Mass Transit in the Utilization of City Streets

WILLIAM P. WALKER, Highway Transport Research Engineer, Bureau of Public Roads
and ROY A. FLYNT, State Highway Planning Engineer
State Highway Department of Georgia

● MASS TRANSPORTATION is recognized as a highly desirable component of the over-all transportation scheme in urban centers. In recent years mass transit systems have experienced a decline in patronage while the number of persons using privately owned automobiles has represented an increasingly larger percentage of the people transported over city streets. The overcrowding of streets is often attributed to this decline in mass transit patronage, and fears have been expressed that cities, and more particularly their transit companies, are facing economic ruin unless the trend is arrested. Subsidization has been proposed, and in several cases resorted to as a means of maintaining mass transit service.

The purpose of the street system is to serve the public, and decision as to how this service can be most satisfactorily and economically provided rests with the highway user, taken collectively. The increased use of private automobiles at the expense of transit patronage is merely a registration of highway user attitudes regarding this decision. However, the expansion in automobile usage has thus far taken place on streets that have undergone only minor change or improvement through the years, and the outlay for capital improvements for street systems has not approached the rate of growth of private automobile usage.

Heavy expenditure for street improvement is a prerequisite to the unabated growth of vehicular traffic. Therefore, the full impact of road-user costs has not been felt by the private automobile user, and the preference which he has thus far exhibited might be altered if he could be apprised of his share of the burden of street improvement costs.

A thorough investigation of the economics of mass transit versus private automobile usage of city streets would be very far reaching and would cover all of the various aspects of user costs, convenience and comfort factors, time savings or losses, and other operational economies. As one phase of an economic investigation, this study compares the relative efficiencies of mass transit vehicles and private automobiles in their manner of utilizing street space and moving people.

A STANDARD FOR MEASURING EFFICIENCY

Any measure of efficiency must consider the space occupied per person in the moving traffic stream, and the length of time that the space is occupied in traveling a given distance. Space per person may be expressed as the space occupied in the traffic stream by a vehicle of a particular type, divided by the number of persons carried by the vehicle. The length of time that the space is occupied may be determined by dividing the distance traveled by the over-all speed of the vehicle. Thus, for comparing efficiencies of different modes of transportation, there are three elements to be considered for each type of vehicle if conclusive results are to be obtained. These are the speed of the vehicle, the space occupied by the vehicle in the traffic stream, and the carried load. These three variables were investigated for automobiles, buses and streetcars in the Washington, D.C. metropolitan area, and for automobiles and trolley coaches in Atlanta, Georgia.

BUS OPERATION ON SURFACE STREETS

The investigation of bus operation included studies of travel speeds and of passengers carried by buses in normal operation during various periods of the day, and of the effect that buses have on street capacity. The speed and loading studies covered a number of bus lines in the Washington metropolitan area. Observers posted on buses compiled complete records showing the number of persons on board between stops, the number of persons boarding and alighting at each stop, the travel time between stops,

TABLE 1

AVERAGE NUMBER OF PASSENGERS CARRIED BY BUSES

Time	Average load (persons per bus)		
	Downtown	Intermediate	Outlying
Morning peak	30.1	47.1	25.6
Afternoon peak	48.5	53.4	36.0
Peak hour avg.	39.3	50.2	30.8

TABLE 2

AVERAGE TRAVEL TIME FOR BUSES

Time	Travel time (min per mi)		
	Downtown	Intermediate	Outlying
Morning peak	10.06	6.17	5.15
Afternoon peak	9.18	6.52	5.42
Peak hour avg.	9.62	6.35	5.28

the length of time spent in loading and unloading operations, and the cause and duration of delays.

The study extended over a period of five days, Monday through Friday, during the spring of 1950. Information was obtained on 283 bus trips (one way) divided about equally between the morning rush period, the afternoon rush period, and the off-peak or base period. Thirteen operating routes were studied.

Average Carried Load

The average loads carried by the buses during peak periods are summarized in Table 1. These buses were inbound during the morning peak and outbound during the afternoon peak. The number of persons shown is the average per bus, weighted according to passenger-miles traveled.

Operating Speed

The travel time for buses is shown in Table 2. The figures in Table 2 include minor traffic delays and delays resulting from traffic signals, and they represent the travel time for buses that were inbound during the morning peak and outbound during the afternoon peak.

