminals were common. The near central location was preferred as high land cost and congestion problems could be overcome without appreciably lengthening the access/egress journey times, while permitting reductions in line haul travel times.

2.3 Location Optimization - The Gravity Principle.

The inference from the early literature that bus terminal locations should be as near as possible to passenger origins and destinations, is one which is strongly supported by more recent literature on the subject. Many of these studies use the measure of time and cost to establish evaluation of terminal location and suggest that the optimal location for a terminal is one where the aggregate times and costs are minimal for all journeys to and from the terminal.

Basically this approach is based on the use of the gravity principle which suggests that the number of trips between two points will vary directly with the total population of those two points and inversely with the distance between those two points, either with reference to a particular mode or to all modes. Thus, if the criteria are to promote travel between two points, either with reference to a particular mode or to all modes, and if populations are constant, the gravity principle suggests that the reduction of distance between the two points will accomplish this desired effect of promoting travel. As was indicated in the introductory chapter, time and cost are good measures of the distance as shifts in demands can be largely related to shifts of these factors.[13] Statistical analysis of data available made by such study groups as M.I.T., S.A.R.C., and Consad Research Corporation tend to confirm this view.[14, 15, 16]

The importance of the access and egress journeys on

the demand factor can be particularly significant when they form a major segment of the total travel time, as is the case in the Northeast Corridor in the United States (Boston-Washington). Therefore, if demand for inter-city travel via common carriers is to be encouraged, these access or egress journeys need to be minimized. One method of minimization is the location of a terminal according to the gravity principle which states that the location should be at the gravitational centre - the point where the measures used for distances are minimal - of all the origins and destinations. Although this statement suggests the evaluation of location to be a relatively simple process, it is the determination of origins and destinations that have created the stumbling block for adequate determination of the gravitational center. In trying to estimate the location of origins and destinations, an analysis by Cramer suggests that the number of origins and destinations at a location is approximately proportional to the number of people living at that point.[17] This method of relating origins and destinations to populations, associated with a measure of the access costs for each individual location to any other location, will identify the most accessible point in the community studied. The model used to identify this point, however, does not recognize the fact that the per capita trip generation can vary and that in urbanized areas this generation will vary from point to point. Further, this approach does not take into consideration those points having low population densities but high trip generation rates such as the central business district.

S.A.R.C. suggests the location of origins and destinations can be identified with a location attractiveness factor which is a "measure of the appeal of specific locations as destination points, estimated from employment in industries supplying traveller accommodations and services".[18] Other factors related to trip generation were found to be per capita income and total employment levels. With reference to income, the study found a correlation between the socio-economic factors of family income and the frequency of travel.[19]

The attractiveness of particular locations of origin or destinations was reflected in the terminal location study of the Buffalo area made by Scott and McCullough with the use of a modified gravity model. The study revealed that air travellers not residing in the city had differing destinations from residents. The CBD has a locational attractiveness for non-resident travellers that does not appear for residents. This pattern became evident once the destination matrix had been split according to resident and nonresident passengers.[20]

Further, with respect to the distribution of origins and destinations in urban areas, the trip purpose of travellers using a particular mode can be of influence. It is suggested that passengers having non-business purposes will have a wider distribution of origins and destinations than those on business trips. Business travellers tend to have origins or destinations centered in areas of high employment or traveller accommodation and services (location attractiveness). Those on non-business

travel, reported in one survey, that the major purpose of their trip was to see friends and relatives.[21] As modern North American cities have scattered residential areas, non-business destinations can be expected to be more scattered than those for business trips.

Measuring the distances to the various origins and destinations in terms of time and cost from the terminal can be quite complex, as, for example, it has been found that trip purpose and income levels of passengers will affect the evaluation of those factors. Unfortunately, most of the work in this field is based on urban transport and commuter flows but the findings can be applied to inter-city travel as well. Beesley, in his analysis of the value of time spent travelling, shows that workers who are earning about the average wage value time spent travelling in the journey to work at about one third of their wages (31 - 37%).[22] Similarly, Quarmby found that commuters tend to value travel time at 20 - 25% of their income and that the proportion is roughly constant over a wide range of incomes.[23] Despite the discrepancy in percentages, it is shown that the value of time does rise with income. Therefore the willingness to pay for the time saving a particular mode offers, will be dependent upon the passengers' evaluation of time. This indicates the sensitivity of model competition to the type of traveller and the performance characteristics of each inter-city mode.

The "Metroliner" experiment between Washington D.C. and New York was based on this concept of the willingness of

passengers to pay for time saved. It was assumed for high income travellers having origins and destinations in the central business district the increase in fare would be offset by the time savings. For this experiment it was noted the volume of business traffic having central origins and destinations was sufficiently large to warrant experimentation with new modes that could serve city centers. As central rail terminals existed in each city, fast rail service was considered to be a viable travel alternative to air, as the long and expensive access trips to and from airports could be eliminated. In New York alone, the average access time from lower Manhattan to the air terminals was estimated by S.A.R.C. to be fifty-two minutes and cost an average of $2.75. In comparison, the access trip to the Penn-Central Terminal was estimated to be 18 minutes with an average cost of 79 cents.

A comparison of the travel times before and after the 'Metroliner' is given in table 2.1 below. This table is to be used only as a rough measure of comparison as S.A.R.C. access times are used; and line haul times are from current schedules.

As the table indicates, a central location is very advantageous to those travellers having origins and destinations in the central city. It is of interest to note that the inter-city bus which has central terminals in both of these cities has similar low access and egress times for this traffic and that its low fares could make it a viable alternative to the "Metroliner" as well. Recent research has suggested that

travel times could be further reduced by the use of V/STOL aircraft with close in terminals.[24,25]

TABLE 2.1 COMPARISON OF BUSINESS TRIPS BETWEEN NEW YORK CITY AND WASHINGTON, D.C. (to and from downtown).

MODE	AIR (airbus)	BUS (express)	RAIL (Conventional)	RAIL (Metroliner)
A. Time: in minutes				
Average local access and egress time. (a)	74	33	32	32(d)
Average terminal time (b)	31	26	31	31(d)
Line haul time (c)	60	240	240	180
TOTAL TRAVEL TIME	185 or 3h.5m	299 or 4h.59m	303 or 5h.3m	243 or 4h.3m
B. Costs: in dollars				
Average local fares (e)	4.55	.84	1.41	1.41(g)
Line haul fares (f)	24.00	10.65	13.00	17.00
TOTAL FARES	28.55	11.49	14.41	18.41

Notes:

(a) Derived from S.A.R.C. data and combines access and egress times for both cities.
(b) Derived from S.A.R.C.
(c) From current time-tables.
(d) Metroliner out of vehicle times are taken from the regular rail access times. It may be that the Metroliner passenger needs less terminal time in that he has less luggage and has a pre-paid ticket.
(e) Derived from S.A.R.C. data.
(f) Derived from current time-tables.
(g) Derived from S.A.R.C. data and may be slightly higher for Metroliner passengers.

A short lived experiment similar in purpose to the "Metroliner" was introduced in Canada by the Canadian National Railways between Toronto and Montreal. The C.N.R. anticipated that the introduction of the "Turbo-train" on this route would

reduce rail line haul times between the two cities from five to three and one half hours. This would have made the total travel times by rail competitive to total travel times by air. Due to technical problems this experiment was abandonned.

To the non-business traveller, the development of such faster modes is of less importance than the increased travel cost.[26] For this reason, it has been suggested that the medium and lower income passengers will not choose a faster but more expensive mode as readily as will high income travellers. For similar reasons the location of a terminal in terms of the gravity principle is not as critical for the non-business traveller.

Cramer, in his study, considered the effect of multiple terminals on aggregate access times. He proposed a hypothesis in which it would be possible to "locate K stations in such a way that we realize the minimum average travel time from all points (in the urban area) to the nearest station."[27] Multiple terminals, properly spaced would, he argued, reduce total access times but would increase total travel times for those passengers already on the vehicle. As Vuchic argues in his article on station spacing for transit, the more passengers already on the vehicle, the less desirable it becomes to have an extra stop. The increase of aggregate in-vehicle time can be greater than the gain in access time for those boarding the vehicle.

> "1. For the maximum number of passengers using the system, the interstation spacing of stations should be increasing in the direction of (passenger) accumulation (on board the vehicle) at a decreasing rate...

