CHAPTER 4.

METHODOLOGY DESIGN

There is a need to conduct a comprehensive collection of pedestrian characteristics data in New York City. The current HCM LOS methodology has shortcomings which have been made apparent by the Department of City Planning Transportation Division's experience and by studies undertaken by other organizations and individuals. Different sidewalk locations in central business districts (CBD) are characterized by unique pedestrian characteristics, a fact which has a significant impact on walkway performance. Because of this, a New York City CBD database of pedestrian characteristics could be useful in current and future pedestrian planning.

Developing a data collection methodology involved trial and error. It was desired to collect as much detailed pedestrian data as possible, but the limited resources available also had to be considered. In the following section, the goals, objectives and data collection methodologies of this study are outlined.

A. Goals and Objectives

Based on the review of the pedestrian literature and experience with pedestrian studies in the past, the TD has concluded that there is sufficient need for a fresh look at the pedestrian LOS process in New York City. Specifically, evidence suggests that the LOS methodology may need to be recalibrated to more accurately measure conditions on the city's sidewalks.

Why does it matter? First, the population of New York City is growing. As the rate of walking trips is high in New York City relative to the rest of the United States, the number of pedestrians can also be expected to increase. Second, transit use is increasing in the city. Because most transit trips involve walking segments, there are more pedestrians on the sidewalk than ever. Third, Lower Manhattan is undergoing physical changes that will alter the pedestrian environment. Replacing millions of square feet of office space, thousands of residential units, hundreds of retail stores, several large-scale cultural institutions and a major memorial will change the fabric of Lower Manhattan. These developments will certainly alter the pedestrian environment and an accurate LOS helps ensure that adequate space is allocated to pedestrian needs.

The purpose of this study is to:

1. Analyze the suitability of the HCM pedestrian LOS methodology for New York City;
2. Empirically measure the factors that contribute to pedestrian congestion on the sidewalks of Lower Manhattan; and
3. Recommend pedestrian policy changes based on this study's findings and propose additional opportunities for pedestrian research in New York City.

The TD has defined the methodology of this study with these three objectives in mind and has decided to use several quantitative observational studies to achieve them. While an experimental approach would allow us to draw decisive causal conclusions, it would require significant interference with the sidewalk conditions, including pedestrian behavior and flow rate. Because of the harmful effect on the external validity of the study, it was unadvisable to use an experimental approach. The data collection methodologies were designed to minimize the impact on pedestrian behavior and the sidewalk environment.

Two types of studies were conducted:

1. Pedestrian Speeds, Counts, and Characteristics
Pedestrian counts were done to study the pedestrian flow rates at different times and days of the week. Vehicular counts were also collected to study the relationship between pedestrian and vehicular volumes.

Observations of the characteristics and walking speeds of pedestrians were collected on sidewalks. A survey was used to build a pedestrian database, to aid in understanding the relationship between pedestrian characteristics and New York City sidewalks.

Using a speed and delay walk, the TD collected sidewalk pedestrian speeds and crosswalk pedestrian speeds at various times of the day.

2. Impedance and Pedestrian Behavior
Using a digital video camera, the TD recorded sidewalks at various locations in 15-minute segments. The videos were then used to observe pedestrian walking behavior, including pedestrian interactions with street furniture or with other pedestrians.

In the process of sharpening the specific data gathering methodology, the TD undertook extensive observations of pedestrians on sidewalks. The TD

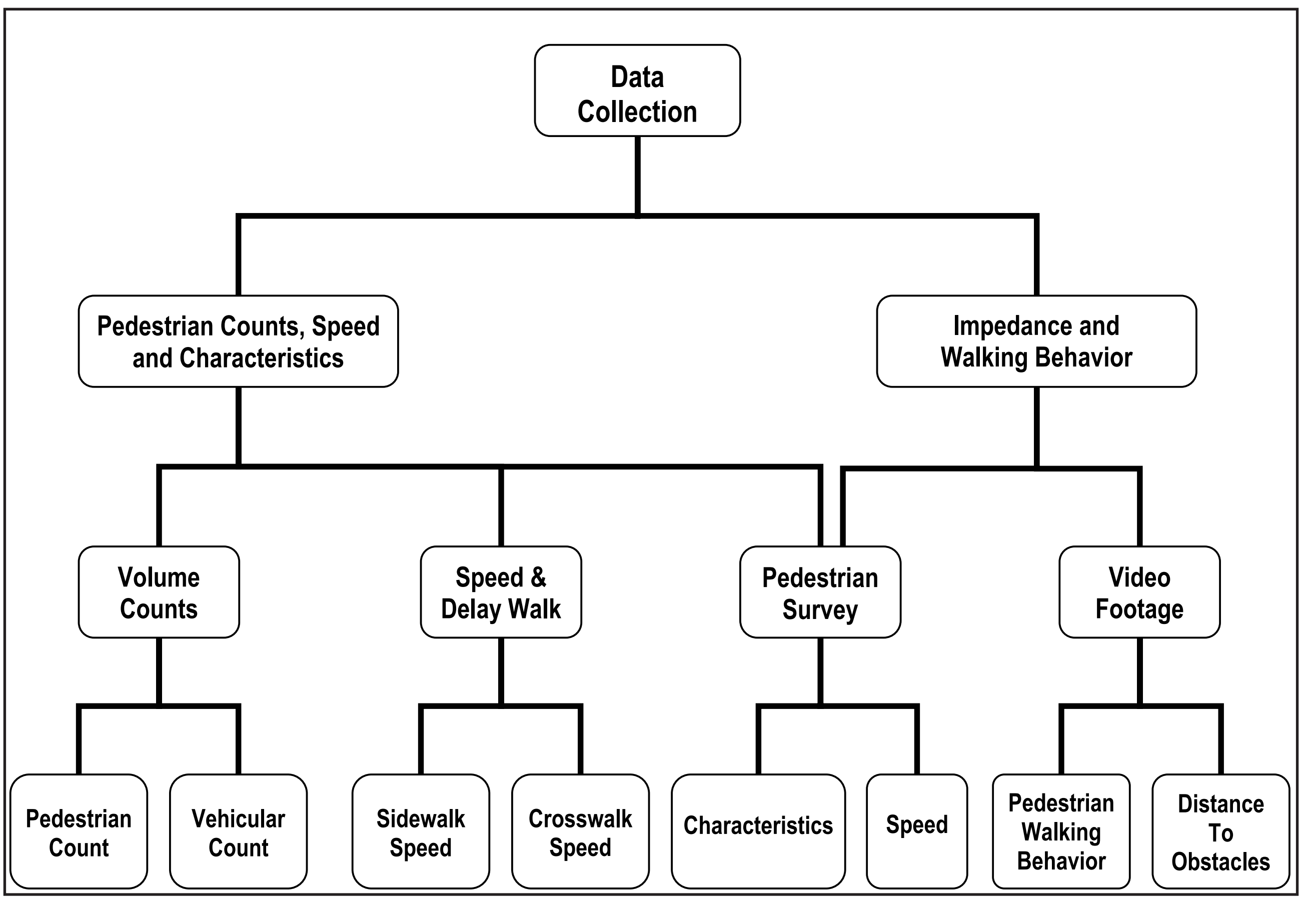


Figure 4.1. Data Collection Methodology

subsequently learned how some data gathering methods may work better than others, and it was learned how to ensure the quality and consistency of the data collection process. A considerable amount of pedestrian and sidewalk data from the Lower Manhattan CBD that is analyzable has been gathered; much of this data might be valuable in future research. Figure 4.1 summarizes the data collection methodology.

