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AMERICAN SOCIETY OF PLANNING OFFICIALS

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THE PEDESTRIAN COUNT

Pedestrians are not only an indisputable fact, but a vitalizing force in the activity of traffic-generating centers of the city. This is particularly so in the CBD. Pedestrian circulation and concentration on downtown streets provide a gross, if incomplete, index to how the CBD is organized and used. Since virtually every person going to the CBD by auto, train, or bus ultimately becomes a person on foot, pedestrians constitute an essential element of downtown traffic. And the movement of persons and goods over pedestrian routes comprises an indispensable part of the CBD's transportation system.

Like the vehicle, the pedestrian requires measures to ensure his mobility and safety. Where possible, his enjoyment of walking should be enhanced and his conflict with vehicular traffic minimized. In the past, these objectives have been subordinated to the more acute problem of alleviating vehicular congestion in the CBD. And because of the widespread absence of research on pedestrian volume and movement, their attainment has been grounded more in intuitive judgments than factual information.

While the sophisticated, computerized transportation studies have placed even greater emphasis on vehicular movement of people and goods in recent years, the pedestrian, largely because of the current interest in revitalizing the CBD, has been the subject of increasing attention among planners and traffic engineers. CBD plans increasingly provide for special pedestrian facilities -- malls, arcades, pedestrian precincts, to name a few -- and some envision a pedestrian circulation system as efficient as that for vehicles. Recent articles have discussed the special requirements of downtown pedestrian travel, and several in-depth empirical studies on pedestrian activity in the CBD have been undertaken.

With the likelihood of this trend increasing, it is important to know more about pedestrians in the CBD -- their numbers, habits, behavior. This report explores one rather elementary yet basic technique for gaining information about the pedestrian -- the pedestrian count, particularly its several applications in planning for a CBD pedestrian circulation system. Methodology and limitations of the pedestrian count will also be discussed as will the presentation of pedestrian count data.

[1]This and subsequent references are listed at the end of the report.

Prepared by David Emmons.

DEFINITION AND LIMITATIONS

The pedestrian count is a simple, relatively inexpensive way to measure the volume and direction of pedestrian traffic in the CBD through time and by location. As such, it provides quantitative data to evaluate the need for and effectiveness of various pedestrian planning measures at particular places in the downtown area.

When collected at a number of points in the CBD, this data may be correlated with land use, street, and transit maps to indicate the traffic pattern of pedestrians as they move between pedestrian generators. (Pedestrian generators are of two types: primary, indicating the starting point of the initial pedestrian trip -- parking facilities, train depots or bus stops; and secondary, indicating the destination of the initial and succeeding pedestrian trips which may generate further movement -- work place, retail outlet or cultural facility.)

The count may stand by itself, be a part of a pedestrian traffic survey, or be a component of broader traffic or CBD studies. It may be geographically comprehensive, covering the entire CBD, or restricted, focusing on the CBD core, particular streets, or special locations such as intersections, building entrances, and store fronts. It may be general, making no distinctions among pedestrians, or selective, tallying the percentage of total pedestrians who are women, jaywalkers, or windowshoppers.

The scope of the count will be dictated for the most part by the purpose it is intended to serve. A strong case can be made for a comprehensive count where cost factors are not prohibitive. The comprehensive count can be applied to a broad range of purposes and readily supplemented by additional data where specialized uses are called for. Furthermore, it will permit pedestrian movement to be treated as an integrated facet of the over-all downtown traffic and transportation system.

It should be cautioned that the pedestrian count alone is rarely a sufficient basis for analyzing pedestrian traffic problems. For some purposes, applications of the count explicitly require correlative information such as vehicular volumes. And, since pedestrian count data is quantitative in nature, more discreet, qualitative information on the length and purpose of pedestrian trips as well as the generation of pedestrian traffic must be supplied by other research techniques. One such technique, recently employed in Washington, D.C., and Chicago, is the downtown pedestrian origin and destination study. In these studies, data are obtained by on-the-street interviews or questionnaires, and pedestrian movement is broken down into various types of walking trips -- work, shopping, pleasure -- and linked to specific origin and destination points.

USES OF THE COUNT

The pedestrian count has specific application for each of three important criteria for CBD pedestrian planning: mobility, safety, and pleasure.

Mobility

The ability of pedestrians to move easily and directly within the CBD depends upon the degree of conflict with vehicular traffic, the extent of sidewalk congestion, the land use pattern, and the availabilty of pedestrian routes.

Conflict with Vehicular Traffic. Pedestrian-vehicle conflicts, which center at downtown intersections, are commonly alleviated by traffic signals and other control devices. To this end, the pedestrian count has several applications. It can be used to determine pedestrian volumes as one condition for installing and operating traffic signals.

a. Where, for each of any eight hours of an average day, a total of 600 vehicles per hour (vph) enter an intersection from both approaches on a major street and the crosswalk with the highest pedestrian load carries at least 150 persons per hour (pph) (traffic engineers refer to this pedestrian load figure as a minimum pedestrian volume warrant), the U. S. Bureau of Public Roads recommends installation of pretimed traffic signals.[2]

b. Where turning vehicles conflict with heavy pedestrian volumes, turn prohibitions or special vehicular turning or pedestrian crossing phases in the signal timing may be required.[3]

c. Where the number of pedestrians waiting to cross a main street intersection exceeds the vehicular volume on the secondary street, signal cycle division must be based at least in part on pedestrian volume.