2. Reduction of the number of stations below optimal increases access times, but also increases the average train travel speed..."[28]

For inter-city transport, the number of suburban terminals should therefore be limited in order to minimize total travel time. Nevertheless, suburban stations can have a profound impact on the mode choice of passengers if total access time reductions are great.

It is estimated that a new suburban bus terminal providing service from a suburb of Washington, Silver Springs Md., to Philadelphia, Pa., will draw up to 20% of the total Washington-Philadelphia passenger traffic with significant shifts from automobile and railway modes.[29] For similar reasons, the CNR established a suburban terminal at Guildwood east of Toronto.

In the CNR case, the possible gains in passenger traffic between Toronto and Montreal is considered by the railway worth the cost of the five minute delay at the station. In terms of total travel time losses for those passengers on board the vehicle versus the gain for those boarding at Guildwood, a net loss is likely. However, the loss will most likely not induce a significant shift to an alternate mode since the inter-city bus loss is less than the travel time of the next less rapid mode. Also, in terms of total travel time the five minutes (out of five hours) is insignificant. Nevertheless, without further data, it is difficult to assess the addition of this terminal in terms of reductions in aggregate travel times.

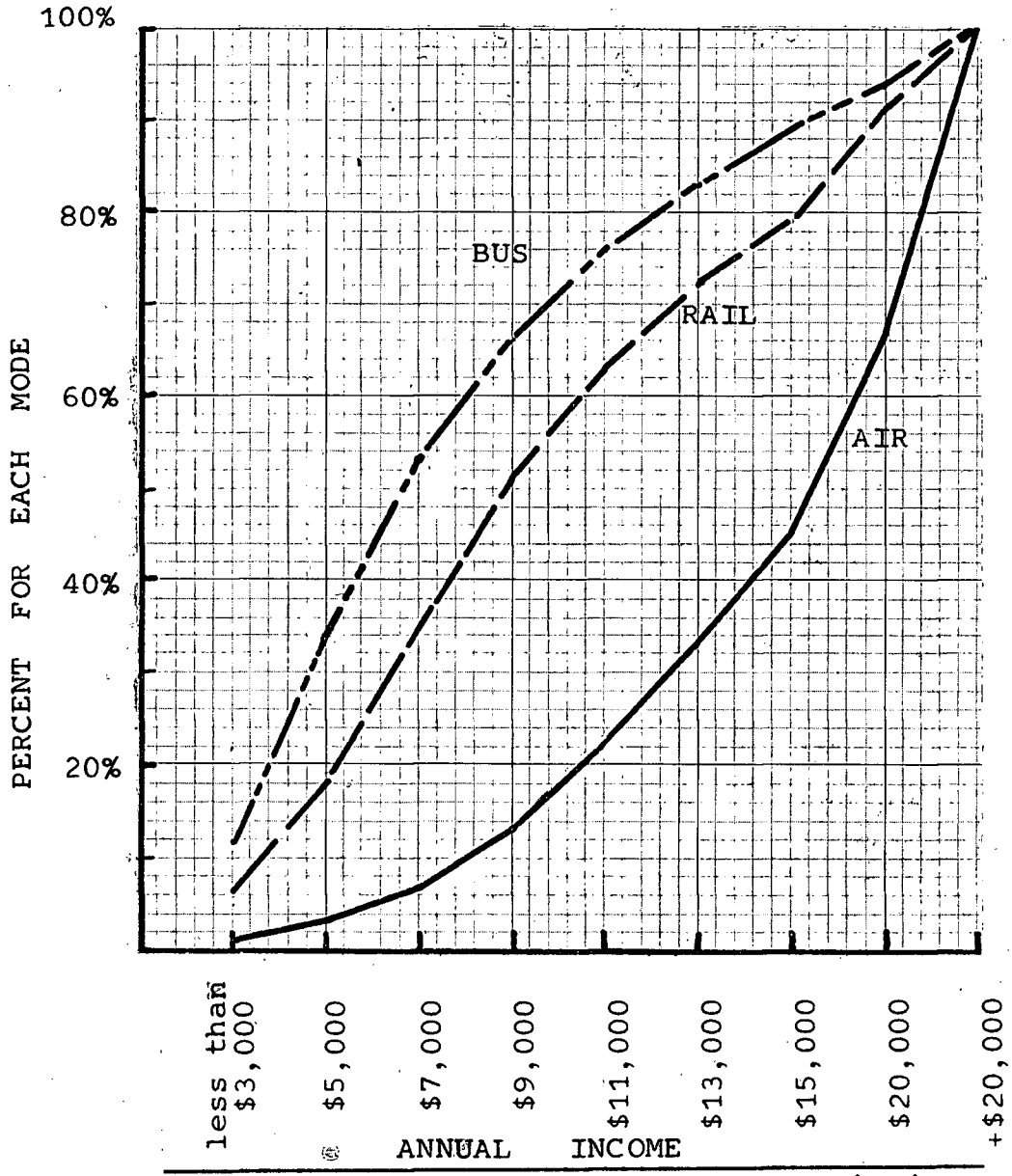
In summary, the gravity principle can be applied to the location of terminals when the criterium is the reduction of access and egress travel times and costs. As the access and egress journey is frequently a significant element in the total inter-city trip, the minimization of their time and cost can enhance the demand for a specific mode and shift the demand balance among the various modes. Thus if the objective is to increase the demand for a particular mode, a terminal should be located in terms of this gravity principle.

2.4 Passenger Characteristics.

Statistics for inter-city travel reveal that each common carrier mode has attracted specific types of passengers in terms of income levels and trip purpose. A stratification is suggested which appears to reflect each mode's performance characteristics and passenger evaluation of time and cost. Data generated for the Northeast Corridor and the Canadian Corridor (Windsor to Quebec City) have shown such stratification in terms of passenger income levels and trip purpose.

For example, in Toronto-Montreal travel, line haul times for bus and rail differ by one hour- rail five hours and bus six hours. Both modes, at the time of the survey, had central terminals in both cities. The line haul journey by air is significantly shorter in terms of time than the two ground modes. Total travel time by air from downtown to downtown (including terminal times) is about three hours. It was found that the median income of rail users was in the $9,000

FIGURE 2.1 CUMULATIVE DISTRIBUTION OF PASSENGER INCOME ON INTER-CITY MODES (TORONTO RESIDENTS).



Data Source: Canadian Transport Commission, Intercity Passenger Study.

to $11,000 range, while income of bus passengers was in the $7,000 to $9,000 grouping. Only 13.5% of bus passengers had an income exceeding $15,000 while for rail this amount was 19.6%. Air passengers had a median income of over $13,000 in 1969. Air fares are approximately three times that of the two ground modes. The distribution of incomes of users of these three modes are shown in figure 2.1.[30]

The graph in figure 2.1 is revealing in that the two ground modes, rail and bus, have comparable clientelle types in terms of income distribution. Similar travel times and comparable fares (rail $11.90; bus $12.15) help account for this distribution similarity.

Statistics for the Northeast Corridor tend to agree with the Canadian data. In summary, the Philadelphia-Washington data amassed by Beimborn revealed that "the low income traveller prefers the bus (69.1%), followed by the automobile (24.1%);..the high income traveller prefers the automobile (44%), followed by air (34.8%) and rail (18.5%)."[31] The study indicated that the differences in usage arises from the value placed on time by the different groups. Bus travel times in the example used were much longer than rail. Central terminal locations existed for both bus and rail. These income data are reproduced in table 2.2.

TABLE 2.2 USAGE OF INTER-CITY MODES BETWEEN PHILADELPHIA AND WASHINGTON BY INCOME GROUPS IN COMPARISON WITH SARC DATA

MODE	LOW INCOME*	MEDIUM INCOME	HIGH INCOME	TOTAL	SARC TOTAL
AUTOMOBILE	24.1	57.7	44.0	50.2	59.0
AIR	0.0	0.0	34.8	6.9	5.1
RAIL	6.7	23.5	18.5	20.1	21.3
BUS	69.1	18.8	2.6	22.8	14.6
TOTAL	100.0	100.0	100.0	100.0	100.0

*LOW INCOME - Under $3,000/yr.
MEDIUM INCOME - $3,000 - $10,000/yr.
HIGH INCOME - $Over $10,000/yr.
- Source: Beimborn

The Canadian Transport Commission study on inter-city travel indicates that an overwhelming proportion of bus travellers have lower incomes and are travelling for pleasure rather than for business. The greatest proportion of air travellers are on business trips.[32] (It should be noted that the data were based on travel in peak summer months and are therefore weighted towards pleasure travel). An example of the distribution of business versus pleasure travel is shown in table 2.3 which summarizes some of the CTC data.