B. Pedestrian Speeds, Counts, and Characteristics

Pedestrians were counted and their walking speeds and relevant characteristics were recorded at different sidewalk locations in Lower Manhattan. These data were used to build a pedestrian database, which is the core data source for this project. The survey data helped in finding out how pedestrian characteristics are affecting, and are affected by, the sidewalk environment.

1. Survey Design

A survey form was designed, on which individual pedestrian speeds and characteristics were collected. Table 4.1 shows the form used for recording pedestrian characteristics. Sidewalk conditions, such as width, existing furniture, and building entrances and exits, were documented before the start of the survey. Using ground references such as pavement lines or fire hydrants, two lines were designated to mark pedestrians' entrance into and exit from the designated study zone on each sidewalk segment. The study zone was usually between twenty to forty-five feet in length, based on available sidewalks' identifiers, like street furniture or pavement markings. The pedestrians' speeds were measured by using a stopwatch to time them walking between the two lines on the sidewalk delineating each study zone (see Appendix C, table C.1 for completed sample survey).

In order to obtain a statistically valid sample of pedestrian speeds in each location, the randomization of the sampling process was sought. By doing this, a representative sample of pedestrian speeds and characteristics could be gathered that could subsequently be generalized to represent the population of all pedestrians in that location (at each given time).

Table 4.1. Pedestrian Characteristics Data Collection Form

Location:

Speed Timing Length on Sidewalk (ft): ______

Name ______ **Date:** ______ **Weather:** **Time:**

PED #	Travel Time (s)	DIRECTION	GENDER	AGE	PERSON SIZE	GROUP	TRIP PURPOSE	BAG(S)	PERSONAL ITEMS					PUSHING	WALKING AIDE	IMPEDED	COMMENT
		N = north S = south E = east W = west	F = Female M = Male	1 = under 14 2 = 14-65 3 = over 65	0 = Average 1 = Large (well over average space req'd)	# = people in group 1 = 1 person 2 = 2 people etc.	0 = Not sure 1 = Tourist 2 = Non-Work 3 = Work	0 = None 1 = Yes, no effect 2 = Yes, affects speed	Phone	Headphone	Drink/Food	PDA	Cigarette	0 = Nothing 1 = Stroller 2 = Service cart 3 = Wheelchair 4 = Rolling suitcase	0 = No 1 = Crutches 2 = Wheelchair 3 = Cane/Walker 4 = Stroller	0 = No 1 = Yes	
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Based on the literature review and field observations, it was determined that the following were important pedestrian characteristics which should be considered:

- Gender
- Age
- Person size
- Group size, if pedestrian is walking in a group
- Trip Purpose (business, non-business, tourist, etc.)
- Personal Items: bag, phone, headphone, food or drink, PDA (Personal Digital Assistant), or cigarette
- Pushing: stroller, service cart, wheelchair, or rolling suitcase
- Walking aide: crutches, wheelchair, cane, or stroller
- Impedance (if the pedestrian is being impeded by other pedestrians or obstacles)

In addition to pedestrian characteristics, pedestrian volume, in both primary flow and counter-flow directions was counted. In addition, it was determined that street and environmental characteristics could also affect the mobility of pedestrians. The following street and environmental characteristics were noted:

- Adjacent sidewalk usage: parking, bus stop, or moving lanes
- Land use (office, retail, or residential)
- Presence of street furniture
- Number of building entrances and exits
- Queue Attractors (bus stops, vendors, etc.)
- Street geometry (sidewalk width, etc.)
- Sidewalk conditions (smooth, cracked, even, uneven, or broken)
- Time of day
- Day of the week
- Weather

The speed observation process began by selecting the first pedestrian who walked by in the direction being monitored, and then noting his/her speed and relevant characteristics. If that pedestrian was walking in a group, the number of pedestrians in the group was noted, and each group members' characteristics were noted as well. When each pedestrian's data had been entered onto a form, the process was repeated for the next pedestrian observed, who would be the very next person to walk by in the observer's direction.

This randomized process helped to ensure that there was no selection bias on the part of the observers. Pedestrians were not selected by their characteristics, but were selected by their being the first who happened to walk by the observer when the observer was ready to record speeds and characteristics.

An internal validity test was conducted to ensure that the team was consistent in gathering pedestrian speeds and characteristics. The test was conducted at three different times and at two different locations. A total of one hundred pedestrians, two sample sizes of thirty-six pedestrians and one of twenty-eight pedestrians, were sampled. All team members sampled the same pedestrians during the test, and the pedestrians being sampled were randomly chosen by one of the team members.

The data was compared to see how consistent the observations were within the team. Overall, speeds, gender, age, group size, pushing and walking aide characteristics were consistent within the team. There were some differences in the size, use of bag and use of personal item categories. It was noticed that not all team members paid the same amount of attention to the impeded attribute. In addition, trip purpose was the characteristic with the most inconsistencies among the team members.

After this analysis, it was concluded that to ensure the quality and consistency of the data collected it was needed to better define each characteristic value, and analyze and standardize some specific cases. As a result, a set of rules for recording pedestrian characteristics (see Appendix B – Pedestrian Survey Rules) was produced. One of the main rules was that when in doubt, leave the column blank or use the "not sure" category. The survey was not designed to confirm the pedestrians' characteristics through interviews; because it was desired not to interrupt the flow on the sidewalks. The idea was to get a large amount of data to obtain trends. Only pedestrians who were obviously over 65 years old were marked down as elderly. If the pedestrians' trip purpose was unclear, it was marked as unsure. Based on the literature reviewed, there were other researchers who used the non-experimental, observational approach in categorizing pedestrians. To make the observation as accurate as possible, it was necessary to collect the pedestrian characteristics data in the field instead of using videos; because it was much more difficult to distinguish pedestrians' gender, age or trip purpose in videos. The possibility of errors in the methodology was understood; however, because of the large quantity of data collected, the margin of error from the few instances of uncertainty of pedestrian characteristics was minimized.

2. Pedestrian Characteristics and Speed Data Collection

Pedestrian counts, speeds, and characteristics at about sixty-two Lower Manhattan locations in the morning, midday, and afternoon peak periods were gathered using the pedestrian survey described above. A control location 7-day 12-hour count, speed, and characteristics data collection was also conducted (see Figure 4.2.).

a. Lower Manhattan 62 Sites

The study locations were selected on the basis of several factors. Most pedestrians arrive in and leave Lower Manhattan by public transit, so attention was focused on locations near subway stations. About fifty sites around subway stations that accounted for the majority of pedestrian access locations to Lower Manhattan streets were identified. The data collection was concentrated at locations near subway entrances and exits, and additional locations that would perhaps yield high pedestrian volume or unique travel patterns were selected (see Appendix C, table C.2. for a list of locations).

Pedestrian counts at each location during peak 15-minute periods of the day between the times of 8:30 – 9:30 AM, 12:30-1:30 PM, and 4:30-5:30 PM (see Table 4.2) were conducted. In addition, the speeds of randomly selected pedestrians during these periods of time were tracked. One person counted pedestrians walking in both directions on the sidewalk, taking note of their walking direction. Two people tracked pedestrian speeds—one in each sidewalk direction.