d. Where pretimed traffic signals are installed or operated in part on the basis of pedestrian volume, pedestrian signals which say "Walk" or "Don't Walk" are required.[4]

e. Where the vehicular and pedestrian traffic volumes decline, for at least four hours, to 50 per cent of the normal values for the minimum pedestrian volume warrant, the signal should be operated on a flashing basis.[5]

The pedestrian count can also help determine the need or priority for constructing painted crosswalks, barriers, refuge islands, underpasses, and overpasses, generally at intersections, but at other locations as well.[6]

Traffic control devices are the simplest means of separating pedestrian and vehicular movement. Other measures, which involve more complete separation of pedestrians from vehicles have ranged from the pedestrian mall, precinct, and midblock arcade to the sunken roadway or elevated pedestrian route. The location of such extensive facilities must not merely take into account pedestrian and vehicular traffic volumes, but the pedestrian trip purpose as well. Needless to say, a shopping mall is better suited to a street carrying heavy loads of shoppers-on-foot than to one where the pedestrian flow is comprised largely of commuters-on-foot approaching and leaving their places of work.

The pedestrian count, conducted on a comprehensive basis and related to an analysis of pedestrian trip purpose, can help to pinpoint the areas of maximum pedestrian activity where exclusive pedestrian routes or areas would be of greatest benefit, and indicate their degree of use after construction. It can also indicate the degree to which such routes or areas would divert pedestrian traffic from adjacent or nearby sidewalks, thereby further reducing conflict with vehicular traffic.

Sidewalk Congestion. Pedestrian volumes and sidewalk width determine the degree of sidewalk congestions. Along the length of a block, congestion may cause pedestrians to reduce their normal walking speed or overflow onto the street. At intersections, where pedestrian volumes are generally higher and traffic lights halt pedestrian flow, sidewalk capacity may be even more taxed. Unfortunately, the question of the feasible or desirable capacity of sidewalks has not been exhaustively investigated. The Traffic Engineering Handbook notes:

> Crowds attracted by sporting events move efficiently at 33 people per 22-inch lane per minute (2,000 per hour). This rate is too high for sidewalks in front of retail stores, where pedestrian comfort and convenience is vital to business, . . . /where/ 18 to 27 per minute (1,100 to 1,600 per hour) is considered the desirable maximum.[7]

Walking speeds will normally vary on the average between 3.5 and 4.5 feet per second on level sidewalks.[8] While these standards may be adequate where most pedestrians move in a purposeful, direct manner, as through traffic, they are probably high where pedestrians are, or should be, encouraged to browse, explore, to wander leisurely. With this caution in mind, the pedestrian count may be used to determine the capacity of sidewalks to accommodate pedestrians in two ways: by examining the average rate of pedestrian speed for peak-hour pedestrian volumes to sidewalk width; and by determining the per cent of pedestrian overflow onto the street. Under conditions of exceptionally heavy overflow and minimal vehicular traffic, it may be advisable to close a street for exclusive pedestrian use, either temporarily or permanently.

The pedestrian count can also be used to examine sidewalk capacity at signalized intersections. Where pedestrian volumes crossing during the "Go" or "Walk" interval of the signal cycle appreciably exceed the volumes which accumulate during the "Stop" or "Don't Walk" interval, an adjustment of the signal cycle may be called for. Also where pedestrian volumes at the intersection corners are significantly larger than the total volume of the sidewalk approaches, congestion may be relieved by widening the sidewalk up to the limit of the vehicular traffic flow.[9]

Land Use and Availability of Pedestrian Routes. Land use and the availability of pedestrian routes act as contraints upon the distances people must walk and the paths they choose within the downtown area. Land use in the CBD may be considered as a network of pedestrian traffic generators separated by varying distances. Where related land uses are far apart, the effect may be to discourage walking between them. In the case of retail operations, which rely directly on pedestrian traffic for business, the distance between stores has vital economic ramifications. A recent survey of pedestrian habits in Washington, D.C., for example, revealed that there was greater mutual exchange of pedestrians between stores in a large retailing concentration than in a dispersed retail area.[10] And a background study for Cleveland's downtown plan noted that the separation of the two major shopping store concentrations created intervening pedestrian dead spots where nonretail functions failed to channel large numbers of shoppers-on-foot.[11] It was precisely this relation between pedestrian movement and land use which, among other things, researchers on Buffalo's CBD grasped in recommending a redevelopment project which would induce pedestrian movement through the heart of the retail area and encourage walking on both sides of the main shopping street.[12]

The inefficient allocation of land uses may also lead to longer walking trips between pedestrian traffic generators. Terminal or unloading points for various modes of transportation, inconveniently situated, will force pedestrians to make longer than average trips to major destinations within the CBD. The Cleveland study states in this regard that the existence of a single rapid transit terminal at the west end of the downtown linear core hampers pedestrian accessibility to destinations at the middle and east end of the area.[13] Parking studies have revealed a correlation between the trip purpose of pedestrians and the maximum distances they will walk to their destinations. While the decision of where to park involves a number of factors, downtown workers are generally willing to walk further than shoppers.