Table 2.3 TRAVEL PURPOSE - % FOR CITY PAIR.

MODE	MONTREAL-TORONTO BUSINESS	MONTREAL-TORONTO PLEASURE	MONTREAL - OTTAWA BUSINESS	MONTREAL - OTTAWA PLEASURE
AIR	81.85	18.15	79.13	20.87
RAIL	26.61	73.39	35.33	64.67
BUS	21.13	78.87	23.80	76.20

Source: CTC

In terms of the gravity model, part of the observed pattern of business versus pleasure and income levels can be explained by the longer travel times by bus (as compared

to air) and the associated lower fares. As rail and bus times and fares are somewhat comparable, rail transports passengers having similar characteristics as bus passengers. In the U.S. lower fares generally prevail for bus service and some differences appear to exist in the passenger composition between rail and bus. Using these observations as a reference point, the improved times available on the "Metroliner" in the U.S. experiment should result in higher passenger income levels and increased business trip patronage than regular rail service.

2.5 Passenger Origins and Destinations.

The "Metroliner" and "Turbo-train experiments were justified by the fact that the city center is still a major generator of origins and destinations of business trips and rail terminals are located in those centers. This is despite the substantial spatial growth of all metropolitan areas. Los Angeles, which is one of the prime examples of dispersed patterns, still generates 20% of all its air passenger origins and destinations in the central city.[33] Nevertheless, the central area of any particular city may generate a higher proportion of airport trips (than any other comparable area in the city). Results from numerous studies indicate that origins and destinations outside of the central area are geographically dispersed throughout the urban metropolitan area.[34]

Data generated by Lansing concerning Northeast Corridor cities indicated that 40% of all air travellers do have

destinations within the central areas and an additional 31% are scattered up to 15 miles from the core. A similar pattern exists for bus and rail passengers. The data given are in linear form in terms of distance from the terminal and do indicate the extent of scatter within this fifteen mile radius.[35]

The S.A.R.C. study approached the problem in a similar fashion using travel times as the distance measure from the central terminal. As a base for further computation, auto travel times were calculated for the trip between the home and the terminal; and taxi travel times were used between downtown business areas and the terminal. For home based trips, access travel times by auto to rail, bus and air terminals were almost equal for most of the Northeast Corridor cities. This reflects the location of the terminal in the urban center and suggests that home based origins are located between the downtown rail and bus terminals and the urban fringe air terminals.[36]

These base times, however, require adjustment as not all passengers travel by car or taxi. In fact the study noted a remarkable variation in access mode choice for the different inter-city modes. The varying speeds and waiting times for the access modes required an adjustment of the base data that indicated higher average home based access times to rail and bus terminals than to air terminals. For downtown based trips this relationship was reversed. The data presented by S.A.R.C. provides a useful insight into this relationship and is summarized in tables 2.4 and 2.5 following.

TABLE 2.4 LOCAL TRAVEL MODES FOR INTER-CITY TRAVELLERS IN NORTHEAST CORRIDOR. (%)

LOCAL MODE	HOME ORIGIN			DOWNTOWN ORIGIN		
	AIR	RAIL	BUS	AIR	RAIL	BUS
AUTO/DRIVER/PASS	39	40	45	5	-	-
TAXI	39	37	12	55	50	25
LIMOUSINE	22	0	0	40	-	-
LOCAL TRANSIT	-	23	43	-	35	45
WALK	-	-	-	-	15	30
TOTAL	100%	100%	100%	100%	100%	100%

Source: S.A.R.C.

TABLE 2.5 AVERAGE LOCAL TRAVEL TIMES (IN MINUTES)

SMSA	HOME ORIGIN			DOWNTOWN ORIGIN		
	AIR	RAIL	BUS	AIR	RAIL	BUS
NEW YORK	51	60	70	52	18	18
PHILADELPHIA	55	65	76	27	14	15
BALTIMORE	39	45	53	32	14	15
WASHINGTON D.C.	41	48	56	22	14	15

Source: S.A.R.C.

With respect to bus stations, a summary of access trips to bus terminals in Washington, New York and Buffalo show the largest proportion of trips via local transity modes.

The distribution of origins and destinations included in the Canadian Corridor study appears to be consistent with this U.S. pattern. In Toronto and Montreal the highest density of origins and destinations occured in the city centers. However, the Montreal distribution of air travellers does have a sub-peak of resident passengers to the west of the city center which suggests a substantial percentage of air passengers live in the western part of the metropolitan area.[37] The highest density of bus and rail passengers lies within the

central city area. With regard to local mode choice, the C.T.C. study noted a variation of local mode choice with the change in distance from the terminal of the origin or destination. A large proportion of the journeys to downtown terminals are by foot, taxi, and public transport with foot being preferred for the shorter journey (less than two miles). The greatest proportion of airport access trips in Toronto and Montreal was completed by automobile.

Unfortunately the data available do not show the distribution of trips in terms of trip purpose to indicate whether or not there is a characteristic distribution for each type of trip. This is important as the various modes do reveal stratification as shown earlier. The C.T.C. data do support the view that trip origins and destinations are not homogeneous and are not, as Cramer suggested, proportional to the number of people living at that point.

In summary, the various studies indicate that the central areas of most North American cities are still the most concentrated generators of inter-city traffic. However, once outside these areas, there is a wide scatter of origins and destinations. This dispersal pattern is dependent upon the distribution of population and their socio-economic characteristics as well as upon the distance from various terminals. It is apparent that high income areas will produce more trips and those trips are usually directed towards the fastest modes. Finally, for central terminals, where local public transport is available, there is a heavy use of those modes for access journey of less than ten miles.

2.6 Future Distribution of Trip Origins and Destinations.

Despite the massive dispersal of activity from the central core in North American cities, some commercial concentration has persisted in the central business district. But as E. N. Hall asks:

> "Our present cities do encompass massive institutions involving insurance, banking, finance, commerce, entertainment and education. While these constitute a substantial percentage of all travel destinations today, can we expect this structure to persist?"[38]

Hall answers this question in the negative, citing as reasons improved communications, increasing affluence, increased value placed on labour time, and spiraling real estate costs. This would imply a further dispersion of the origin and destination patterns resulting in a lower proportion of all origins and destinations in the C.B.D.

Of concern should be the dispersion of residential areas into the outskirts of cities away from the local transit systems. Transit provides the access mode for many rail and bus travellers. In terms of commuting (which appears to be the prime function of urban transit systems), Herbert Gans suggests that the great concern for reducing commuting time is far more a concern of the professional group than for the majority for whom they plan, as physical access to the central city is not important to the urban home seeker. "His decision is more often dominated by the desire for more land at reasonable cost."[39] These dispersing patterns would suggest that single central locations for inter-city public modes will require longer access journeys, thus decrease the attractiveness of

that mode in favour of the automobile.

Should the resultant increased automobile use be considered undesirable (e.g. to avoid the need for additional freeways), inter-city common carriers will have to adjust to remain competitive. Most of the suggested changes, including those previously discussed, require technological innovation of line haul modes to provide faster line haul services to compensate for increased access journey times. Suggestions to reduce the access times include the relocation and/or the addition of inter-city terminals; and the introduction of local transit modes such as "dial-a-bus". Peat, Marwick, Livingstone and Co. suggest the best alternative would be improved road systems:

> "Given the diffused nature of trip origins and destinations and the bias against the use of public transportation in most urban areas, it appears logical to argue, at least in the short run, for the provision of improved highway facilities leading to the terminal area..."[40]

2.7 Line Haul Times

In addition to the introduction of complete new technologies, improvements can be made to existing modes to improve line haul times. An extreme example of this is the extensive improvement to the track, catenary, and rolling stock that permitted the "Metroliner" experiment.[41] As was indicated in chapter one, improved highways have permitted reductions in travel times for private automobiles as well as for inter-city buses. Improved buses with turbine engines and better

road travelling abilities may result in additional savings in travel time.[42]