Table 4.2. Pedestrian Volume Count Form

Name: Date:

Location:

Start Time: Weather:

	5 min	10 min	15 min
Eastbound/Northbound			
Westbound/Southbound			

b. Seven-Day Vehicular and Pedestrian Count

Vehicular counts, pedestrian counts, and pedestrian speed and characteristic data were collected at the study's control location, Broadway between Duane Street and Reade Street. At the same time, a 24-hour vehicular count was collected using an Automatic Traffic Recorder (ATR) for seven days. Pedestrian counts were collected on the west sidewalk of the control location, during the same week of the ATR count, between 7am and 7pm from Monday to Friday, and between 10am and 3pm on Saturday and Sunday (see Table 4.3). Sample pedestrian characteristics and speeds were collected on the weekdays during the count hours. The same pedestrian characteristics and speed collection methods were used here as mentioned in the earlier section.

The objectives of this data collection effort were to:

- Establish a pedestrian flow profile, determining pedestrian traffic peak times and off-peak times;
- Determine the relationships between the time of day and pedestrian volumes and speeds; and
- Determine any correlation between vehicular volumes, pedestrian volumes and pedestrian speeds.

See Appendix C, Table C.3. for a sample data collection form.

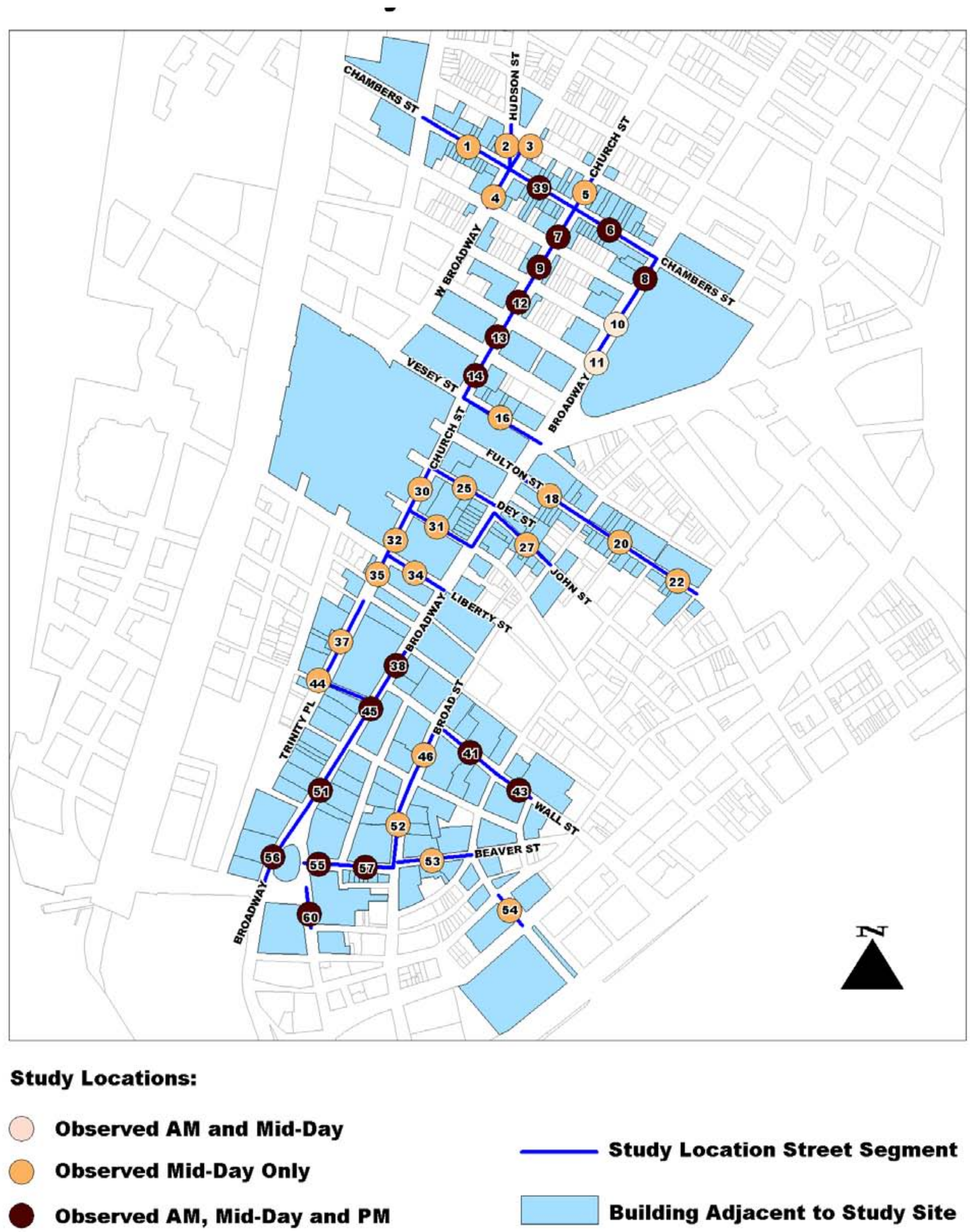


Figure 4.2. Lower Manhattan Study Locations

Table 4.3. Seven Day Pedestrian Count Form

Broadway between Duane and Reade, West Sidewalk

Name: Date:

Start Time: Weather:

	5 min	10 min	15 min	20 min
Northbound				
Southbound				

	25 min	30 min	35 min	40 min
Northbound				
Southbound				

	45 min	50 min	55 min	60 min
Northbound				
Southbound				

3. Speed Walk

During the course of designing this study, it was decided to re-create vehicular speed and delay run survey techniques for sidewalk traffic. The purpose was to determine the average speed and delay experienced by pedestrians at crosswalks on a designated route at specific times of day, and the sidewalk speeds of different walkers at different times of day. This could be used to study sidewalk density in relation to speed.

a. Background

Vehicular speed and delay runs involve a vehicle driving on a road while a surveyor in the car marks down distance and time traveled. During the run, the vehicle's time is marked at each predetermined distance interval. For example, the test driver will record a start up time of 1:30pm as the beginning time; then every 0.2 miles the driver will record the time traveled, such as 45 seconds for 0.2 miles, 1 minute and 10 seconds for 0.4 miles, and so on. With repeated runs during different hours of the day, a profile of travel speed of the corridor is established.

From the data gathered as described above, the degree of vehicular delay on the test route can be determined. For example, on a ten-mile stretch of road with a sixty-five mile per hour speed limit, a driver should ideally take less than 10 minutes to travel the segment. During the peak hour, according to the speed and delay run results, each run might take fifteen to twenty minutes. In these cases, one could draw the conclusion that the delay on the road is five to ten minutes for a ten mile distance during peak hours. Also, one could compare the seriousness of congestion for different hours. For example, if the data shows 15 minutes travel time in the morning peak and 20 minutes travel time in the evening peak for the same stretch of road, the study segment can be said to be more congested in the evening than in the morning. Engineers and planners can then compare the speed and delay run data for AM and PM vehicle counts and see if the two data sets agree. Vehicular speed and delay run analysis provides useful information for understanding how the streets function, contributing to an overall illustration that enhances volume and flow rate measurements.