Space Occupied by a Bus

In the study of the effect that buses have on street capacity, the maximum rates of traffic flow (possible capacities) for selected intersections in the Washington metropolitan area were determined by counting the numbers of vehicles entering each intersection from one of its approaches when the traffic demand was equal to or greater than the capacity of that approach. The traffic count for each signal cycle was classified as to the extent of interference by buses; that is, no interference, interference by one bus, by two buses, etc. The capacity of the intersection approach without bus interference was compared to its capacity with bus interference, and a determination was made of the number of automobiles displaced by one bus in the traffic stream. Satisfactory data were obtained for 16 intersection approaches, 11 on arterial streets and 5 on secondary or feeder streets. This study was conducted in June, 1953.

The amount of space in a traffic stream

TABLE 3

AVERAGE NUMBER OF AUTOMOBILES DISPLACED BY ONE BUS IN A STREAM OF TRAFFIC

Time	Number of Automobiles Displaced	
	Arterial Street	Secondary Street
Morning peak	3.9	1.6
Afternoon peak	2.7	1.7
Peak hour avg.	3.3	1.6

TABLE 4

AVERAGE TRAVEL TIME FOR AUTOMOBILES ON STREETS USED BY BUSES

Time	Travel time (min per mi)		
	Downtown	Intermediate	Outlying
Morning peak	5.79	3.94	2.84
Afternoon peak	6.17	3.86	3.11
Peak hour avg.	5.98	3.90	2.96

TABLE 5

RELATIVE EFFICIENCIES OF AUTOMOBILES AND BUSES IN THE UTILIZATION OF STREET SPACE AND MOVEMENT OF PEOPLE DURING PEAK HOURS OF TRAFFIC MOVEMENT ON SURFACE STREETS

Area	Type of Vehicle	Travel Time (min per mi)	Carried Load (persons per veh)	Space per Vehicle (auto. units)	Relative Efficiency
Downtown	Automobiles	6.0	2.0	1.0	1.0
	Buses	9.7	39.3	3.3	3.7
Inter-mediate	Automobiles	3.9	2.0	1.0	1.0
	Buses	6.4	50.2	3.3	4.6
Outlying	Automobiles	3.0	2.0	1.0	1.0
	Buses	5.3	30.8	3.3	2.6

that a bus occupies varies with the street width, the number of passengers loading and unloading, the gradient of the street, parking conditions, and a number of less important factors. The 11 arterial-type streets on which studies were conducted were from 40 to 60 ft wide. All but one of these intersection approaches had near-side bus stops and the exception had a far-side stop. None of the study sites was in the central business district although some were on the fringe of the downtown area. Most of the locations were in intermediate-type areas with a few being in the outlying suburban districts. Parking was not permitted on any of the arterials during the course of the studies and all bus traffic was straight through. The interchange of passengers at the bus stops was only moderately heavy. Studies were conducted during morning and afternoon hours of peak traffic movement. With such a notable variation in the conditions at the various study sites, a corresponding variation in results is to be expected. On the average arterial, one bus was found to have a displacement equivalent to 3.3 automobiles (Table 3). The range in the passenger-car equivalent of one bus was from 2.1 to 6.0. For the five secondary sites the average bus was found to be equivalent to 1.6 automobiles with a range of from 1.0 to 1.9. An appreciable difference was observed in the bus equivalent between morning and afternoon periods on the arterial streets, the former being about one and one-half times the latter, on an average.

The difference between the morning and afternoon values is presumed to be a result of differences in the conditions at the study sites and not a result of any difference in the characteristics of bus operations for the two time periods. The average of the values for morning and afternoon on arterial streets will be used in subsequent comparisons of vehicle efficiencies.

Automobile Operation on Routes Used by Buses

For automobiles the space per vehicle in the traffic stream has been taken as unity for purposes of this analysis. The two other variables, namely, travel time and the average load for automobiles, were determined by field investigation. The average number of persons in automobiles was 1.97 persons per vehicle.

Travel time for automobiles was determined by driving a test car over the routes that were covered in the study of buses. On each of these routes, 9 trips were made with a test car driven at a speed which the driver thought was representative of the average speed of traffic. Three trips were made during the morning rush hour (not necessarily on the same day), 3 during the afternoon rush period, and 3 during the off-peak period. Results of these tests are shown in Table 4. The travel time shown for the morning peak is for inbound trips only, while outbound trips only are represented by the figures for the afternoon peak.