For the bus system, perhaps the greatest reduction in line haul times can be made in the urbanized areas where the terminal is located. As was the case with early terminals, the central city area is the point of highest congestion and frequently it is these congested streets that a bus must travel to get to its central or near central location. Improvements to terminal access or the relocation of terminals could permit bypassing of these congested streets. A classic example of such an improvement is the Port of New York Authority's Mid Manhattan Bus Terminal which was located in such a manner as to permit direct access to the Lincoln Tunnel via special ramps.[43] The location of this terminal was based on the public policy that a single terminal should replace various terminals scattered throughout mid-Manhattan and that this terminal be placed west of the congested Times Square area. The new terminal with its special ramps, was opened in December 1950 and significant line haul travel time savings were achieved (up to 30 minutes for some operators).[44] Similar special ramps exist at the East Bay Terminal in San Francisco, and at the terminal near the George Washington Bridge in Upper Manhattan.[45]

This need for easy access in and out of cities is well recognized by bus operators and has become one of their criteria for locating terminals. Greyhound's Chicago terminal, mentioned at the start of this chapter, has direct access to

Wacker Drive, thus bypassing the congestion of the Loop.[46] The general manager of Voyageur Inc. which operates a major bus network in eastern Canada, states that a terminal location must be:

> "Close to super highways so that quick exit from the congested downtown area can be made. This is important because it permits a faster running time, thereby permitting us to be competitive with other modes of transportation."[47]

The importance of reducing line haul travel times is indicated by Voyageur in its comparison of line haul travel times between Montreal and Quebec City. This run is two hours and forty minutes by bus and two hours and fifty-nine minutes by rail.

Finally, as previously indicated, line haul times will be adversely affected by additional stations in the metropolitan areas. Bus operators have introduced such terminals in Toronto, Montreal, and several other large urban areas. Suburban terminals, however, are costly as only those services entering or leaving the urban area from a particular direction can effectively use the facility. In terms of time, an upper limit to the number of such suburban terminals should be determined by a formula derived from the Vuchic model regarding time losses for those on board the vehicle.

2.8 Supply of Transport Services - An Economic Consideration.

To this point, the discussion has centered on factors relating to the demand and to the distribution of that demand for inter-city transport services. The emphasis has been on

time and direct costs to the passenger. However, the costs of possible improvements to be justified by anticipated increased revenues - directly or indirectly - from increases in patronage. Although it is not within the scope of this study to develop a cost-benefit analysis a few comments raised in the literature need to be noted.

When terminals are separate operations from the transport service, revenues from ticket sales and other activities such as concession rentals must be sufficient to cover expenses. However, as many terminals are considered to be part of the transport service (as in the view of the writer they should be considered) their justification lies in the ability to attract additional passengers to the service and to improve the total net revenue of the system. Costs incurred by the carrier to improve services are usually passed on to the users of the service, and if improvements do not attract new patronage sufficient to cover costs, higher fares may result, thus discouraging the use of the mode.

With reference to the incidence of costs, consideration needs to be given to the matter of public subsidies which form part of a national transportation policy promoting the use of particular modes and discouraging the use of others by cross subsidization. The move in the U.S.A. to use Federal Highway Funds to subsidize rapid transit can be cited as an example. In such cases, improvements to a particular mode need to be considered in terms of reduced per passenger costs for the total inter-city transportation system (including all modes).

One approach from the cost side of the demand equation has been made by McDonnell Aircraft in evaluating V/STOL terminals.[48] In determining optimal terminal capacity and location, the study related access costs and terminal costs per passenger to a function of departure volume. The optimum location is the point where access costs per passenger (an increasing function) plus terminal related costs per passenger (a decreasing function) is minimal.

A terminal cost that played a dominant role in the recent relocation of a Montreal bus terminal was land cost. In 1970, Voyageur (1969) Inc. closed its Dorchester street terminal and developed an existing facility at Berri - de Montigny into its major facility. The Dorchester street terminal was 3/10 of a mile west of the heart of Montreal - at Place Ville Marie - while the new terminal is 1½ miles east of this point. The shift in location was made despite the operator's opinion that a downtown terminal is most desirable. The company admits that the decision was primarily based on land economics and indicates the land value at Dorchester street was $60.00 per square foot in comparison to $25.00 per square foot at the more remote terminal. In this case, the savings in land costs (and the possible increased revenue from alternate land use) offset any anticipated losses of passenger volume due to the less central location. The company did feel, however, that the new location was a viable alternative as ready access is available to Montreal's metro.[49]

Although this treatment of economic aspects is cursory, the comments demonstrate that the cost of terminal construction can affect location decisions and may result in locations which do not minimize all travel times. In effect, the decision-making process for operators may involve economic factors not related to the transportation system as such when transportation forms only a part of the total enterprise.

2.9 Community Planning Considerations.

As Scott and McCullough pointed out in their study of Buffalo, once an optimal terminal location has been found with respect to minimal travel times, certain modifications in location choice may be necessary for urban planning reasons, such as traffic planning, urban land use, the impact of location on local traffic patterns, noise and other forms of pollution, and the compatibility of the activity with adjoining land uses.

With reference to traffic patterns, congestion levels in mid-Manhattan resulted in the city government policy to remove the bus terminals from the Times Square area. In this case the volume of buses on public streets created additional and undesirable congestion levels which could have been avoided by relocation of terminals. Gaekenheimer's discussion presented in the introductory chapter considered the problem of congestion caused by the concentration of all access and egress journeys. He suggested a single terminal to serve all inter-city modes is undesirable. This statement does

indicate that the Metro center project in Toronto may need re-evaluation as congestion problems could occur on the access systems.

Environmental questions have frequently been raised concerning the noise and air pollution created by inter-city vehicles. For example, there is much concern over the location of V/STOL terminals in central cities as the noise problems associated with this vehicle have not yet been overcome. This environmental factor of noise could prevent the location of these terminals at the most desirable location in terms of origins and destinations.

Using the example of the Toronto subway, it was suggested by Heenan that the location of terminals can have profound impact on urban development patterns. For example, the intensity of new development and the volume of retail sales near terminals is directly proportional to the passenger traffic to and from the closest subway station.[50] In effect, a terminal can spur urban renewal. It is hoped that the Toronto Metro center scheme will stimulate redevelopment in the lower downtown area in a similar fashion. According to the developers:

> "The health of the city, especially its downtown core depends heavily on the efficiency of its transportation.
>
> The organization of road, rail and pedestrian facilities into logical inter-relationships is at once a foundation and a motive force of the projects' master plan."[51]

The terminals are considered to be an essential feature for the success of the project.

Therefore, the long range plans and development concepts for an urban area can be strengthened by the location of terminals consistent with such plans. On the other hand, the existence of long range urban development plans can assist the planning of future inter-city traffic by permitting operators to select appropriate terminal sites which interface with local modes - e.g. with subways. Knowledge of plans for future highways can assist bus operators greatly in selecting the location of sites that will reduce line haul times in the future.

2.10 The Ottawa Terminal Relocation - An Example.

A recent shift in traffic demand from rail to bus for travel between Ottawa and Montreal demonstrates the importance of a central location near the transit system. On this route there is both regular bus and rail service with the same travel times of 2¼ to 2½ hours. Both modes charged in 1969 approximately the same fare, $4.00, for the 120 mile journey. As was observed in the C.T.C. data, both modes carry passengers of similar income levels.

Prior to 1967, both carriers had downtown terminals in Montreal and Ottawa. In Ottawa, the terminals were situated close to the Federal Parliament Buildings and the accompanying concentration of federal offices. This area is also the central business district. Both terminals were near all major transit routes and downtown arterials.

In 1967, the C.N.R.-C.P.R. rail terminal was moved 1.5 miles to the south-east of the downtown area. The new station is located along Ottawa's major east-west freeway, the Queensway which has direct access to the facility. The location, however, does not lend itself to the local transit network configuration and the Ottawa Transit Commission does not serve the station. An experimental service was operated in 1967 but was soon abandonned. The relocation of the terminal was part of the beautification project of the Rideau Canal and removal of the station from the bank of the waterway permitted the relocation of yards as well.

Shortly after the relocation of the terminal, the inter-city bus operator experienced a substantial increase in patronage. Although actual statistics are not available, the operator claims the growth was substantially greater than was expected from the "Expo 67" traffic generation and higher levels of patronage have continued since that time.[52] In response to that growth, the bus operator has doubled the frequency on the Montreal-Ottawa route to hourly service. Meanwhile the railways have suffered substantial traffic losses.

The bus operator attributes this shift in ridership to the relocation of the rail terminal. The shift away from rail can be partially explained by the decrease of accessibility to the central business area and the public transit system. The Ottawa CBD is believed to be the origin and destination of a large number of business as well as recreational trips

and the new rail terminal is no longer within walking distance. Taxi is the only public transport available to the rail station. The terminal is convenient only to those who complete their access or egress journey by automobile.