b. Methodology

With the vehicle speed and delay analysis in mind, a pedestrian speed and delay walk survey was designed. The Lower Manhattan CBD walk used for this survey covers an eighteen-block, 1-mile route starting from the southwest corner of Broadway and Duane Street to the northwest corner of Wall Street and William Street, and then back to the point of origin (see Figure. 4.3.). Each of the members of this project team was assigned a certain time slot during the day to carry out the walk. After two weeks, team members exchanged time slots. A tape recorder or a digital recorder was used to document locations and times of reaching each intersection. During each walk, the starting and ending times were recorded. Between the starting time and ending time, the time of arrival at each side of each crosswalk was recorded, as were the times of any instances of stopping at crosswalks, which would have their corresponding start-up times recorded, as well. Team members then transcribed their recordings onto a data transcription form. See Table 4.4 for the data collection form. See Appendix C, table C.4. for a filled out sample.

c. Data Summary

The transcribed data was input into a spreadsheet to calculate overall route speed, speed over specific street segments, and stop times. Using measurements of street segment lengths from the DCP's LION street centerline Geographic Information Systems (GIS) files and then field verifications in some locations, the recorded travel times were manipulated into:

- Average sidewalk speed
- Sidewalk speed with stop
- Sidewalk speed with no stop
- Average crosswalk speed
- Crosswalk speed with no stop
- Crosswalk speed after stop

The observations above were then summarized as:

- Team member individual walks
- Comparisons between team members' walks
- Walks between specific intersections by team members

4. Other Pedestrian Counts – Expository Database

In addition to the data that collected by the TD, pedestrian data from outside sources was also gathered. The purpose was to cross reference the data collected against established data sources, to make sure this study's data is accurate. Also, one of the criteria that was used to select filming and count locations was the number of pedestrians that use a specific sidewalk. In general, sidewalks with the highest pedestrian use were the ones selected for conducting field work. As many pedestrian counts from recent years as possible were consulted in order to determine the busiest sidewalks in Manhattan CBDs.

One source for pedestrian surveys were Manhattan's Business Improvement Districts (BIDs). BIDs serve the businesses in their areas by promoting retail and tourism, and by providing services such as security and beautification. In addition, one of the services that BIDs provide to businesses is information on the economic market and on retail opportunities in

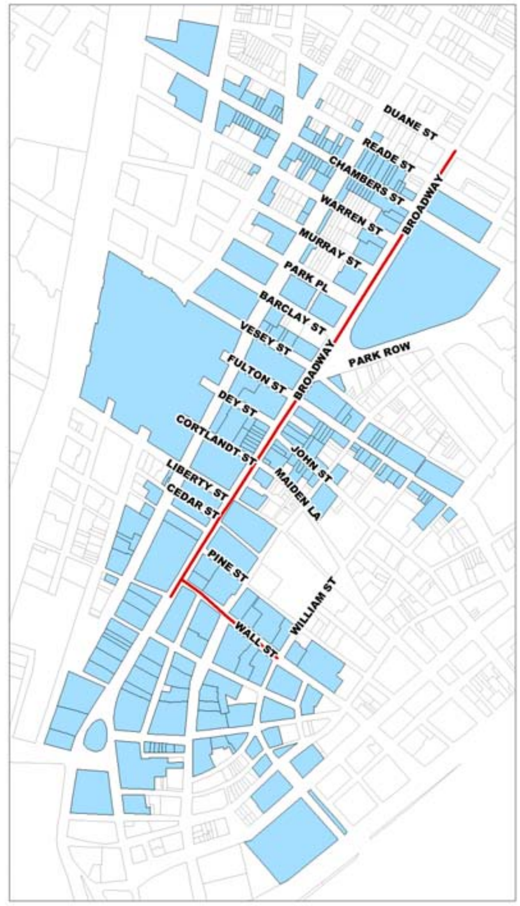


Figure 4.3. Speed and Delay Walk Route

the area. Pedestrian counts are usually conducted to study potential retail attraction within the BID. Counts are useful for both existing and potential retailers, property owners and real estate companies. Pedestrian traffic numbers inform decisions such as business hours of operation, timing of promotions, and locations for new businesses.

For this study, the following were contacted:

- Lincoln Square BID
- Downtown Alliance
- Grand Central Partnership
- Fashion Center BID
- Union Square Partnership
- Lower East Side BID
- Noho NY BID
- 34^{th} Street Partnership
- Times Square BID
- Village Alliance

Table 4.4. Speed Walk Data Collection Form

PEDESTRIAN LOS SPEED WALK SHEET

ROUTE CHARACTERISTICS

Route:	Broadway to Wall Street to William & back	Date:	
Walker:	Timer:	Time of Day:	
Weather:		Route time:	

	Name	Arrive	Depart	Comments
Intersection 1:	Bway/Duane South			
Intersection 2:	Bway/Reade North			
Intersection 3:	Bway/Reade South			
Intersection 4:	Bway/Chambers North			
Intersection 5:	Bway/Chambers South			
Intersection 6:	Bway/Warren North			
Intersection 7:	Bway/Warren South			
Intersection 8:	Bway/Murray North			
Intersection 9:	Bway/Murray South			
Intersection 10:	Bway/Park North			
Intersection 11:	Bway/Park South			
Intersection 12:	Bway/Barclay North			
Intersection 13:	Bway/Barclay South			
Intersection 14:	Bway/Vesey North			
Intersection 15:	Bway/Vesey South			
Intersection 16:	Bway/Fulton North			
Intersection 17:	Bway/Fulton South			
Intersection 18:	Bway/Dey North			
Intersection 19:	Bway/Dey South			
Intersection 20:	Bway/Cortlandt North			
Intersection 21:	Bway/Cortlandt South			
Intersection 22:	Bway/Liberty North			
Intersection 23:	Bway/Liberty South			
Intersection 24:	Bway/Cedar North			
Intersection 25:	Bway/Cedar South			
Intersection 26:	Bway/Thames North			
Intersection 27:	Bway/Thames South			
Intersection 28:	Bway/Rector North			
Intersection 29:	Bway/Rector South			
Intersection 30:	Bway/Exchange Northwest			
Intersection 31:	Bway/Exchange Northeast			
Intersection 32:	Bway/Wall South			
Intersection 33:	Bway/Wall North			
Intersection 34:	Wall/Nassau West			
Intersection 35:	Wall/Nassau East			
Intersection 36:	Wall/Willam West			
Northbound				
Intersection 1:	Wall/Willam West			
Intersection 2:	Wall/Nassau East			
Intersection 3:	Wall/Nassau West			
Intersection 4:	Bway/Wall North			
Intersection 5:	Bway/Pine South			
Intersection 6:	Bway/Pine North			
Intersection 7:	Bway/Cedar South			
Intersection 8:	Bway/Cedar North			
Intersection 9:	Bway/Liberty South			
Intersection 10:	Bway/Liberty North			
Intersection 11:	Bway/Maiden South			
Intersection 12:	Bway/Maiden North			
Intersection 13:	Bway/John South			
Intersection 14:	Bway/John North			
Intersection 15:	Bway/Fulton South			
Intersection 16:	Bway/Fulton North			
Intersection 17:	Bway/Ann South			
Intersection 18:	Bway/Traffic Island South			
Intersection 19:	Bway/Traffic Island North			
Intersection 20:	Bway/City Hall Park South			
Intersection 21:	Bway/Chambers South			
Intersection 22:	Bway/Chambers North			
Intersection 23:	Bway/Reade South			
Intersection 24:	Bway/Reade North			
Intersection 25:	Bway/Duane South			

Pedestrian count data was obtained from the Downtown Alliance, the Grand Central Partnership, the Fashion Center BID, the Union Square Partnership and the Times Square BID. Even thought this study is concentrated in Lower Manhattan BIDs outside the area were also consulted, so a pedestrian count database could be built for future reference in site selection and trend observation.