Since the pedestrian circulation system generally forms a grid, coinciding with the street plan, the distance between origin and destination points within the CBD is usually not equivalent to the shortest available walking distance. While the shortest route may be generally preferred by the pedestrian, longer routes may be chosen. Within the limits prescribed by land use and the availability of routes, whim, curiosity, lack of knowledge, or aesthetic motives may all influence pedestrians to take the untried or seemingly inconvenient path. In this area, the pedestrian count may be used to:

Study the pedestrian traffic-generating characteristics of various land uses throughout and at different times of the day.

Estimate the effect of new or proposed developments in the CBD -- major employment centers, parking facilities or shopping centers, -- on pedestrian volume and flow.

Provide a means to derive an adequate sampling base for conducting a pedestrian origin-and-destination study in the CBD and, concurrently, for generalizing the conclusions of such a study to the total volume of pedestrian movement.

Safety

Safety for the pedestrian is directly bound to his conflict with vehicular traffic, which results not only in reduced pedestrian mobility but also in the far more hazardous consequence of injury. Needless to say, measures undertaken to lessen the conflict and thereby enhance the pedestrian's mobility will usually benefit his safety as well. To help achieve greater pedestrian safety, the count may be used in three ways: to generalize the results of a detailed study of how pedestrians observe traffic signals[14]; to relate traffic accidents involving pedestrians to pedestrian volumes along adjoining sidewalks; and to determine the number of jaywalkers at intersections or elsewhere as a percentage of total pedestrian volume.

Pleasure

While the enjoyment and comfort of walking are ultimately determined by the total downtown environment in which the pedestrian moves, they may be enhanced by special features of the pedestrian circulation system. Such facilities as canopies, waiting stations, and heated sidewalks contribute to pedestrian comfort. Trees, shrubs, artwork, and the like provide sources of visual interest which create an atmosphere of beauty for the pedestrian. In this instance, the pedestrian count may be used to establish priorities for locating improvements for the pleasure of the pedestrian on the basis of greatest efficiency, that is, where the greatest number of pedestrians would be benefited.

Other Uses

The pedestrian count has a wide variety of other applications. Not directly germane to pedestrian planning itself, they are mentioned here briefly. The count may be used to:

a. Select retail store locations on the basis of pedestrian movement past prospective locations.[15]

b. Select locations for public buildings such as libraries so that they are accessible to the centers of CBD pedestrian movement.

c. Determine downtown retail property values on the basis of pedestrian traffic volumes.

d. Establish central traffic district boundaries for vehicular cordon counts.[16]

e. Delimit the boundaries of the CBD.[17]

f. Provide an indication of the rise or decline in CBD land values, when pedestrian volume data for a number of years is available.[18]

METHODOLOGY

A comprehensive pedestrian count, to determine the over-all pedestrian traffic patterns for a multiplicity of purposes, should include all midblock points and intersections in the CBD core. Where manpower and funds are limited, the count may be confined to midblock locations alone or to principal pedestrian routes in the CBD core. More restricted pedestrian counts should be undertaken as follows: at intersections where pedestrian accidents exceed four a year[19] or where pedestrian movement creates other traffic problems; at mid-block locations where heavy pedestrian volumes occur; or at areas or locations prescribed by the count's purpose.

To provide an accurate picture of pedestrian traffic, the distorting effects of abnormal seasonal and temporal conditions should be avoided. The count should not be conducted when unusually hot or cold weather keeps people off the streets or out of the CBD altogether. Holidays, special events involving parades and the like, or unusual disturbances such as fires and major accidents should also be avoided. The hours for the count are perhaps the crucial consideration. In all instances the count should fall between the hours of 6 a.m. and 7 p.m.; at a minimum, it should include the period from noon to 6 p.m., when peak volumes generally occur. While some counts have been taken for periods as short as six hours, nine to 12-hour counts will offer more accurate results, particularly where heavy pedestrian flows throughout the day can be expected.

The counting locations may be subject to additional distorting influences which should, if possible, be avoided; in any event, the distortions should be recorded by the counter. Street or sidewalk repairs and new construction will divert pedestrian traffic from normal routes, as will heavy activity at truck loading zones and delivery areas. Where a counting location falls between two nearby major pedestrian traffic generators -- large department stores, for example -- large numbers of pedestrians approaching and entering the generators will not be recorded. In such an instance it is necessary to relocate the count station or possibly to add a second.

While the precise manpower requirements for a counting station can only be fixed by a test count, Table 1 lists some guidelines.

For mid-block counts, a single counter should station himself on the building side of the sidewalk so as not to obstruct the flow of pedestrians. If two or more counters are required at a location, they should stand on the edge of the sidewalk that is most convenient for counting. In such cases, counting may be facilitated by dividing the sidewalk into lanes with chalkmarks. A counter using a mechanical counting device merely enters the cumulative totals on a half-hour or hourly basis onto a tally sheet and later transcribes the data on a summary sheet, subtracting one total from the next to find the actual count for each time period. (A sample summary sheet is shown in Figure 1 on page 11.) If a pencil is used, the count is tabulated directly on the tally sheet and summarized later.

For intersection counts, a single counter should station himself at the inside of a corner offering a clear view of all crosswalks. If two counters are required at an intersection, they should stand on diagonally opposite corners. Table 2 indicates the appropriate division of counting responsibility for the most common types of intersections and numbers of counters. Data are recorded in the appropriate box on a special intersection field sheet (see Figure 2 on page 11) and later entered and totaled on a summary sheet.