The increase of time and cost of access to the railway station has altered the balance of demand in favour of the inter-city bus as the downtown bus terminal location offers lower overall travel time than does the railway from its single suburban terminal. Ottawa is therefore an example of the importance of central terminal location. It demonstrates the impact of access mode availability. Further, this example demonstrates the impact of urban planning decisions which did not enhance the demand for inter-city transportation systems.

2.11 Inter-city Terminal Location, a Summary.

Much of the literature referred to in this chapter is based on the total systems approach which describes the balance of demand among the various inter-city modes and the effect on that balance if certain factors affecting that demand are varied. Factors relating to time and cost have been found to be prime determinants of this balance and variation of these factors explains a great deal of the observed shifts in inter-city travel. Further, it was shown that a variation in terminal location can affect these factors and for this reason the optimization of terminal location will enhance the demand for transport as optimization will result in the minimization of aggregate time and costs of access journeys.

Therefore, it is necessary to determine the location of origins and destinations of the modes with great care.

Although the minimization of access or egress journeys is important, the evaluation of a particular location for a terminal serving a particular mode must take into account its effects on the urban area in which it is situated, and the location must be economically feasable for the operation of that mode.

FOOTNOTES - CHAPTER 2

1. Proceedings of the Ninth National Conference on City Planning, New York, 1917, p.257
2. F. L. Mogen, Letter to the Writer, February 1, 1971
3. C. Colby "Centrifugal and Centripital Forces in Urban Geography", Readings in Urban Geography, ed. H. M. Mayer, C. F. Kohn, University of Chicago Press, 1959, p. 287.
4. F. L. Mogen, op. cit.
5. J. S. Worley, "Buses, Trucks, and Architecture", Architectural Record, Vol. 90, Oct., 1941, p. 82.
6. G. J. MacMurray, "Solving the Bus Terminal Problem", The American City Magazine, December 1925, p. 651.
7. MacMurray, op. cit., p. 650.
8. Ibid.
9. Proceedings of Ninth National Conference on City Planning, p. 257.
10. H. S. Pack, "Bus Terminal Design and Construction," Architectural Record, Vol. 90, October 1941, p. 83.
11. Toronto Transit Commission, Wheels of Progress, Toronto, 1944, p. 85.
12. "Greyhounds' New Chicago Terminal", Architectural Record, Vol. 115, April 1954, p. 167.
13. Systems Analysis Research Corporation (S.A.R.C.), Demand for Inter-city Passenger Travel in the Washington Boston Corridor, Clearinghouse, PB 166 884 p. I-7.
14. B. E. Cramer, Optimum Allocation of Transportation Terminals in Urban Areas, M.I.T. Department of Civil Engineering, Clearinghouse, PB 173-684.
15. Systems Analysis Research Corporation, op. cit.
16. Consad Research Corporation, Transit Usage Forecasting Techniques, Pittsburgh, Pa., 1968.
17. B. E. Cramer, op. cit, p. 4.
18. S.A.R.C., op. cit., p. I-6.

19. S.A.R.C., op. cit., p. I-10.

20. R. S. Scott and D. M. McCullough, Optimizing Common Carrier Terminal Locations, N. Y. State, Dept. of Public Works, Clearinghouse, P.B. 184-409, p. 34.

21. Canadian Transport Commission, Research Branch, Intercity Passenger Transport Study, Ottawa, September, 1970. p.37

22. M. Beesley, The Value of Time Spent in Travelling: Some New Evidence, H. M. S. O., London.

23. D. Quarmby, "Travel Mode for the Journey to Work", Journal of Transport Economics and Policy, Sept. 1967.

24. Statler and Blay, "Role of Rotary Wing in Future Short Haul Transportation, "High Speed Ground Transportation Journal, Vol. II (1968), No. 2, p. 369.

25. "Aviation - Subway in the Sky", Time Magazine, Vol. 97, No. 5.

26. S.A.R.C., op. cit., p. I-10.

27. B. E. Cramer, op. cit., p. 10.

28. Vuchic, "Rapid Transit Interstation Spacing for Maximum Number of Passengers", Transportation Science, Vol. 3, No. 3.

29. E. A. Beinsborn, "Terminal Access and the Choice of Intercity Modes", Transportation Engineering Journal, Proceedings of the A.S.C.E., August, 1969, p. 474.

30. Canadian Transport Commission, Transportation Data; Data Abstract No. One, Ottawa, 1970.

31. E. A. Beimborn, op. cit., p. 469.

32. C.T.C., Intercity Passenger Transport Study, p. 37.

33. McDonnell Aircraft Corporation, Technical and Economic Evaluation of Aircraft for Inter-City Short Haul Transportation., Vol. III, St. Louis, Ms., 1966, Clearinghouse AD641-508, p. III-112.

34. S. G. Ladiere, F. E. Jarema, "Impact of Projected Air Travel Demand on Airport Access", Highway Research Record, No. 274, 1969, p. 21.

35. Lansing, cited in McDonnell Aircraft Corporation, op. cit., p. III-111.

36. S.A.R.C., op. cit., p. V-19.

37. C.T.C., op. cit., p. 22.

38. E. N. Hall, "Central Elements of a National Transportation System", High Speed Ground Transportation Journal, Vol. 2, No. 1, p. 88.

39. E. N. Hall, cited in R. A. Gaekenheimer, "High Speed Transit in Urban Areas" High Speed Ground Transportation Journal, Vol. 1, No. 1, Jan., 1967, p. 30.

40. Peat, Marwick, Livingstone, and Co., Terminal Interface System, U.S. Department of Transportation, Clearinghouse PB188209, p. 3.2.1.

41. G. D. Friedlander, "Railway vs. Highway - the Zoom of Things to Come", I.E.E.E. Spectrum, September 1967, p. 66.

42. B. W. Firth, Evolutionary Development of the Public Transport System, Society of Automobile Engineers, Paper No. 696124, Jan. 1969, p. 7.

43. A. J. Tobin, "The Mid-Manhattan Bus Terminal of New Yorks Port Authority", Traffic Quarterly, Volume 6, p. 69.

44. W. Owen, The Metropolitan Transportation Problem, Anchor Books, 1966, p. 63.

45. E. J. Lessieu, "Bus Terminal Planning and Design", Proceedings of the Institute of Traffic Engineers, Thirty-Fifth Annual Meeting, 1965, p. 147.

46. "Greyhounds New Chicago Terminal", Architectural Record, Vol. 115, April 1954, p. 167.

47. R. Tittley, Letter to Writer, January 12, 1971.

48. McDonnell Aircraft Corporation, op. cit.

49. R. Tittley, op. cit.

50. W. G. Heenan, "The Influence of Rapid Transit on Real Estate Values in Metropolitan Toronto," Institute for Rapid Transit.

51. S. M. Andrews, "Metro Center" Urban Renewal and Low Income Housing, Vol. 5:2, 1969, p. 2.

52. G. Gill, Colonial Coach Lines Ltd., Ottawa, Interview with writer in August, 1969.

CHAPTER THREE: BUS TERMINAL LOCATION

3.1 Introduction.

This chapter will apply the factors determining optimum location discussed in chapters one and two to one of the common carrier modes - the inter-city bus. This vehicle, because of its technology theoretically can perform its function without formalised stopping places or terminals. It can be as flexible as the automobile in route choice and does not require the specialised structures common to rail and air modes in order to pick up and drop off passengers. The flexibility of this mode, and the fact that relocation of the stopping places as a rule does not necessitate costly relocation of rights of way or runways, make the bus particularly suitable for study of terminal locations.

3.2 The Terminal in the Inter-City Bus System.

The bus stopping place with a heavy passenger density usually has a terminal structure that is capable of handling batch flows between the various access/egress modes and the line haul vehicles. The terminal usually provides

passenger holding (waiting) areas and processing (e.g. ticketing) facilities which permit reduction of bus loading time. Frequently the terminal also functions as a dispatching point and a bus express freight loading station. (Carriers still consider freight loading a minor factor in terminal location.) Despite the fact that terminals are specialised structures they do not differ from the simple road side stop in the basic function of facilitating interchange and access to the line haul mode. For this reason the discussion of terminal location must include these road side stops.