Relative Efficiencies of Automobiles and Buses on Surface Streets

Table 5 compares automobiles with buses in their travel time, carried load, the space per vehicle in the traffic stream, and relative efficiencies. Travel time, carried load, and space per vehicle are average values for the morning peak hour in the inbound direction and the afternoon peak hour in the outbound direction. The relative efficiencies for the two types of transportation, automobiles and buses, are shown in the right-hand column, using the automobile as unity as a basis for comparison. In the downtown area, 39.3 passengers in one bus occupy as much space in the traffic stream as 6.6 passengers in 3.3 automobiles, a ratio of 5.95 to 1 in favor of the bus. These bus passengers occupy their space 1.62 times as long as the automobile occupants in traveling any given distance, so the efficiency of the bus is thereby reduced by the speed differential in the ratio of 1 to 1.62, or to 62 percent. The resultant efficiency of the

TABLE 6

RELATIVE EFFICIENCIES OF AUTOMOBILES AND BUSES IN THE UTILIZATION OF STREET SPACE AND MOVEMENT OF PEOPLE DURING PEAK HOURS OF TRAFFIC MOVEMENT ON AN URBAN FREEWAY

Type of Vehicle	Travel Time (min per mi)	Carried Load (persons per veh)	Space per Vehicle (auto. units)	Relative Efficiency
Automobiles	1.8	1.7	1.0	1.0
Buses	2.4	27.9	1.7	7.2

bus in the downtown area during peak hours is 3.7 times that of the average automobile. In the intermediate area the bus is 4.6 times as efficient as the automobile, and in the outlying area the bus is 2.6 times as efficient as the automobile.

BUS OPERATION ON FREEWAYS

The average load and rate of travel for diesel-powered buses while operating in express service on a freeway were determined as one part of a study of mass transit operation in Atlanta in 1955. The bus route traverses the northeast leg of the Atlanta expressway system, which is a freeway with full control of access. There are no intermediate bus stops between the point where the route enters the freeway in the residential district and the point of exit in the downtown area.

During the morning peak period, the average bus on the expressway carried 31.3 passengers and traveled at the rate of one mile in 2.5 minutes. During the afternoon peak period the average load was 24.5 passengers, and the rate of travel was one mile in 2.4 minutes. For the morning and afternoon combined the average express bus carried 27.9 passengers and the average rate of travel was one mile in 2.4 minutes.

Automobiles using this portion of the Atlanta expressway carried an average of 1.7 persons during the morning and afternoon peak periods and traveled at the rate of one mile in 1.8 minutes.

The number of buses in service on this route was too small to permit a reliable determination of the space occupied by a bus in a stream of expressway traffic. The Shirley Memorial Highway in Arlington, Virginia, a freeway in the Washington metropolitan area, afforded a more satisfactory location for comparing the space occupied by an automobile with that occupied by a bus.

An extensive study by the Bureau of Public Roads revealed that, for any given volume of traffic, the average bus on the Shirley Highway occupies a time-gap in the traffic stream which is 1.7 times that for the average automobile. The study covered the operation of 658 buses and more than 75,000 automobiles.

Relative Efficiencies of Automobiles and Buses on a Freeway

By using the travel time and carried load for automobiles and buses as found on the Atlanta expressway, and the space occupied by a bus as found on the Shirley Highway, buses on freeways are found to be 7.2 times as efficient as automobiles in the utilization of street space and moving people (Table 6).

TABLE 7

AVERAGE NUMBER OF PASSENGERS CARRIED BY TROLLEY COACHES

Time	Average Load (persons per trolley coach)		
	Downtown	Intermediate	Outlying
Morning peak	50.4	51.7	38.9
Afternoon peak	47.0	52.5	40.1
Peak hour avg.	48.7	52.1	39.5

TABLE 8

AVERAGE TRAVEL TIME FOR TROLLEY COACHES

Time	Travel time (min per mi)		
	Downtown	Intermediate	Outlying
Morning peak	10.66	5.55	4.22
Afternoon peak	12.19	6.38	4.31
Peak hour avg.	11.42	5.96	4.26

TROLLEY COACH OPERATION

The procedures used in making studies of bus operation on surface streets in Washington were employed in a study of trolley coaches in Atlanta. The study was made in February and March 1955, and the results are summarized in Tables 7, 8, and 9. Table 7 shows the average number of passengers carried by trolley coaches, and Table 8 shows the average rate of travel by these vehicles. Table 9 shows the average number of automobiles displaced by one trolley coach on different types of streets during the morning peak and during the afternoon peak, from studies at 11 intersections. The similarity between the displacement of trolley coaches on arterial streets in Atlanta and of gaso-