C. Impedance and Walking Behavior

The video camera has proven useful to researchers of pedestrian facilities in the past (see Chapter 3). The videotaping procedure enables one to capture a large volume of pedestrian data for an extended period of time, freeing researchers to conduct less data intense surveys on-site and to analyze video captured data later. Depending on the site being filmed, the video camera can be set up in an unobtrusive space to the side of the sidewalk, and can capture facility characteristics as well as pedestrian characteristics which might not have been caught by the researcher's eye during the on-site data capturing process. In this study, extensive video footage of sidewalk traffic has been collected, primarily in an effort to analyze pedestrian walking behavior and how it is affected by sidewalk obstacles.

1. Site Selection

For the videotaping undertaken in this study, the video camera was placed atop an 80-inch high tripod, which created an elevated view. This view afforded the recognition of pedestrian characteristics and sidewalk traffic patterns in a clearer manner than would a less elevated, or "straight-on" view. Previous studies have placed cameras on scaffoldings or filmed from windows of buildings adjacent to the sidewalk, in order to create a similar – though more pronounced – overhead view. Capturing the sidewalk from above minimizes perspective distortion and allows a researcher to assimilate the study area to a planar geometry on which to project Cartesian coordinates and draw imaginary measurement lines or grids for detailed analysis. The ideal setting would include two cameras filming simultaneously: one overhead camera to facilitate the analysis of trajectories and measurements of distances to obstacles, and an eye-level camera to capture pedestrian characteristics. In this study, a completely vertical vantage point was considered but decided to be unfeasible, because of the needs of flexibility in site selection. The elevated tripod would be the closest available approximation to a completely vertical vantage point, and it would allow us to observe pedestrian characteristics as well.

In order to select New York City sidewalk sites to film for this study, several factors were taken into account. First of all, pedestrian volumes on sidewalk facilities in Lower Manhattan were derived from all day 15-minute counts undertaken by the Department of City Planning and the Downtown Alliance (Lower Manhattan BID) and from the measured widths of the sidewalks in question. On heavily trafficked sidewalks, such factors as platooning and variation in pedestrian walking speed can make for a large diversity of flows, more so than on sidewalks with relatively little traffic. Therefore, in the site selection process, it was decided to focus on high-volume facilities. In addition, potential sites were visited and evaluated for possible filming spots (out of the way, sufficient viewing angle, etc.), as well as for the extent of possible flow-affecting factors on the sidewalk, such as street furniture (phone booths, signs, newspaper boxes, etc.) and queuing sites (bus stops, vendors, etc.), which might add to the diversity of the data gathered.

Some additional criteria used for the selection of sidewalks in this study were:

- The section of sidewalk should have had a moderate to high pedestrian flow rate at the time it was recorded.
- The section of sidewalk should have had one or more active front doors (offices, retail stores, restaurants, etc.) adjacent to it.
- Pedestrians on the sidewalk should have appeared to have a diverse mix of purposes: office workers, shoppers, delivery people, tourists, etc.
- If possible, the sidewalk should have been a fairly static color to make the computer grid overlay easier (see below).

- – While interesting sidewalk obstructions should have been sought out, they should not have significantly obstructed the viewing angle of the camera.

2. Filming Preparation

Prior to the actual filming of each sidewalk, the geometry of the sidewalk facility and its surroundings were noted. The sidewalk width, distance between recognizable features (such as pavement joints), width of street furniture and their distance from curbs, and related sidewalk features were measured. An "analysis zone" or study area, a rectangular zone within the sidewalk facility, was measured using a 30-foot string ruler with attached reflective domes at 5 foot intervals, and was photographed on the sidewalk for later use in the computer analysis phase (see Figure 4.4.). The analysis zone was typically 30 feet long and as wide as the width of the sidewalk. The 5-foot intervals between reflective domes were used in the computer analysis phase to measure and draw horizontal lines for the analysis of pedestrian flow patterns.

In addition, initially a large, custom made sidewalk ruler was used to measure 6-inch intervals along the width of the sidewalk. The ruler was stretched out along the width of the sidewalk and was photographed for use in the computer analysis phase. This ruler device consisted of a twenty foot wide black vinyl sheet with white vertical lines spaced 6 inches apart, and was unfurled when sidewalk traffic was light or non-existent (see Figure 4.4.). If there was sidewalk traffic, pedestrians were told to wait to proceed until the ruler was photographed, in order to avoid possible accidents. The image taken of the unfurled ruler was used in a computer program to draw a ground-truthed series of lines, 6-inches apart and parallel to the curb line, for the analysis of lateral pedestrian movements. The ruler was black and wide in order to block out the color of the sidewalk on which it was unfurled (enhancing its visibility), and its measurement lines were white in order to contrast with their black background, for easy identification in the line drawing process.

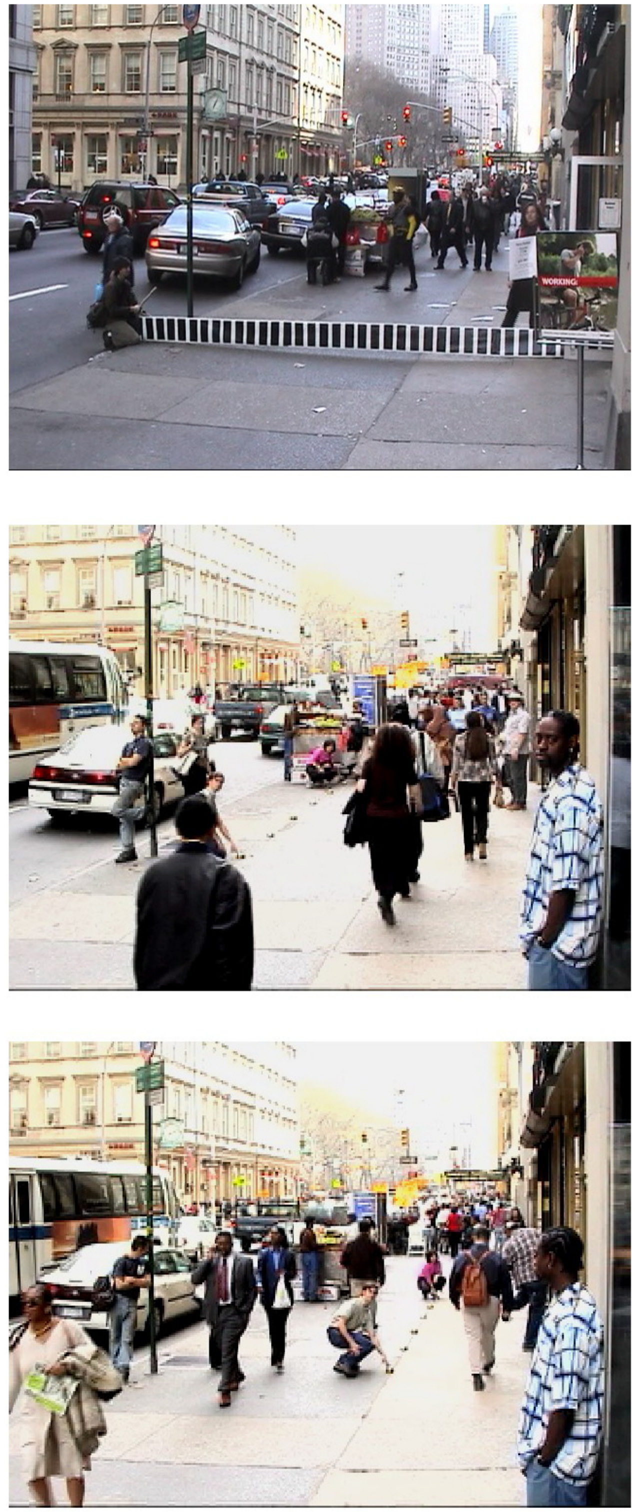


Figure 4.4. Sidewalk Ruler and Reflective Domes Demonstrations

After developing this measurement tool, it wsa realized that there was also a geometry measurement-based technique for drawing the 6-inch spaced sidewalk lines which could be accomplished in AutoCad without the use of the sidewalk ruler (see computer techniques discussion below and in the Appendix D). The AutoCad method of line drawing has primarily been used in the computer analysis of sidewalk videos. However, this technique requires visible sidewalk reference lines. If these lines were not visible on the sidewalk video, the sidewalk measurement tool was used as a standby for the longitudinal line drawing technique.