3.3 Bus Terminal Use and Location.

Before discussing the terminal in terms of its relation to origins and destinations, it should be noted that services with multiple terminals in urban metropolitan areas find an overwhelming proportion of passengers board at the central terminals. Greyhound of Canada estimates the use of the central terminal to be as high as 95% of all passengers using the services.[1] This heavy use of central terminals would suggest that they have particular attributes which make their location attractive to bus passengers despite the fact that at least 50% of the origins and destinations are outside the central business district. Some of the possible reasons for this are discussed below.

3.4. Access and Egress Journeys - Modal Choice.

The statistics previously presented indicate that the majority of access trips to central inter-city bus terminals are by local transit and by foot. This is particularly true

for access trips originating in the central city. Transit usage is highest in cities where rapid transit systems are well developed and its routes pass near the terminals. For example, in New York City 56% of access trips use transit. Even in cities with bus transit only, the proportion of transit usage is high as in the case in Washington D.C. (45%) and Buffalo (34%).[2] The studies on inter-city travel demand reveal some possible explanation for this heavy transit usage to downtown rail and bus terminals.

Most local transit networks have radials extending far into the suburbs converging towards the central area. At most central or near central terminals, access from the transit mode is easily achieved with minimal time loss. Given this transit pattern and the fact that transit will be used for distances up to 10 miles from the terminal in cities such as Toronto (as determined by the C.T.C.), the transit system is a readily available access mode from many parts of the urban area. At suburban bus terminals, access by transit is usually more difficult as the transit network is less dense and frequencies are lower. The absence, or near absence of transit, logically precludes the use of this mode for access or egress journeys. For example, at airports where good public transit is often nonexistent, taxis and limousines are important carriers (the most notable exception to this pattern is Cleveland with its rapid transit service to the airport).

The availability of transit, however, does not automatically infer that this mode will be used as frequently as it is not the fastest nor the most convenient mode and

therefore may not be used by many people. Many local transit studies show that transit use is mainly restricted to riders who find it difficult to dispose of their vehicle at their destination, who cannot drive, who will not drive on congested downtown streets, who do not have a vehicle available, and/or who cannot afford taxis. The study of transit habits in Pittsburgh illustrates this point.[3] Peat, Marwick, Livingstone and Co. suggest that the problem of parking, loading and unloading, and the general congestion existing on downtown streets restrict the use of the automobile. (Airports on the other hand, usually provide passenger parking areas and "drop off" locations, which encourage automobile use and result in higher auto access percentages).[4]

As was previously indicated, inter-city bus passengers tend to be from lower income groups (this statistic possibly reflects the large number of bus riders under 25 years of age). Fewer automobiles are available to this group and these people must therefore rely on transit to gain access to the bus terminal. As transit makes the central area most accessible to this group, heavy use of central inter-city bus terminals is made. General observations made from the data discussed tends to confirm this point. For transit-oriented access trips, the terminal should be located on a major transit route, near the hub of the system, as this point minimizes access times and costs for all origins and destinations.

The hub of the transit system, although frequently in the central business district is not always in the C.B.D., as is exemplified by the subway systems in Toronto and

Montreal. However, as the central area generates a high density of origins and destinations, especially for business trips, a terminal location outside the C.B.D. at the hub of the subway system, may not be the optimal location for C.B.D. oriented trips.

The C.T.C. survey suggests that congestion, as well as transfer and waiting times for transit make walking the fastest access mode for distances up to less than two miles.[5] Therefore, for concentrated C.B.D.'s, with central, or near central terminals, one can expect a large proportion of the C.B.D. based access journeys to be on foot. This is precisely the situation in Montreal and Buffalo. However, in New York where the C.B.D. is quite extensive and walking unattractive, this mode accounts for only 4.5% of all access journeys.[6] In general, Northeast Corridor cities have fairly concentrated C.B.D.'s and consequently over 30% of all downtown oriented access journeys are made on foot.[7] For this type of passenger traffic any central location would be satisfactory as long as it would be within walking distance of the origins and destinations.

3.5. Implications of Future Demand on Terminal Location.

Over the long run, the desirability of central locations will be dependent upon future urban land use patterns of urbanized areas. The land use pattern will determine the distribution of origins and destinations and the associated transportation developments will affect modal choice. For example, if urban planning policies

encourage the dispersal of the central business district by providing suitable land elsewhere or by allowing the transit systems that feed that centre to deteriorate, the concentration of C.B.D. origins and destinations will decline, and poor transit will increase the total travel times to central terminals.

A note needs to be made regarding the increasing use of the automobile. As the S.A.R.C. report indicates, the relative costs of automobile ownership and operation have declined since the second world war. The report suggests this trend will continue and will result in increased car ownership.[8] This can result in a greater use of this mode for line haul trips when line haul times between bus and auto are comparable. In order to attract some of this automobile traffic, and as more access journeys will be made by car, bus systems will have to provide terminals which are readily accessible by car and can store these vehicles until the passengers return. In this way, argued Beimborn, the inter-city bus can maintain its position in terms of lower total travel times and costs.[9] Beimborn suggested that suburban terminals with parking facilities could divert passengers away from other modes including the automobile. In particular, he suggests, these terminals would attract higher income travellers since a large proportion of the population dispersion occurs in the higher and middle income strata. He concludes that with automobile access, suburban terminals with line haul frequencies comparable to those of the central terminal could become more popular than terminals located in the central city.

The implication of dispersed urban development is that existing central terminals will become less accessible in terms of total access times and will probably contribute relatively fewer passengers to the inter-city bus system. If traditional public transit prevails (thus excluding personal public modes), a central terminal will continue to provide minimal access times and costs for transit riders but more and more 'choice' riders will turn to alternate terminals or stopping places.

3.6 The Line Haul Journey and the Bus Terminals.

The importance of minimal line haul travel time was underscored by the fact that the inter-city bus, which is basically an extension of the automobile, has comparable speeds and travel times to the private mode. For this reason, terminal locations should be such, that the line haul is minimized where possible to remain competitive. This was essentially Beimborn's argument favouring suburban terminals where the line haul travel time into and out of the central city can be overcome.

The proposed bus terminal in the Toronto's 'Metro Center' is of interest to bus operators because it will have direct access to the Gardiner Expressway (a major east-west freeway), thus bypassing the congestion in downtown Toronto. The new Montreal terminal at Berri-de-Montigny was considered by the operator to be suitable as access to inter-city highways can readily be achieved.

There is, however, a problem related to suburban terminals. As was pointed out by Voyageur Inc. in connection with possible terminals in the western part of the Island of Montreal:

> "It is becoming more and more difficult to service suburban areas with express services because of the location of controlled access highways" [10]

If communities West of Montreal are to be serviced, line haul times between the center of Montreal and Ottawa would be increased by 10 to 15 minutes as a slower route has to be used. Thus, using Vuchic's concept previously discussed, the effectiveness of suburban locations to attract patronage if the total travel times for those already on board the vehicle are significantly increased. A possible solution to such a problem would be to provide separate services from suburban points. However, existing patronage levels would make such a service highly unprofitable.

3.7 Inter-City Bus Costs.

The provision of bus terminals can involve substantial capital expenditure or almost none at all. For example, the New York terminals can be compared to the wayside stop with a single "Bus Stop" sign to designate its location. The bus system has the advantage over other common carriers in that extensive expenditures on rights of way are usually not required until traffic densities justify such expenditure. Capital costs of a terminal are limited to the site and structure, and the related servicing areas. These can vary according to traffic densities as well.

The provision of additional terminal structures need only be considered when existing or anticipated patronage requires specialized facilities for ticketing and baggage identification to avoid line haul delays for equipment and staff (drivers).

Substantial expenditures, however, may be required to provide direct access to transit, automobile/taxi drop off points, and automobile storage areas. In central areas such facilities could incur substantial land and maintenance costs.

Although inter-city bus systems require relatively low capital expenditures, operating costs are high as the ratio of passengers to operating personnel is low. Labour costs are of prime concern to operators and future labour contracts will most likely result in higher fares, thus making the bus less attractive to travellers. Although bus fares are still the lowest of the three common carrier modes, the inter-city bus does have the dubious distinction of having the highest increase in user costs in constant dollar terms.[11] Travel time and vehicle size are therefore extremely important in holding down fare increases.