TABLE 9

AVERAGE NUMBER OF AUTOMOBILES DISPLACED BY ONE TROLLEY COACH IN A STREAM OF TRAFFIC

Time	Number of Automobiles Displaced	
	Arterial Street	Secondary Street
Morning peak	4.0	3.8
Afternoon peak	2.6	3.8
Peak hour avg.	3.3	3.8

TABLE 10

AVERAGE TRAVEL TIME FOR AUTOMOBILES ON STREETS USED BY TROLLEY COACHES

Time	Travel time (min per mi)		
	Downtown	Intermediate	Outlying
Morning peak	8.19	5.29	3.69
Afternoon peak	8.62	5.90	4.16
Peak hour avg.	8.36	5.60	3.92

TABLE 11

RELATIVE EFFICIENCIES OF AUTOMOBILES AND TROLLEY COACHES IN THE UTILIZATION OF STREET SPACE AND MOVEMENT OF PEOPLE DURING PEAK HOURS OF TRAFFIC MOVEMENT ON SURFACE STREETS

Area	Type of Vehicle	Travel Time (min per mi)	Carried Load (persons per veh)	Space per Vehicle (auto. units)	Relative Efficiency
Downtown	Automobiles	8.4	1.7	1.0	1.0
	Trolley coaches	11.4	48.7	3.3	6.3
Intermediate	Automobiles	5.6	1.7	1.0	1.0
	Trolley coaches	6.0	52.1	3.3	8.7
Outlying	Automobiles	3.9	1.7	1.0	1.0
	Trolley coaches	4.3	39.5	3.3	6.3

line-powered buses on arterial streets in Washington (Table 3) is very striking. Trolley coaches as well as buses seem to reduce the capacity of arterial streets to a considerably greater extent during the morning period of peak traffic movement than during the afternoon peak. The reason for this is not clear. As in the case for buses, the average of the morning and afternoon values for the space occupied by trolley coaches on arterial streets is used in comparing vehicle efficiencies.

Automobile Operation on Routes Used by Trolley Coaches

At the time that trolley coaches were carrying the number of passengers shown in Table 6, automobiles using the same streets in Atlanta were carrying an average of 1.7 people. The average travel times for automobiles on these same streets are shown in Table 10.

Efficiencies of Automobiles and Trolley Coaches Compared

The three variables used in this analysis to compare efficiencies of the various types of vehicles are shown in Table 11 for automobiles and trolley coaches. The figures are average values for morning and afternoon peak periods. Relative efficiencies are shown in the right-hand column of this table. In the downtown area, for example, trolley coaches are shown as being 6.3 times as efficient as automobiles. Their speed is 0.7 that of automobiles; their load is 28.7 times that of automobiles; and their space in the traffic stream is 3.3 times that of an automobile. In the intermediate area the trolley coach is 8.7 times as efficient as the automobile, and in the outlying area the relative efficiency of the trolley coach is 6.3, the same as in the downtown area.

STREETCAR OPERATION

The procedure for studying streetcar operation differed in several respects from that employed for buses and trolley coaches. The major difference, however, was that vehicles and passengers were counted as they passed fixed points along the routes rather than by having observers on the vehicles. The majority of the study sites chosen were in the downtown business district, with the remainder being in the area immediately adjacent thereto. Study sites were selected at loading platforms where automobiles and streetcars were each allotted a specific portion of the street separate and distinct from that available to the other. Attempt was made to choose locations where conditions were most favorable for mass transit operations; that is, along those routes with the heaviest traffic and highly patronized transit service.

A total of 10 sites were studied and, with one exception, these sites happened to be on important automobile routes. However, transit traffic was the primary consideration governing their selection.

Studies were conducted during morning and afternoon hours of peak traffic on four weekdays in April 1952. Information collected consisted of a simple count of vehicles in each category, and the number of persons in each vehicle. Traffic in the direction of heavier movement only was counted and the field data were summarized for each signal cycle (80 seconds). From this study a comparison was made between the space occupied by streetcars and automobiles, and of the load carried by vehicles of each type.

Average Load Carried

A summation of data for the heaviest hour at each of the ten study sites shows that 690 streetcars and 9,126 automobiles were observed. The 690 streetcars transported 35,070 passengers while the automobiles carried a total of 17,932 passengers, including drivers. Average carried loads were 50.83 persons for streetcars as against 1.97 for automobiles. The average streetcar carried 25.8 times as many people as the average automobile.