3. Counts

Once the sidewalk geometry had been noted and the appropriate photographs for computer analysis had been taken, the filming of sidewalk traffic began. In order to ensure the accuracy of film-based counts and to consider aspects of sidewalk traffic which may not have been apparent in the film (see Table 4.5), the following counts were performed during each 15-minute sidewalk filming:

- Pedestrian traffic entering or exiting buildings whose doors are adjacent to the study zone, in five minute increments
- Vehicular traffic adjacent to the study zone (taking note of the existence or non-existence of a buffer space between the sidewalk and the street, usually consisting of planters or a parking lane) for the 15-minute total
- Queues which may exist within the study zone, for vendors, bus stops, etc. The number of people in the queues per minute of filming and the distance to which the queues invade

Table 4.5. Video Filming Pedestrian Count Form

P E D E S T R I A N L O S F I E L D C O U N T S H E E T

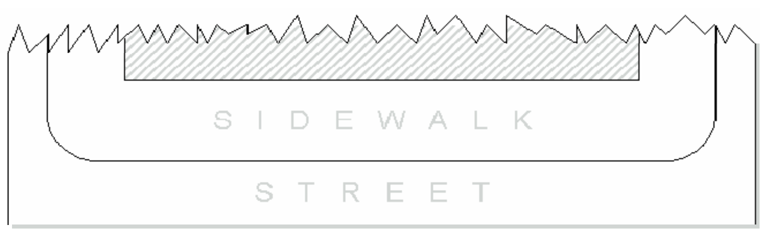
S T R E E T / E N V I R O N M E N T C H A R A C T E R I S T I C S

Street / intersection: | Date: | Weather:
Adjacent sidewalk usage: parking / bus stop / moving cars | Time: | Sidewalk quality: 1 - 2 - 3 - 4 - 5

Direction 1: (N / S / E / W) | Total width: | Timed length:
Direction 2: (N / S / E / W) | Effective width: | Land uses:

Vendor / queue 1:
Vendor / queue 2:
Vendor / queue 3:
Vendor / queue 4:

Building entrance 1:
Building entrance 2:
Building entrance 3:
Building entrance 4:



C O U N T S

P E D E S T R I A N C O U N T B Y M I N U T E

	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00
Pedestrian count (Dir. 1):															
Pedestrian count (Dir. 2):															
Vendor / queue 1 count:															
Vendor / queue 2 count:															
Vendor / queue 3 count:															
Vendor / queue 4 count:															
Entrance 1 count (IN):															
Entrance 1 count (OUT):															
Entrance 2 count (IN):															
Entrance 2 count (OUT):															
Entrance 3 count (IN):															
Entrance 3 count (OUT):															
Entrance 4 count (IN):															
Entrance 4 count (OUT):															

Vehicle count (Dir. 1):	
Vehicle count (Dir. 2):	

the effective walking space were noted
- Pedestrian flow by direction in one minute intervals

In addition, the walking speeds of randomly selected pedestrians wee noted throughout the 15 minute site visit by measuring a length on the sidewalk (approximately 30 to 40 feet long, depending on the location) and timing how long it took the pedestrians to traverse the measured length. Selected characteristics of the speed-tested pedestrians were also noted.

4. Control Location

A control filming location was chosen on the West sidewalk on Broadway between Duane and Reade Street. This was a site whose variations in traffic, pedestrian characteristics and environmental characteristics were used to measure against those of the "experimental" study sites. The control location was filmed for 15 minutes each day on which a study site was filmed. The control location was on a relatively busy sidewalk, and filming was chosen for a time (around 3 pm) when the TD was not likely to be filming at a study site. The filming of the control location served as a regulatory device, allowing for the observation of any non site-specific anomalies due to attributes of the particular filming day which might also affect the study area visited on the same day. The control film could show inter-site variations in traffic which might not necessarily have been unique to the study site filmed. If the traffic at the control location was significantly different on one day than it was on others because of reasons not specific to the site, some related inferences might be made about any similar anomalies in the traffic at the study site for that day.

5. Video Processing

When a day's filming was complete for the control location and the study site, the video was exported into a computer using the Adobe Premiere editing program. Still pictures of the string ruler with reflective domes, stretched out on the sidewalk (see description above), and the large sidewalk ruler (if it is being used) were also exported from the camera into the computer for grid-line rendering. These stills were brought into AutoCad, where images of the string ruler with domes (which had been stretched out at two parallel lengths on the sidewalk) were used to draw horizontal lines across the sidewalk (see Figure 4.4.). These horizontal lines measured an initial reference line in front of the camera and parallel lines 15 and 30 feet away from the reference line, which represented the beginning, middle and end of the study zone, used for pedestrian analysis. If the large sidewalk ruler was being used for grid line drawing, two stills of the ruler stretched across the sidewalk at parallel widths were used for reference measurements, as each ruler line pair represented a measurement of 6 inches. The stills were used in AutoCad to draw several 6-inch separated longitudinal lines – parallel to the curb line – on the sidewalk in the video, stretching from the curb to the adjacent building line. If the sidewalk ruler was not being used, a geometry-based process was employed, using measured reference lines from the sidewalk to draw the longitudinal measurement lines. In this procedure, a one-point perspective drawing was used to represent the screen image and draw 6-inch-apart longitudinal lines on the sidewalk with AutoCad (see Appendix D for a detailed explanation).

In both cases, once the 6-inch longitudinal lines had been drawn in AutoCad, they had to be superimposed onto the video using the "blue screen" option was used in Adobe Premiere (see Figure 4.5.). This feature allowed us to composite a blue background with the 6-inch lines in bright color and the video with the moving pedestrians; blue was the standard color for this transparency overlay because it is relatively absent from human skin tones. As a result, the timeline output had a slight blue tint from the underlying "blue screen."