3.8 Community Planning and Bus Terminals.

With the advent of greater controls on land use such as zoning bylaws, increasing public input has occurred in determining the location of bus terminals. For example, the development and location of the Mid-Manhattan bus terminal

was the result of a public policy to reduce congestion in the Times Square area. Public planning agencies may encourage the location of future suburban terminals near existing or proposed freeways, or near future rapid transit lines. This type of public involvement has occurred in Dade County, Florida (Miami) with the objective to enhance urban structure.[12]

3.9 Summary

Despite the wide scatter of origins and destinations of inter-city bus trips, a large proportion of the trips originate from central area terminals. This is attributable to the high use of public transit as the access or egress mode, and the focus of transit systems on the central area. As the inter-city bus will most likely continue to be the mode choice of middle and lower income travellers having non-business travel purposes, transit will remain an important determinant of location in the future.

Future urban patterns suggest further dispersal of origins and destinations which will encourage the use of the private automobile and reduce the role of local transit. In order to attract "choice" riders to the inter-city bus, suburban terminals with good automobile access and storage facilities may be required. The number of such suburban terminals will have to be limited because of delays to those on board the bus.

The location of terminals will have to be such that line haul delays caused by congestion on local streets will be minimized. This is important in order to maintain a

competitive position to other inter-city transport modes. Reduction of line haul times is particular important to minimize rising labour costs. The inter-city does have the fortunate position that capital costs are low and can rise with small increments according to passenger volumes.

As urban transport problems become more complex it can be expected and it is desirable that greater public input will occur with bus terminal location decision making.

FOOTNOTES - CHAPTER III

1. F. L. Mogen, Letter to the Writer, February 16, 1971.
2. Peat, Marwick, Livingstone, and Co., Analysis of the Locations and Functions of the Terminal Interface System, U.S. Dept. of Transportation, Clearinghouse PB 188-209.
3. Pittsburgh Area Transportation Study, Vol. 1, U.S. Department of Commerce, 1961.
4. Peat, Marwick, Livingstone, and Co., op. cit., p. 3.2.1.
5. Canadian Transport Commission, Intercity Passenger Transport Study, Ottawa, September 1970, p. 22.
6. Peat, Marwick, Livingstone and Co., Loc. cit.
7. Systems Analysis Research Corporation, Demand for Intercity Passenger Travel in the Washington Boston Corridor, Clearinghouse, P.B. 166-884, p. V-21.
8. S.A.R.C., op. cit., p. III-1.
9. E. A. Beimborn, "Terminal Access and the Choice of Intercity Modes", Transportation Engineering Journal, Proceedings of the A.S.C.E., August, 1969.
10. R. Tittley, Letter to the Writer, January 12, 1971.
11. S.A.R.C. op. cit., p. III-10.
12. Metropolitan Dade County (Florida) Planning Department Terminal Facilities Master Plan, Dec. 1968, Clearinghouse P.B. 184-729 p. ix.

CHAPTER FOUR: DISCUSSION AND CONCLUSION

The analysis of the factors affecting terminal location suggests that the hypothesis presented in chapter one is valid for urban patterns observed in eastern Canada and United States cities. The Ottawa example indicated the effects of terminal relocation on the balance of demand among inter-city travel modes and confirms this hypothesis. The optimal location for an inter-city bus terminal is in or near the central business district of a metropolitan area, near the hub of the urban transit network and with ready access to major highways.

The analysis further suggests that the optimization of terminal location in future land use patterns will require multi-terminal systems to stimulate demand for travel via such common carriers as the inter-city bus. This would reduce the need for additional inter-city highways and freeways catering to the automobile. As many of the access or egress journeys of this additional common carrier traffic will be by automobile, optimal location would be near major traffic arteries that give direct access to large areas of the metropolitan area. Such locations can be predetermined so that compatibility of land uses can be established and site costs for the terminal minimized. As shown by the Toronto examples, the

terminal can stimulate retail activity and perhaps bus terminals should be co-ordinated with the development of local town centers.

To conclude, the various studies discussed and the available data suggest three basic criteria for the location of inter-city bus terminals in urban metropolitan areas which have determined this optimal location in urban metropolitan areas. These are:

1. Maximization of demand for inter-city bus service

This maximization can be achieved by minimizing access and egress times and cost as these costs frequently form a substantial proportion of the total travel time and cost. This study shows that a central location on or near the hub of the transit system satisfies this criterion.

2. Minimization of costs per passenger carried.

This minimization can be achieved by determining a location in such a way that capital costs and line haul costs per passenger carried are minimized. Such locations should be away from the area of highest land values and should have ready access to inter-city highways.

3. Compliance with urban development policies.

This criterion requires the coordination of public and private location decision making so that the location is consistent with planning policies. In this way the terminal can assist in the realization of these

policies which are designed to improve the urban environment.

The third criterion is often neglected in the independent decision making processes of bus service operators. Public input into this process is required as was demonstrated by the congestion problems caused by buses on Manhattan's busy streets. Public input into the decision making processes will most likely increase as more complex urban and inter-city transportation problems require more comprehensive solutions.

By using these criteria for bus terminal location determination, it is possible to determine the optimal location for inter-city bus terminals.

BIBLIOGRAPHY

I Printed Books

American Institute of Planners. Proceedings of the Ninth National Conference on City Planning, Kansas City, 1917. New York, 1917.

Ashley, C.A. The First Twenty-Five Years: A Study of Trans Canada Airlines. Toronto, MacMillan, 1963.

B. C. Electric Railway Co. Ltd. Twenty-Nine Years of Public Service. Vancouver, 1925.

Greyhound Incorporated. Greyhound Annual Report. Chigago 1969.

Hilton, G.W. Due, J.F. The Electric Interurban Railways in America. Stanford California, Stanford University Press, 1960.

Loomis, N.M. Wells Fargo. New York, Clarkson N. Potter, Inc., 1968.

Mayer, H.M., Kohn, C.F. Readings in Urban Geography. Chicago, University of Chicago Press, 1959.

Owen, W. The Metropolitan Transportation Problem. New York, Anchor Books, 1966.

Salt, A.E.W. Imperial Air Routes. London, John Murray, 1930.

Schnore, L. F., Fagin, H. ed. Urban Research and Policy Planning. Beverly Hills, Sage Publications Inc., 1967.

Toronto Transportation Commission. Transit in Toronto. Toronto, 1969.

Toronto Transportation Commission. Wheels of Progress, Toronto, 1944.

Wilson, F.R. Journey to Work - Modal Split. London, Maclaren and Sons Ltd., 1967.

II Government Statistics.

Statistics Canada. Passenger Bus Statistics. Cat. No. 53-002,1969.

Statistics Canada. Railway Transport. Cat. No. 52-208,1969.

U.S. Census Statistical Abstracts of the United States. U.S. Department of Commerce, 1969.

III Research Publications and Reports

Canadian Transport Commission, Research Branch. Intercity Passenger Transport Study. Ottawa, Queens Printer, 1970.

Canadian Transport Commission Research Branch. Transportation Data: Data Abstract No. One., Ottawa, 1970.

Consad Research Corporation. Transit Usage Forecasting Techniques. Pittsburgh Pa., 1968.

Cramer, B. E. Optimum Allocation of Transportation Terminals in Urban Areas. M.I.T. Department of Civil Engineering. U.S. Department of Commerce, Clearinghouse PB 173-684.

McDonnell Aircraft Corporation. Technical and Economic Evaluation of Aircraft for Intercity Short Haul Transportation, Vo. III. St. Louis, 1966. U.S. Department of Commerce, Clearinghouse AD 641-508.

Metropolitan Dade County (Florida), Planning Department. Terminal Interface Master Plan. U.S. Department of Transport, 1968. U.S. Department of Commerce Clearinghouse PB 184-729.

National Analysts Incorporated. The Needs and Desires of Travellers in the Northeast Corridor. Philadelphia, Pa., 1970. U.S. Department of Commerce, Clearinghouse, P.B. 191-027.

Parkinson, T.E. Trends in Public Transport Systems. Swansea, University College, December, 1968.

Peat, Marwick, Livingstone and Co., Access Characteristics Estimation System - Final Report. U.S. Department of Transport, 1969. U.S. Department of Commerce Clearinghouse PB 190-444/5.

Peat, Marwick, Livingstone, and Co., Analysis of the Location and Functions of the Terminal Interface System. U.S. Department of Transportation, 1969. U.S. Department of Commerce, Clearinghouse PB 188-209.

P.A.T.S., Pittsburgh Area Transportation Study, Vol. 1. Pittsburgh, 1961. U.S. Department of Commerce, Clearinghouse.