Space per Vehicle

The space occupied by the average vehicle of each type may be measured by dividing the number of vehicles per hour by the width of street available to that type of vehicle.

At the average site, 4.7 streetcars per hour per foot of width availed themselves of the space allotted to them, that is, the width of the car-track lane to the center of the street and including the loading platform. The average number of automobiles utilizing the space between the curb and platform was 35.9 per hour per foot of width. For operating conditions as they occurred during the week of the study, the average streetcar occupied 7.6 times as much space in the traffic stream as the average automobile occupied.

Travel Time

For the purpose of measuring streetcar travel time, three streets were selected and these were either within or adjacent to the central business district of Washington.

Travel time for streetcars was determined by observers working in pairs on the three streetcar lines. The observers were stationed several blocks apart and each recorded the exact time that every streetcar passed his station, together with the identification number on the side of the car. Later, the records for the two observers were compared and the elapsed time for each streetcar to traverse the known distance between the observation points was computed. Data were collected for 750 streetcars covering approximately 450 vehicle-miles of travel. The average travel time during periods of peak traffic was found to be 11.0 minutes per mile.

Automobile Operation on Routes Followed by Streetcars

The method used, as well as the results obtained, in determining the average number of people in automobiles has already been described. The average occupancy of automobiles was 1.97. The rate of travel for automobiles as measured in the study of bus operation (Table 4) is used in comparing automobile and streetcar operation.

Relative Efficiencies of Automobiles and Streetcars

The procedure for calculating the relative efficiencies of automobiles and streetcars is the same as that followed in comparing automobiles and buses. Relative efficiencies

TABLE 12

RELATIVE EFFICIENCIES OF AUTOMOBILES AND STREETCARS IN THE UTILIZATION OF STREET SPACE AND MOVEMENT OF PEOPLE IN A DOWNTOWN AREA DURING PEAK HOURS

Type of Vehicle	Travel Time (min per mi)	Carried Load (persons per veh)	Space per Vehicle (auto. units)	Relative Efficiency
Automobiles	6.0	2.0	1.0	1.0
Streetcars	11.0	50.8	7.6	1.8

of streetcars, as compared with automobiles, together with values of the variables used in developing these efficiencies, are shown in Table 12. The streetcar is shown as being 1.8 times as efficient as the automobile in downtown Washington. Data were not obtained for other areas of the city.

SUMMARY

The operation of each of three types of mass transit vehicles has been compared with automobiles that were using the same streets during approximately the same period of time. The three variables used in the comparison were travel time, number of passengers, and space occupied in the traffic stream. The resulting efficiencies, based on a comparison between these variables, are summarized in Table 13.

Figures in Table 13 cannot be used to compare transit vehicles in one city with transit vehicles in another city because the automobiles, which were used as a standard for comparison, varied in their operation on different types of streets, and more particu-

TABLE 13

RELATIVE EFFICIENCIES OF VARIOUS TYPES OF VEHICLES IN THE UTILIZATION OF STREET SPACE AND MOVEMENT OF PEOPLE

Type of Vehicle	Relative Efficiency		
	Downtown	Intermediate	Outlying
Automobile	1.0	1.0	1.0
Bus (surface street)	3.7	4.6	2.6
Bus (freeway)	-	7.2	-
Trolley coach	6.3	8.7	6.3
Streetcar	1.8	-	-

TABLE 14

SPACE IN THE TRAFFIC STREAM OCCUPIED BY ONE PERSON IN VEHICLES OF DIFFERENT TYPES

Type of Vehicle	Relative Amount of Space Occupied		
	Downtown	Intermediate	Outlying
Automobile	1.00	1.00	1.00
Streetcar	0.30	-	-
Bus (surface street)	0.17	0.13	0.21
Bus (freeway)	-	0.10	-

TABLE 15

RELATIVE EFFICIENCIES OF VEHICLES OF VARIOUS TYPES IN THE UTILIZATION OF STREET SPACE, Considering Space Occupied per Vehicle and Number of Persons per Vehicle

Type of Vehicle	Relative Efficiency of Utilization of Street Space		
	Downtown	Intermediate	Outlying
Automobile	1.00	1.00	1.00
Streetcar	3.38	-	-
Bus (surface street)	5.95	7.60	4.67
Bus (freeway)	-	10.00	-

larly between cities. Automobiles in Atlanta, for example, traveled slower and carried fewer passengers than did automobiles in Washington. It is primarily for this reason that trolley coaches in Atlanta are shown to have a higher efficiency than buses in Washington. The inference should not be drawn that trolley coaches would be almost twice as efficient in Washington as buses are. In the case of streetcars vs buses such a comparison is valid because both of these transit vehicles are compared to automobiles operating over the same Washington streets.