6. Data Collection – Pedestrian Characteristics and Speed

The pedestrian characteristics to be observed from the captured video were: walking direction; start time and end time of the pedestrian walking through the study area; gender; age (under 14, 14 to 65, or over 65 years old); size (average or significantly larger than average); group size (number of people walking with the pedestrian being studied); estimated trip

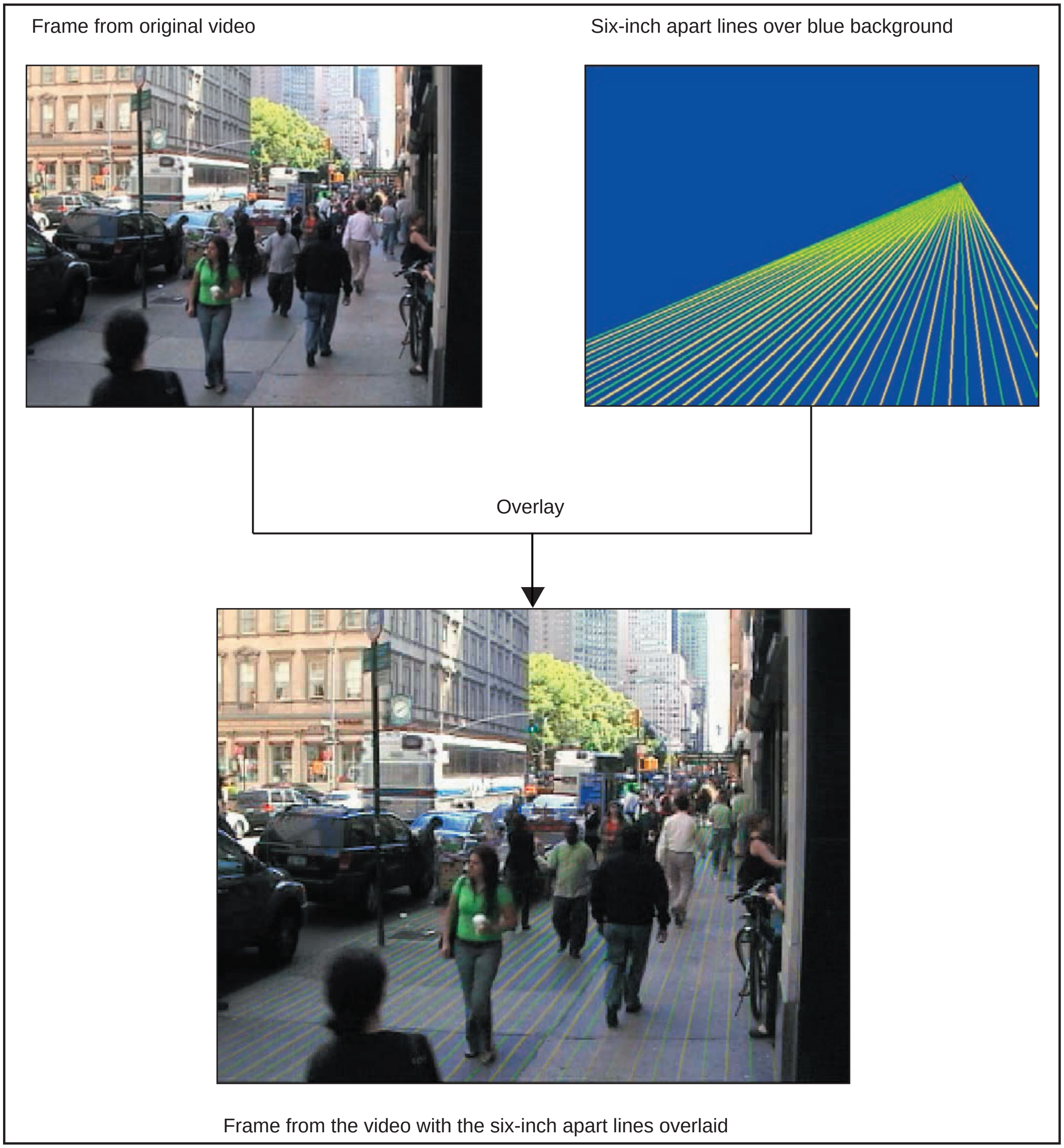


Figure 4.5. Video Overlay of Lines with 6-inch Apart

purpose; carrying bags (yes/no, if yes, did bag affect walking speed or not); holding a phone; using headphones; drinking or eating; using a PDA; smoking a cigarette; pushing a stroller, service cart, wheelchair or rolling suitcase; using walking aides such as crutches, a wheelchair, a cane or a stroller; if the pedestrian stopped, the time at which they stopped, the time at which they resumed walking, and the observed reason for their stopping; and the pedestrians' walking distance ("shy distance") from sidewalk borders, obstacles and each other (measured using lines derived from the 6-inch wide stripes or AutoCad process discussed above). The methodology for determining peoples' "shy distance" from obstacles, an important component of this study, is described below.

7. Obstacle Study

The TD is interested in determining the distance that pedestrians walk away from obstacles on the

Lower Manhattan CBD sidewalks. Videotaping of pedestrian traffic is essential in the process of determining this "shy distance," the measurement of which is itself essential in determining the effective width of sidewalks. The obstacles that can be studied in these videos are: bus stops, bicycles attached to bus stops, vendors, store displays, doors, street lights, stairs, bollards, subway entrances/exits, planters, trash cans, bus shelters, phone booths, cones and news stands.

While establishing a methodology for analyzing pedestrians' relationships to obstacles, the main question was whether all of the pedestrians in a video should be studied, or only those in platoons. In addition, it was asked if this study should look at pedestrians walking on "empty" sidewalks, or at pedestrians on crowded sidewalks; pedestrians walking within a specific distance from the obstacle and what this distance is; and the impacts of obstacles have on pedestrians.

It was decided to account for all pedestrians that were seen on the screen. By studying all of them, it was attempted to compile information for two main scenarios: first, when the sidewalk was empty and a pedestrian could follow his or her "desired path"; and second, when there were other people on the same sidewalk section and the pedestrian's available path choices were therefore reduced. To distinguish between these scenarios, it was necessary to record the number of people walking close to each individual pedestrian being studied. Based on observations and the literature review, it was learned that in the United States pedestrians tend to form lanes, walking on the right hand side of the sidewalks when the sidewalks are busy or where there are obstacles. The TD believed it was also important to note the pedestrian's walking direction.

The video analysis methodology that the TD has developed to analyze "shy distance" consists of the following steps:

a. Determine the obstacle to be studied. Typically there will be a building wall or border on the side of the sidewalk opposite the curb. The TD is also interested in determining the distance that people walk away from this border.
b. On an auxiliary transparency overlaid on the computer screen, draw a horizontal line perpendicular to the curb from the center and the inner most edge of the obstacle to the building wall. Calculate the length of this segment.
c. Draw a line belonging to the same beam as the 6 inch lines going through the middle point of the segment above. This line is named the middle line.
d. Mark the intersections of the horizontal line with every two six inch lines. Number the intersections starting both on the obstacle side and on the border side, increasing towards the middle line.
e. Draw a rectangular buffer zone centered on the horizontal line. The total width of the buffer zone is approximately twice a person's stride. See Figure 4.6.
f. Every pedestrian whose feet can be seen when he/she is crossing the horizontal line will be studied – due to the camera position, not all pedestrians' feet are visible because other people might block the view. If there is more than one pedestrian in the same cross section as the obstacle, the pedestrian closer to the obstacle will be observed. For every pedestrian considered, information will be noted regarding the person's:
   - Distance from the obstacle to the outmost edge of the foot that is closer to the obstacle;
   - Gender;
   - Walking direction;
   - Impediment (whether they are impeded or not); and
   - Number of pedestrians walking in both directions on both sides of the middle line and within the buffer zone.