A half-hour -- occasionally a quarter-hour -- division for count tabulation is generally used for partial counts, while the hourly division is used for continuous counts. The latter is a complete enumeration, the counter remaining stationary throughout the count. In the former, which greatly reduces the

Table 1

PEDESTRIAN COUNT MANPOWER REQUIREMENTS

Pedestrian Volume	Number of Counters Necessary	Manual Counting Devices Necessary*	Counting Capacity of Counter
MID-BLOCK COUNTS			
If peak hour pedestrian volumes rate is: less than 2,000 in both directions	1	2	Volume for each direction of flow
Greater than 2,000 but somewhat less than 5,000 in both directions	1	1	Total volume with no differentiation by direction of flow
Greater than 2,000 in both directions	2	1 per counter	Volume of 1 direction of flow per counter
Greater than 2,000 but less than 5,000 in 1 direction	1	1 (a tally being made for every 5 to 10 pedestrians)	Volume of 1 direction of flow
As high as 10,000 in 1 direction for short periods of time	1	1 (a tally being made for every 5 to 10 pedestrians)	Volume of 1 direction of flow
INTERSECTION COUNTS**			
If volume is: light and crosswalks are used alternately	1	1	Total volume in all 4 crosswalks
Moderate and crosswalks are used alternately	1	1 or 2	Separate or total volume in 2 crosswalks converging at count location
Greater than 2,000 pph in each crosswalk and crosswalks are used alternately	8 (2 for each crosswalk)	1 per counter	Volume for 1 direction of flow in 1 crosswalk per counter

*If pencils and tally sheets are used instead of manual counting devices, the counting capacity is reduced by approximately one-half.

**This refers to simple intersections with 4 crosswalks. Where intersections with more than 4 crosswalks are involved, more counters than listed may be required.

SOURCE: Manual of Traffic Engineering Studies, p. 92.

personnel needed for an area-wide count, the counter records pedestrian traffic at one location for the first 15-or 30-minute interval of an hour, and then moves to another, nearby location for the second interval, returning to the first location at the end of the hour cycle. The process is repeated through the duration of the count. The total hourly traffic volume at each location can be approximated by multiplying the partial count data for each hour by the number of intervals in each hour cycle. However, a more accurate method of expanding the partial count involves the use of total count figures at locations with similar characteristics as the partial count locations. A recent pedestrian traffic survey of Salt Lake City describes the method:

> To expand the sample counts to an estimate for a full eight-hour day, a ratio was computed. This was done by using the counts taken at total count locations during the periods of the day which corresponded to the periods during which counts were taken at the sample locations. By adding together the counts taken during the matching periods and subtracting this figure from the sum of the all-day counts of the total count locations, a ratio was then calculated as a simple percentage. This ratio, when established, was then used to expand the counts taken at the sample locations to the equivalent of full-day counts.[20]

Table 2

INTERSECTION COUNT INSTRUCTIONS

Type of Intersection	Number of Counters		
	2	4	8
Unsignalized	Each counter counts pedestrians to and from his corner in converging crosswalks and jaywalkers on one diagonal		
Signalized (pedestrians cross alternately)		Each counter counts pedestrians to his corner in converging crosswalks and jaywalkers to his corner	Each counter counts pedestrians to his corner in one crosswalk; every other one counts jaywalkers to his corner
Signalized (pedestrians cross alternately)		Each counter counts pedestrians to and from his corner in one crosswalk and jaywalkers to his corner	Each counter counts pedestrians to his corner in one crosswalk; every other one counts jaywalkers to his corner

SOURCE: Manual of Traffic Engineering Studies, p. 93.

PRESENTATION OF DATA

The standard technique for presenting pedestrian count data is the statistical table. The example shown in Figure 3 on page 11 lists for part of a day total pedestrian traffic on east-west streets in downtown Denver. For more refinement, a table may list the hourly or half-hourly volume totals for each count location, differentiating volumes by direction of flow. For comparative purposes it is useful to rank the total volumes for each count location as a per cent of the highest volume count location.

While graphs and maps cannot present count data with the precision of a statistical table, they allow for more vivid comparison and analysis. By representing volume and time on the vertical and horizontal co-ordinates of a graph, volume lines for one or more count locations can be plotted. As illustrated in Figure 4 on page 11, the effect is to make the peak-hour pedestrian volumes for each of three count locations clearly visible. Where pedestrian counts have been taken over a number of years at various locations, graphic presentation of data facilitates comparison between corresponding volume levels.

When pedestrian count data is diagrammed onto a street map, the effect, as shown in Figure 5 on page 12, is a clear representation of pedestrian volume -- in this case at main intersections. Where midblock data are shown on a map, as seen in Figure 6 on page 12, the over all pedestrian flow pattern is readily apparent. Another variation is to diagram the direction of pedestrian movement; in Figure 7 on page 13, arrows are used to show the direction of predominant movement.

If land uses were shown on the maps in Figures 5, 6, and 7, then some insight could be obtained into the pedestrian-generating capacities of specific land uses. However, a more accurate understanding of the link between pedestrians and specific land uses requires more qualitative studies such as the pedestrian O & D survey.