Port of New York Authority. A Report on Airport Requirements and Sites in the Metropolitan New Jersey - New York Region. New York, P.O.N.Y.A., May, 1961.

Scott, R.S., McCullough. Optimizing Common Carrier Terminal Locations. N. Y. State, Department of Public Works. U.S. Department of Commerce, Clearinghouse PB184-409.

Scrafton D., van Steenburgh, S. The Inter-City Motor Coach Industry in Canada. Ottawa, Ministry of Transport, April 1970.

Systems Analysis Research Corporation (S.A.R.C.). Demand for Inter-city Passenger Travel in the Washington-Boston Corridor. U.S. Department of Transport. U.S. Department of Commerce, Clearinghouse PB 166-884.

Westinghouse Airbrake Co. (Wabco.). A Study of Evolutionary Urban Transportation, Volume II. U.S. Department of Transportation. U. S. Department of Commerce, Clearinghouse PB 178-268.

IV Journals and Individual Papers

Andrews, S.M. "Metro Center" Urban Renewal and Low Income Housing, Vol. 5 No. 2 (1969), pp. 2-7.

Avery, W.H. "An Integrated Urban-Interurban Transportation Concept." Traffic Quarterly, April 1969. p.285.

Beesley, M. The Value of Time Spent in Travelling: Some New Evidence. London, H.M.S.O., 1968.

Beimborn, A.E. "Terminal Access and the Choice of Intercity Modes" Transportation Engineering Journal of the A.S.C.E., Vo. 95, No. TE3., Proc. Paper 6731, Aug. 1969, pp 463-481.

Boorer, N.W. and Davey, B.J. "The Characteristics and Problems Associated with V/STOL Operations." Aircraft Engineering Vol. 6 No. 5, March 1969, pp. 47-58.

Bruce, J. Balek, A.J. "On the Need for a Definition of Demand for Transportation." High Speed Ground Transportation Journal, Vo. II, No. 3, p. 576.

de Bruijn, H.M. "Modellen voor een Wijk Rond een Station." Stedebouw en Volkshuisvesting. The Hague, May 1969. (reprint)

Detmold, P.J., Parkinson, T.E. Clark, G.A. Aspects of Intercity Passenger Transport. Canadian Good Roads Association, 1970.

Dewees, D. "The Decline of American Street Railways". Traffic Quarterly, Vol. 24 No. 2. p.563.

Dodson, E.N. "Cost Effectiveness in Urban Transportation." Ekistics, Vol. 29, No. 170 (Jan. 1970) pp. 32-38.

Firth, B.W. Evolutionary Development of the Public Transport System. Society of Automobile Engineers, Paper No. 696124, Jan. 1969.

Friedlander, G.D. "Railway vs. Highway." "The Zoom of Things to Come". I.E.E.E. Spectrum, September, 1967. p. 69.

Gaekenheimer, R.A. "High Speed Transit in Urban Areas". High Speed Ground Transportation Journal, Vol. II No. 1 (Jan. 1967) pp. 22-32.

Hall, E.N. "Central Elements of a National Transportation System" High Speed Ground Transportation Journal, Vol. II, No. 1, pp 88-96.

Hansen, W. G. "How Accessibility Shapes Land Use" Journal of the American Institute of Planners, Vol. 25, No. 3 (May, 1959) p. 73.

Heenan, W.G. "The Influence of Rapid Transit on Real Estate Values in Metropolitan Toronto. Institute for Rapid Transit.

Herbert, L. Community Consequences of Rapid Transit, University of British Columbia, Masters Thesis, 1969.

Hoel, L.A. "Evaluating Alternative Strategies for Central City Distribution" Highway Research Record No. 293., 1969.

Janelle, D. G. "Spatial Reorganization: A Model Concept." Ekistics, Vol. 29, No. 170 (Jan. 1970) pp 39-46.

Ladiere, S. G., Jarema, F. E. "Impact of Projected Air Travel Demand on Airport Access." Highway Research Record, No. 274, 1969, p. 21.

Lessieu, E. J. "Bus Terminal Planning and Design." Proceedings of the Institute of Traffic Engineers, Thirty-Fifth Annual Meeting, 1965, p. 147.

Lovin, P.J., Lumsden, A. "The Los Angeles La Brea Station." Journal of the Franklin Institute, Vo. 286, No. 5, 1968, p.500.

MacMurray, G. J. "Solving the Bus Terminal Problem." The American City Magazine, December, 1925, pp. 650-652.

Marshall, E.E. "The Role of Aircraft in Future Transport Systems." Aircraft Engineering (London) Vol. 41, No. 5 (May 1969) pp 21-28

Mauro, J. L. "A Transportation Inquisition---."Metropolitan Magazine, Vol. 64, No. 4 (July - Aug., 1968) pp 25-27

Miller, D. R.,Dela Barre, W.A. "Urban Passenger Terminal Interfaces" 1966 National Transportation Symposium, San Francisco, Aviation and Space Division of A.S.C.E., 1966, pp 411-417.

Miller, M. "High Speed Ground Transportation Research and Development." High Speed Ground Transportation Journal, Vol. I, No. 1 (January 1967) pp 13-19.

Moody Investors Services Inc. Moody's Transportation Manual. New York, Moody, 1970.

North, A. T. "The Camden Municipal Bus Terminal" The American City, Vol. 42, May 1930, pp 155-156

Pack, H. S. "Bus Terminal Design and Construction." Architectural Record, Vol. 90, October 1941, pp 83-85.

Pfarr, J. J. "A Systems Engineering Approach to Transportation" High Speed Ground Transportation Journal, Vol. 2, No. 2, p.324

Quarmby, D. "Travel Mode for the Journey to Work." Journal of Transport Economics and Policy, September, 1967.

Quinby, H. D. "Some Considerations in Ongoing Rapid Transit Planning and Design" Traffic Engineering, Vol. 40, No. 11 (August, 1970), pp 14-19.

Roennau, L. The Possibilities of Developing an Effective National Transport System in the 1970's. Rand Corporation Paper No. P. 4277, March 1970.

Silence, S. M. "A Preliminary Look at Ground Access to Airports" Ekistics, Vol. 29, No. 170 (Jan. 1970), pp 68-74.

Sillcox, L. K. "Railways Role in Speed Service, and Safety." High Speed Ground Transportation Journal, Vol. II: No. 1 (January, 1968), pp 205-213.

Statler, W. H. Blay, R. A. "Role of the Rotary Wing in Future Short Haul Transportation." High Speed Ground Transportation Journal, Vol. II, No. 2 (1968) pp 369-380

Tobin, A. J. "The Mid-Manhattan Bus Terminal of New York's Port Authority." Traffic Quarterly, Vol. 6, pp 68-75.

U. S. Government Panel on High Speed Ground Transportation. "Research and Development for High Speed Ground Transportation." High Speed Ground Transportation Journal, Vol. 1, No. 2 (May 1967) pp 202-240.

Vuchic, V. R. "Rapid Transit Interstation Spacings for Maximum Number of Passengers." Transportation Science, Vol. 3, (August, 1969) pp 214-232.

Wohl, M. "An Uncommon View of the Ground Transportation Problem." Transportation Engineering Journal of the A.S.C.E., Vol. 95, TE1 (Feb. 1969) pp 143-156.

Worley, J. S. "Buses, Trucks, and Architecture," Architectural Record, Vol. 90, October 1941, pp 81-83.

"Comments on Terminals - Terminal Planning for Future Highways." Journal of the Highway Division of the A.S.C.E., Vol. 92, No. H.W. 2 (Oct. 1966) pp 64-74.

"Greyhound's New Chicago Terminal." Architectural Record, Vol. 115, April 1954, pp 167-170.

V Correspondence and Interview

Gill, G., Colonial Coach Lines Ltd. Interview with writer. Aug. 1969.

Mogen, F. L., Vice President - Marketing and Traffic, Greyhound Lines of Canada Ltd. Letter to writer. February 16, 1971.

Tittley, R., General Manager, Voyageur (1969) Inc. Letter to writer. January 12, 1971.

VII Unsigned Newspaper and Magazine Articles.

"Aviation - Subway in the Sky." Time Magazine, Vol. 97, No. 5 (Feb 1, 1971)

"Fighting a Doggy Image." Time Magazine, Vol. 96, Nov. 2, 1970, p. 59.

"Railpax Passenger Trains Will be in Service in Six Months." Railway Age, October 26, 1970, p. 14.