As a result the TD intends to develop a database with a measurement of the distance that people walk away from each different obstacle. This database will be analyzed to obtain an average "shy distance" for each obstacle and to establish the potential relationship between this distance and gender, sidewalk impediment and sidewalk crowdedness. Also, it might be possible to develop an index of precise "buffer zone" distances from specific obstacles (mentioned above), based on pedestrian "shy distances" from those obstacles (see Table 4.6. for sample data collection form).

At the time of writing this report, the TD has just tested the proposed methodology with one of the videos. Future work will include an exhaustive collection of data for every observable obstacle from the corresponding video(s) and their analyses (see Appendix C, Table C.6. for a filled out sample form).

8. Street Furniture

Several physical components on sidewalks may be classified into different categories while others belong to more than one category. Some elements are part of the infrastructure that provides basic urban services, such as street lights, fire hydrants and manhole covers. Others provide different services, such as mail boxes, telephones, trash cans and informational signs. Examples of transportation related features are bus stops, bus shelters, parking meters, bicycle racks, traffic signals and subway entrances and exits. Some sidewalk elements have mainly an aesthetic function, such as trees, planters, benches and artwork, while others serve mainly security purposes, like bollards, barriers and fences. Finally, some are retail oriented, such as vendors, news stands and news boxes.

Sidewalk elements may be classified as permanent or temporary. Except for sidewalk vendors, most street furniture is permanent. In terms of space, surface elements can be distinguished from elements with volume. Surface elements include grates, manhole covers, metal plates and ventilation shafts. These do not occupy vertical space above the sidewalk, but may affect pedestrian behavior just the same. Table 4.7 contains a list of obstacles that are found on New York City sidewalks.

It is important to document the existing street

Figure 4.6. Obstacle Analysis Video Grid

Table 4.6. Obstacle Data Collection Form

Location:

Date: **Time:** **Observer:**

Ped #	Gender	Pedestrian Direction	Left of Screen					Right of Screen				
			Obstacle: / Distance (ft)	Impeded? (Y/N)	# of Pedestrians			Obstacle: / Distance (ft)	Impeded? (Y/N)	# of Pedestrians	
					NB	SB			NB	SB
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										

furniture and other elements on sidewalks because they are impediments that affect pedestrian movement and behavior, and, thus, may affect that sidewalk's level of service. Surface features such as grates tend to affect pedestrian movement; indeed, it appears that people avoid them if they have the choice to walk next to them instead of on top of them – particularly people wearing pointy heels. The elements which occupy vertical and horizontal space on the sidewalk are also obstacles to pedestrian movement, reducing the space available for walking. Some street furniture, like mail boxes, telephones, news stands and vendors might affect pedestrians' behavior by making them stop momentarily.

Maps have been created for filmed locations, to store the approximate locations of existing street furniture, building entrances and other significant elements. Figure 4.7. shows the legend of sidewalk elements with the symbols used to represent these elements and the street furniture map for the control location (Broadway between Duane St and Reade St, west sidewalk). For other data collection locations, street furniture placements are recorded on hard copies.

Table 4.7. Obstacle Categories

Street Furniture
Alarm Box
Art Work
Barrier/Fence
Bench
Bike Rack
Bollard
Bus Shelter
Bus Stop
Fire Hydrant
Flag Pole
Information Sign
Mailbox
Metal Plate
News Box
Parking Meter
Sign Pole
Street Light
Telephone
Trash Can
Ventilation Shaft

Public Underground Access
Elevator Box
Subway Entrance/Exit

Landscaping
Planter
Street Tree

Commercial Uses
Advertising Display
News Stand
Sidewalk Café
Vendor

Building Protrusions
Cellar Door
Stairs
Standpipe

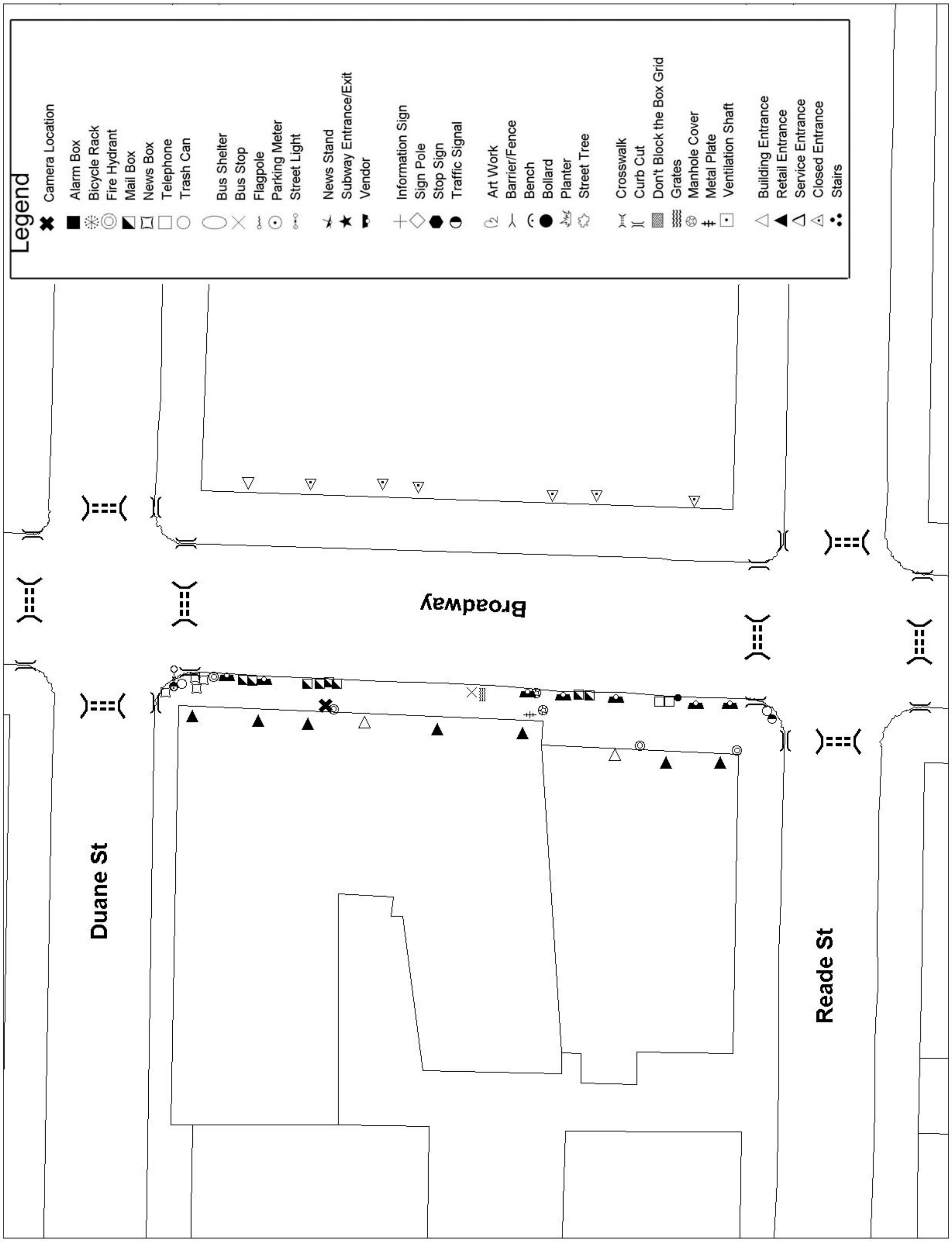


Figure 4.7. Street Furniture Map Sample: Broadway between Duane and Reade Street