CONCLUSION

If pedestrian planning is to maximize the mobility, safety, and pleasure of the pedestrian as he travels in the CBD, the characteristics of pedestrian movement must be known. To this end, the pedestrian count is a useful research aid, providing quantitative data on the volume, direction, and over-all traffic pattern of pedestrians in the downtown. Its limitations suggest that other more sophisticated research techniques must be developed to provide a more complete understanding of pedestrian traffic. Nevertheless, with greater attention being directed to pedestrian needs in the CBD, the pedestrian count, with its numerous planning applications, should not be ignored.

Figure 1

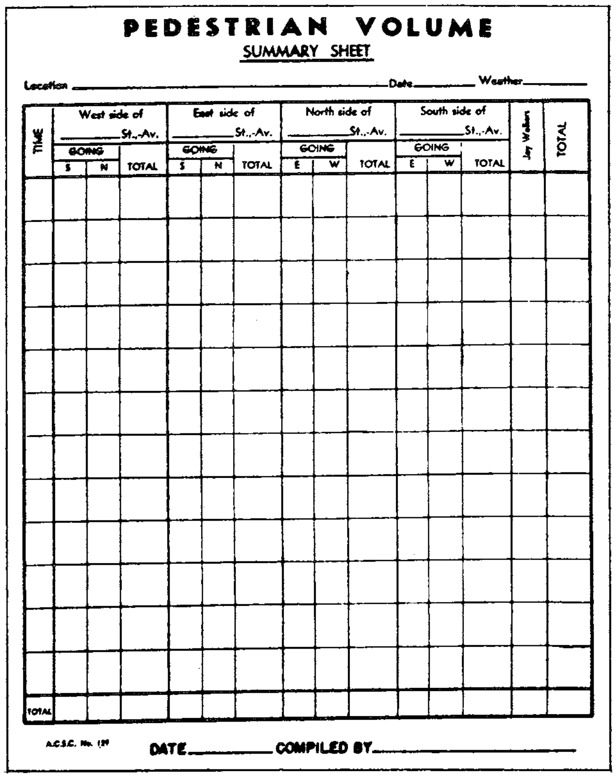
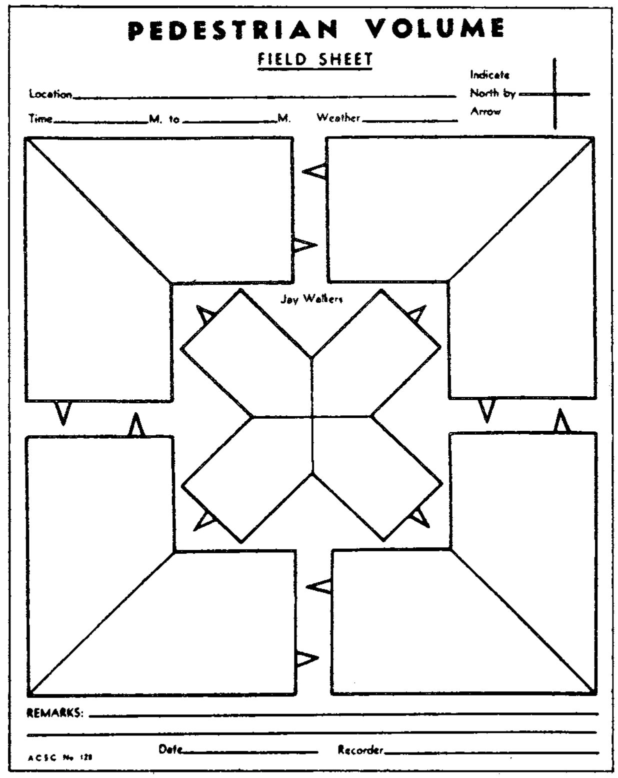


Figure 2



SOURCE FOR FIGURES 1 AND 2: Manual of Traffic Engineering Studies (New York: Association of Casualty and Surety Companies, 1953), p. 94.

Figure 3

Pedestrian Traffic on East-West Streets in Downtown Denver, June, 1951

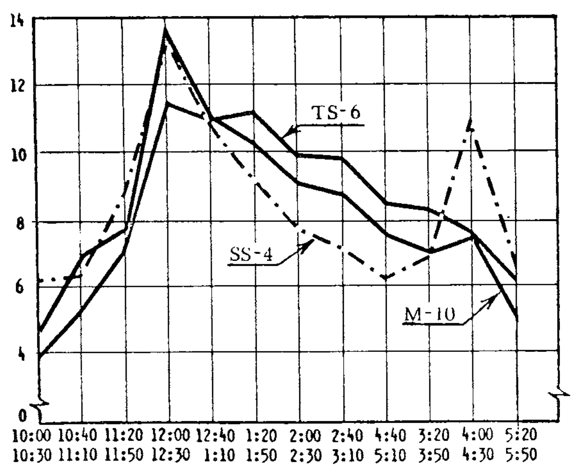
9:30 A. M.-12:00 Noon and 2:00 P. M.-4:00 P. M.