As another precaution, Table 13 should not be interpreted as meaning that automobiles could be substituted for transit vehicles in the numbers shown in the table and the same total number of persons be transported by automobile alone as are presently being moved by transit vehicles and automobiles combined.

Fewer people could be transported in automobiles alone than can be moved on a street by automobiles in combination with transit vehicles, but this smaller number of people would reach their destinations in a shorter length of time. If the concern is with absolute numbers of persons that can be moved on a street without regard to rate of travel, then the transit vehicle enjoys a much greater advantage than is reflected in Table 13. The space in the traffic stream which a person occupies while traveling in various types of vehicles is a more reliable measure of the number of people that can be moved past a point in vehicles of each type. Table 14 shows the relative amount of space in the traffic stream a person occupies while traveling in each of the several types of vehicles.

Translated into relative efficiencies of street-space utilization the reciprocals of the figures in Table 14 are shown in Table 15. As in the case of the figures in Table 13, a direct comparison cannot be made between trolley coaches and buses or streetcars because trolley coach operation is related to automobile operation in Atlanta, whereas bus and streetcar operation is related to automobile operation in Washington.

CONCLUSIONS

The investigations here reported upon are exploratory in nature and the interpretations placed upon the results are based on operating conditions as they actually occurred during the periods studied. Operating conditions are subject to change and the rates at which people are moved in various types of vehicles do not in any sense represent the maximum number of people that could be moved under hypothetical operating conditions. For example, in no instance was the potential capacity of the car-track lane fully utilized by mass transit vehicles although the routes studied were the most heavily traveled in the city; one site, with 113 streetcars in one hour, approached what is considered the limit in numbers that can use a street in one direction. More people could have been moved by streetcars without any further encroachment upon the street space, but this could happen only if more people wished to avail themselves of this mode of transportation, and if more streetcars were made available for their use.

In the case of automobiles, the potential capacity of the street space was more fully utilized by vehicles at most of the study sites than was the case for streetcars. Automobiles were only one-third filled to their capacity, however. To hypothesize that more streetcars could operate over a single track (if there were people to fill them) merely invites a parallel hypothesis that more people could band together as group riders in automobiles if they should so choose. For current operations, comparisons as made in this report would seem to be founded on as firm a basis as any that might be conceived. On this premise the following conclusions are drawn for peak-hour operations:

1. In Washington, D.C., buses were 3.7 times as efficient as automobiles on downtown streets, 4.6 times as efficient in intermediate areas, and 2.6 times as efficient as automobiles in outlying areas. On a freeway, buses in Atlanta, Georgia, were 7.2 times as efficient as automobiles.

2. In Atlanta, trolley coaches were 6.3 times as efficient as automobiles on downtown streets, 8.7 times as efficient in intermediate areas of the city, and 6.3 times as efficient as automobiles in outlying areas.

3. In Washington, streetcars were 1.8 times as efficient as automobiles on downtown streets.

4. The efficiencies of mass transit vehicles in Washington, as derived in this investigation, cannot be compared directly with those in Atlanta because of differences in the operation of automobiles in the two cities. Automobiles in Washington traveled faster and carried more passengers than automobiles in Atlanta.

ACKNOWLEDGMENT

This investigation is a product of the joint efforts of several agencies. The studies of travel time and of passengers carried by trolley coaches and automobiles in Atlanta were performed by personnel of the State Highway Department of Georgia, with the cooperation of the Atlanta Transit Company in the selection of routes and the furnishing of riders' passes to those engaged in the study. Field work for a determination of the space occupied by trolley coaches in the traffic stream was performed by the Traffic Engineering Department of the City of Atlanta.

Field work for the bus study in Washington was performed by Bureau of Public Roads personnel assisted by personnel furnished by the Capital Transit Company. Participation by that company included the services of five observers under the supervision of the Research and Planning Department. The company also participated in establishing procedures for the study and in furnishing riders' passes to all engaged in the study. The W.V. and M. Coach Company of Arlington, Virginia, supported the study furnishing free fares to observers operating on its lines.