Street (both sides)	Number of Pedestrians: Male	Female	Total	Per Cent of Total Count on East-West Streets: Male	Female	Total
Larimer	9,054	1,407	10,461	5.5	0.9	6.4
Lawrence	5,228	4,045	9,273	3.2	2.5	5.7
Arapahoe	5,386	3,550	8,936	3.3	2.1	5.4
Curtis	13,482	9,623	23,105	8.2	5.9	14.1
Champa	11,335	10,913	22,248	6.9	6.7	13.6
Stout	12,192	9,755	21,947	7.5	6.0	13.5
California	10,717	8,222	18,939	6.6	5.0	11.6
Welton	9,078	4,895	13,973	5.6	3.0	8.6
Glenarm	7,704	5,035	12,739	4.7	3.1	7.8
Tremont	7,600	5,256	12,856	4.6	3.2	7.8
Court	3,857	2,167	6,024	2.4	1.3	3.7
Cleveland[a]	1,671	935	2,606	1.0	0.6	1.6
Cheyenne[b]	227	145	372	0.1	0.1	0.2
Total	**97,531**	**65,948**	**163,479**	**59.6**	**40.4**	**100.0**

[a]No count on south side between 15th Street and W. Colfax.
[b]North side only between Broadway and 15th Street.

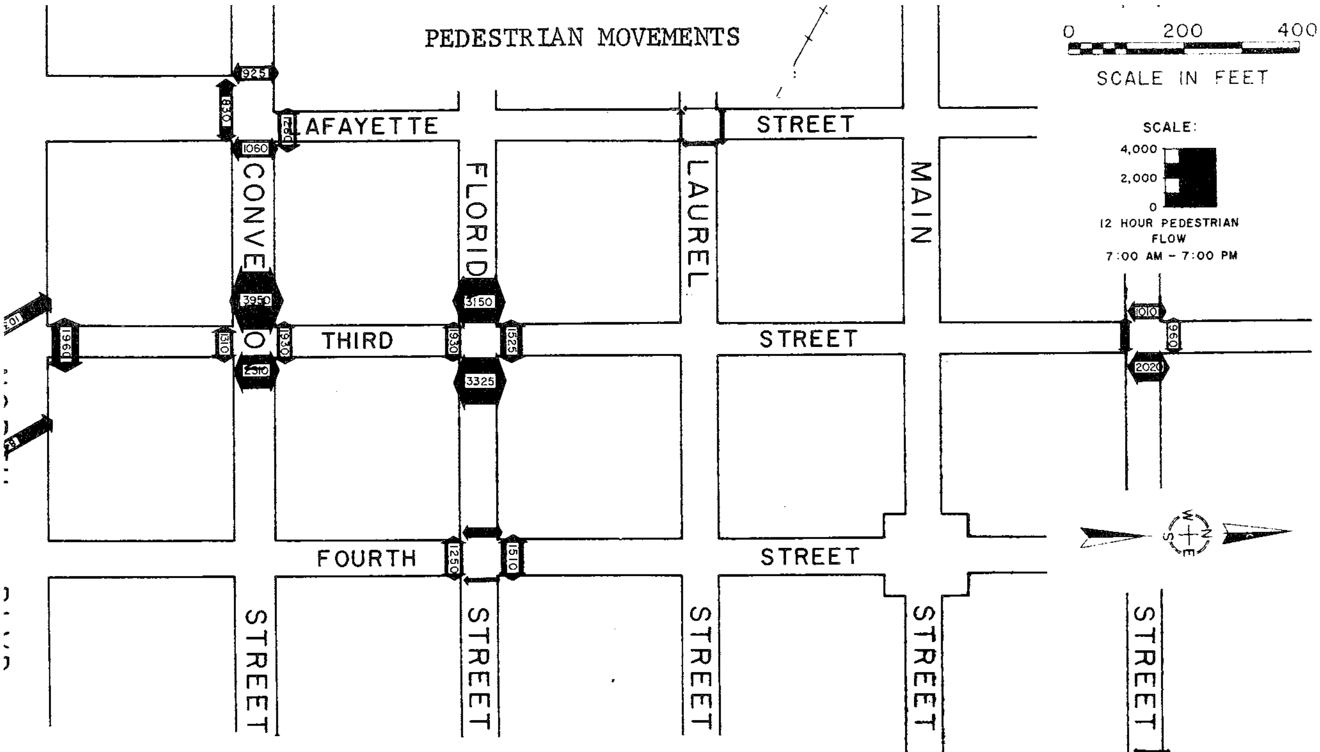
Figure 4

INDEX OF PEDESTRIAN TRAFFIC COUNTS BY TIME PERIODS, SELECTED LOCATIONS, SALT LAKE CITY, 1961

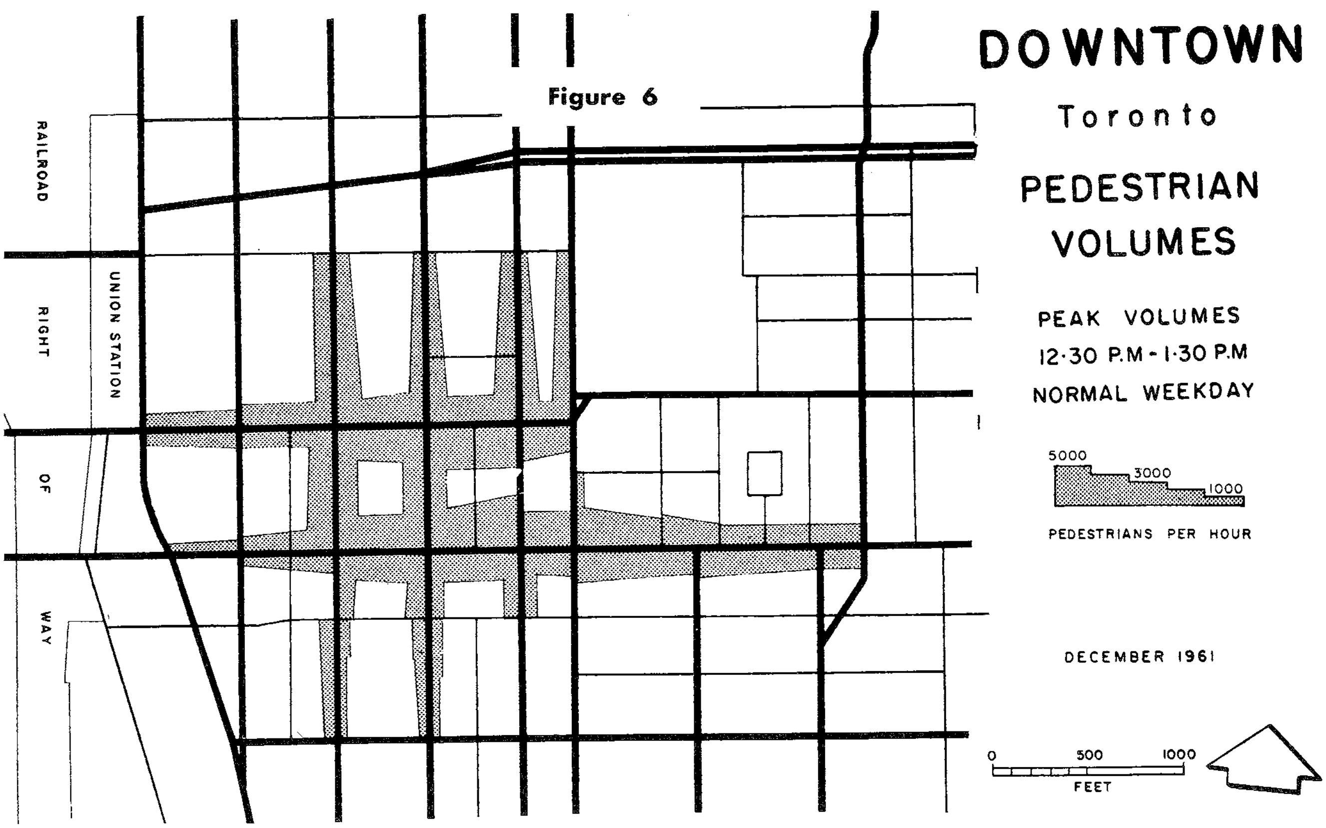


SOURCE FOR FIGURE 3: "Pedestrian Traffic in Downtown Denver," University of Denver Reports, August 1951, (Business Study No. 119), p. 3.

SOURCE FOR FIGURE 4: "Pedestrian Traffic Patterns in Salt Lake City," Utah Economic and Business Review, September, 1962, p. 4.

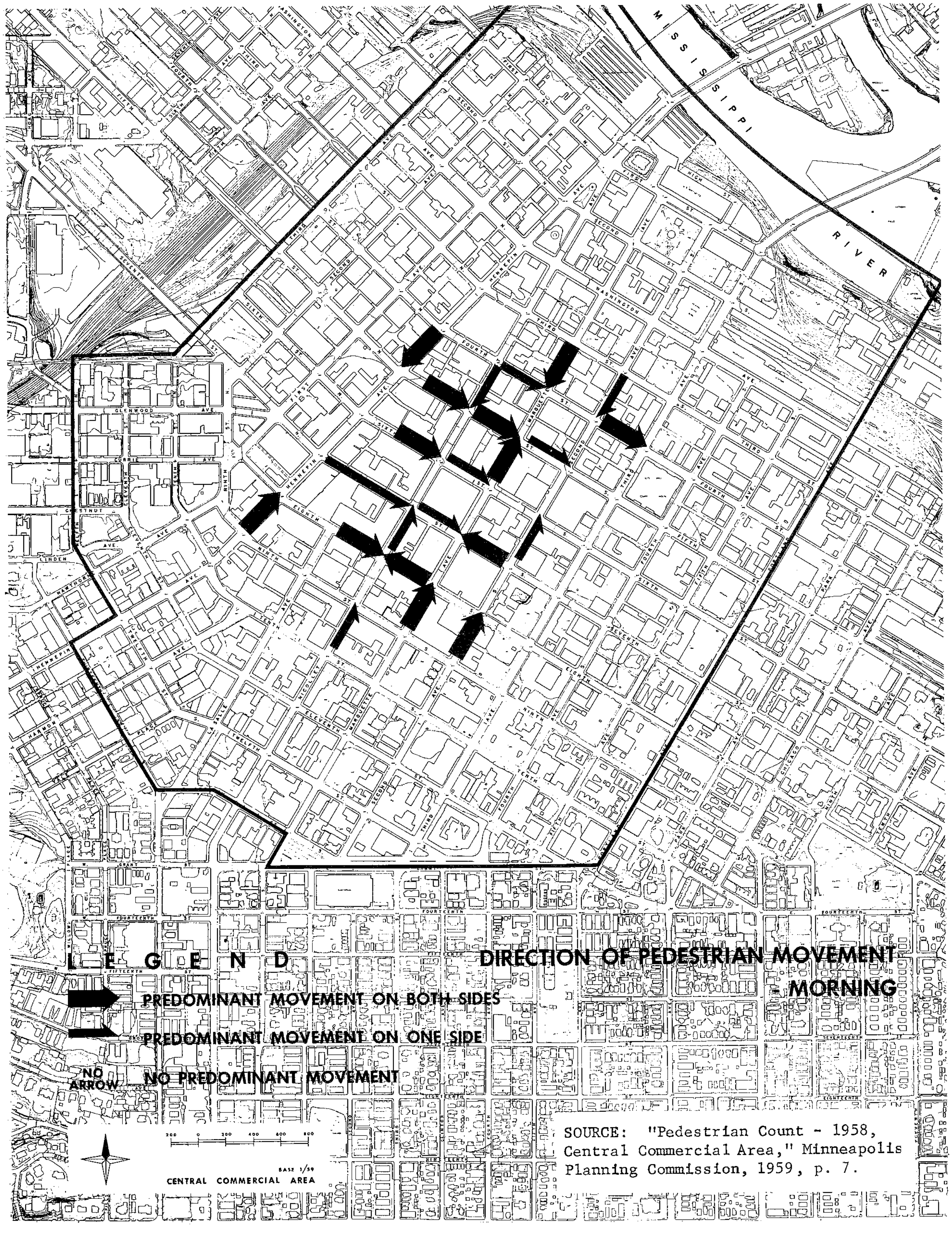


ɪRCE: Traffic and Parking, Baton Rouge, Louisiana, (New 'en: Wilbur Smith and Associates, 1955), p. 21.



SOURCE: Downtown Planning District Appraisal, Toronto Planning Board, 1961, p. 10a.

Figure 7



MISSISSIPPI RIVER
LEGEND
DIRECTION OF PEDESTRIAN MOVEMENT - MORNING
PREDOMINANT MOVEMENT ON BOTH SIDES
PREDOMINANT MOVEMENT ON ONE SIDE
NO ARROW
NO PREDOMINANT MOVEMENT
CENTRAL COMMERCIAL AREA
SOURCE: "Pedestrian Count - 1958, Central Commercial Area," Minneapolis Planning Commission, 1959, p. 7.

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1. Recent articles include: Robert L. Morris and S. B. Zisman, "The Pedestrian, Downtown, and the Planner," Journal of the American Institute of Planners (August, 1962), pp. 152-158; Barry Benepe, "Pedestrians in the City," Traffic Quarterly (January, 1965), pp. 28-42; and Archibald C. Rogers, "Downtown Pedestrian System: Integral Part of Traffic Plan," Traffic Engineering (January 1965), pp. 20-21, 44-47.

2. See Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD) (Washington, D.C.: Bureau of Public Roads' National Joint Committee on Uniform Traffic Control Devices, U.S. Department of Commerce, 1961), Section 3D-6. Where vehicular speeds are high or where the intersection lies in a small municipality, the warrant is satisfied for lower values. For a full discussion of traffic signal warrants, of which the pedestrian volume warrant is only one, see Sections 3D-3 through 9, and 3E-1 through 4 of the Manual.

3. For a full discussion see ibid., Section 3F-1 through 7; Henry K. Evans (ed.), Traffic Engineering Handbook (TEH) (New Haven: Institute of Traffic Engineers, 1950), pp. 248-9; Theodore M. Matson, Wilbur S. Smith, and Frederick W. Hurd, Traffic Engineering (TE) (New York: McGraw-Hill Book Co., 1955), pp. 298-302.

4. For full discussion see MUTCD, Section 3F-1, 7.

5. Ibid., Section 3D-6.

6. For a full discussion see MUTCD, Section 4B-3; TEH, pp. 109-10, 182, 411-412, 415-16; TE, pp. 299-301.

7. TEH, op. cit., pp. 105-6.

8. Ibid., p. 108.

9. Pedestrian counts may also be used to study warrants for sidewalk construction. See Policies on Geometric Highway Design (Washington, D.C.: American Association of State Highway Officials 1950), p. 13.

10. Morris and Zisman, op. cit., pp. 154-55.

11. Eric A. Grubb, Downtown Cleveland 1975, (Cleveland: City Planning Department, 1959), p. 30.

12. Buffalo Downtown Study (Boston: Arthur D. Little, Inc., 1960), pp. 113-116.

13. Grubb, op. cit., p. 32.

14. Manual of Traffic Engineering Studies (2nd ed., New York: The Accident Prevention Department of the Association of Casualty and Surety Companies, 1953), pp. 41-45.

15. For an exhaustive discussion of this use of the pedestrian count see Vincent J. Hubin, "Pedestrian Traffic Counts," The Appraisal Journal (July, 1953), pp. 397-415.

16. See Measuring Traffic Volumes, Procedure Manual, Public Administration Service (Chicago, 1958), p. 22.

17. See Jack P. Gibbs (ed.), Urban Research Methods (Princeton, N.J.: D. Van Nostrand Co., Inc., 1962), p. 197.

18. See Paul Wendt, The Dynamics of Central Land Values -- San Francisco and Oakland, 1950 to 1960 (Berkeley, Calif.: Institute of Business and Economic Research, University of California, 1961), p. 31.

19. Manual of Traffic Engineering Studies op. cit., p. 92.

20. David E. Ford, Frank Johnson and Connie P. Faulkner, Salt Lake City Pedestrian Traffic Patterns (Studies in Business and Economics, Vol. 22, No. 1) (Salt Lake City: The Bureau of Economic and Business Research, College of Business, University of Utah, 1962), p. 17.

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